17. Cross-Cutting Patient Safety Topics/Practices

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Introduction

Over the last decade, there have been more quality and safety improvement efforts in healthcare than ever before, with programs funded by Federal grants, State agencies, and privately run organizations.[1] Despite these efforts, reliably safe healthcare has remained somewhat elusive as adverse events continue to occur. A more recent trend in healthcare quality improvement has been focused on building high reliability organizations (HROs). HROs are described as organizations that operate in complex environments while maintaining high levels of safety for extended periods of time.[2] HROs also have strong leaders who are committed to safety. Leaders are key to instilling a commitment to safety in all members of the organization to create a positive safety culture, where staff continually scan and monitor their environment to identify and correct even minor deviations that could lead to unsafe conditions. When a deviation in safety processes or practices is observed, staff speak up or take action to contain the problem and/or resolve the issue. In the event that an adverse event or near miss does occur, incidents are reported without fear of blame or punishment. In addition, HROs rely on process improvement tools to systematically solve safety issues, including reliable assessments of the problem's scope (e.g., isolated to a unit or organizationwide), identification of root causes associated with the problem, and application of the most appropriate solutions.

While a great deal can be learned through the study of HROs, it can be difficult to articulate the exact steps to achieve high reliability, as many different paths can be taken.[1] Moreover, what works in one organization does not always work in another, as demonstrated by the many conflicting results found within the healthcare quality and patient safety literature. To increase the reliability of healthcare quality, it is also necessary to understand the context in which improvement practices are applied. Any pre-existing norms, processes, resources, or quality improvement initiatives will influence how new practices are viewed and adopted, and the degree to which they achieve their intended result(s).

A wide range of contextual factors can impact performance. In considering five specific (yet diverse) patient safety practices, Taylor et al. (2011)[3] generated a total of 42 contextual factors that could influence their implementation and effectiveness. To identify the most important contextual factors, a panel of subject-matter experts were surveyed regarding the importance of each of the factors and then engaged in group discussions. Through an iterative process, the original list of 42 contextual features was reduced down to 4 factors that could influence successful implementation.

The current review followed a similar approach to that described by Taylor et al. (2011). Specifically, an initial scan of the literature was conducted related to the specific patient harms included in the current report (e.g., diagnostic errors) to better understand each problem/harm, the contributing factors, and the potential practices to address each. Members from the Technical Expert Panel and the Advisory Group were surveyed and their input was reviewed via conference calls. While the specific patient safety practices related to each harm has been detailed in the previous chapters, several factors were identified as contributing to, or as being root causes of, multiple harms. These factors included: (1) patient and family engagement, (2) safety culture, (3) clinical decision support, (4) cultural competency, (5) monitoring, auditing, and feedback(6) teamwork and team training, and (7) education and training through simulation. These contextual factors were thought to be among the most important ones with

respect to potentially influencing the success of the patient safety practices related to the specific harms discussed in the current report. For example, clinicians must monitor vital signs to accurately identify patient deterioration, but communication (a key aspect of teamwork) between clinicians and rapid-response teams was identified as a contributing factor in failure-to-rescue cases. In addition, the six cross-cutting contextual factors often represent broader organizational initiatives. For instance, efforts to improve teamwork represent a popular patient safety initiative that is expected to directly improve patient outcomes overall, not only those related to failure-to-rescue cases. These seven selected cross-cutting contextual factors are presented in the following sections.

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17.1 Patient and Family Engagement

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Introduction

Traditionally, patient safety management has been the sole responsibility of the healthcare provider, but in recent decades, new approaches to patient safety include actively engaging patients and/or patients' families and caregivers. While there is no standard definition, patient and family engagement (PFE) is commonly defined as "the desire and capability to actively choose to participate in care in a way that is uniquely appropriate to the individual, in cooperation with a healthcare provider or institution, for the purposes of maximizing outcomes or improving care experiences."[1]

17.1.1 Patient and Family Engagement as a Patient Safety Practice

The Agency for Healthcare Research and Quality (AHRQ) identified four overarching threats to primary care patient safety—communication breakdowns, medication issues, diagnosis and treatment issues, and fragmentation—in its *Guide to Improving Patient Safety in Primary Care Settings by Engaging Patients and Families: Environmental Scan Report* (2018).[2] One way to address these threats is by engaging patients and families in a patient's care and, as stated in recent systematic reviews by Park and Giap (2019) and Berger et al. (2014), including the patient in patient safety. This makes sense because patient-centeredness is a vital aspect of healthcare, and patients are uniquely positioned to provide information throughout an entire course of care.[1,3]

Patient and family engagement can be conceptualized in two primary ways: (1) as an overarching principle that is applicable to many patient safety practices and (2) as a specific component of another particular patient safety practice.[3] Some strategies to encourage adoption of patient and family engagement patient safety practices are highlighted in AHRQ's *Guide to Improving Patient Safety in Primary Care Settings by Engaging Patients and Families: Environmental Scan Report* and Web page.[2] They include:

- Patient and family advisory councils, boards, and committees.
- Team-based care.
- Interventions to support medication safety.
- Structured communication for patients, families, and primary care providers.
- Teach-back.
- Warm handoffs.

As patient and family engagement is still an emerging patient safety practice (PSP), there is little if any published research that provides comprehensive insight into its relationship to patient safety. Because such studies are limited, healthcare providers may find it difficult to apply appropriate guidelines and implement effective patient and family interventions in their current practice.

17.1.2 What's New/Different Since the Last Report?

Key Findings:

- Although four of the six studies related to adverse events resulted in statistically significant results, more studies are needed to measure the direct outcomes of patient and family engagement as a PSP.
- The studies included in the systematic reviews revealed a lack of understanding about the effects of PFE on patient safety among healthcare providers, patients, and families.
- PFE implemented through an educational intervention was linked to positive perceptions and attitudes about PFE among healthcare providers.

In Making Health Care Safer II (MHCS II), the authors noted that when compared with other PSPs, patient and family engagement did not lend itself to specific practices, in part because "engagement" is an umbrella term that does not refer to specific PSPs. In MHCS II, the case was made that this PSP involves patients being present for all treatment, providing important information that may not be available from other sources, and being highly motivated to decrease the risk of harm and ensure good outcomes. In MHCS II, only three studies were identified as relevant to patient and family engagement; they focused on medication management and hand washing, and were of low methodological rigor. Since the publication of MHCS II, there are still too few studies that empirically measure changes in patient and family engagement after implementation of practices focused on this topic.[4] Typically, patient and family engagement is not the primary target of overall PSP interventions reviewed; instead, it is treated as a contextual variable and is often not separately reported.[3]

In addition to the AHRQ material on patient and family engagement, the American Institutes for Research (AIR), along with the Gordon and Betty Moore Foundation, published *A Roadmap for Patient and Family Engagement in Healthcare* (2015),[5] which recommended eight strategies for change and improvement in patient and family engagement:

- Patient and family preparation.
- Clinician and leadership preparation.
- Care and system redesign.
- Organizational partnership.
- Measurement and research.
- Transparency and accountability.
- Legislation and regulation.
- Partnership in public policy.

17.1.3 Methods

Two databases (MEDLINE® and CINAHL®) were searched for articles published in English within the past 10 years using terms related to patient and family engagement and safety improvement. The search generated 220 citations. Duplicates were removed, and the remaining abstracts were reviewed for relevance, leading to the review of one full-text article. Since the individual study results yielded few results, we also included systematic reviews published in English within the past 10 years. This chapter is

based on two recent systematic reviews and the one individual study we found. Key findings are located in the box above.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

17.1.4 Review of Evidence

Since individual studies are limited, this chapter provides an overview of the current landscape of patient and family engagement as a PSP using two recent systematic reviews and one identified study.

17.1.4.1 Implementation of Patient and Family Engagement

One systematic review by Berger et al. (2014) evaluated how patient and family engagement is implemented. The authors used MEDLINE®, CINAHL®, Embase®, and Cochrane to find two types of studies: (1) standalone interventions meant to improve patient or family engagement and (2) patient and family engagement interventions implemented as part of an overarching PSP. The review identified six articles with standalone interventions, four of which focused on hand hygiene. All four studies used a pre-post methodology, and one study found that, post-intervention, patients asked their physicians about hand hygiene 40 percent of the time and asked nurses 95 percent of the time. Another study, by Davis et al., found that patients showed an increased willingness to ask healthcare providers about hand hygiene and expressed an increased appreciation of the importance of participating in safety-related behaviors post-intervention. The authors noted that, while appreciation of importance increased, patients' willingness to participate remained lower than their appreciation of importance.[2]

One randomized controlled study cited in the Berger et al. review (Weingart et al.) found no significant differences in adverse drug events (ADEs) or close calls between the control group and the patient and family engagement intervention group, which used a personalized medication list to reduce ADEs and close calls. In another study in the Berger et al. review, the authors cited limited evidence and poor quality of benefits for patient involvement in patient safety.[3]

Berger et al. identified 12 studies in which patient and family engagement was part of a broader PSP intervention. These studies focused on hand hygiene, rapid response systems, surgical checklists, prevention of falls, prevention of ventilator-associated pneumonia, and prevention of medical errors after discharge. Patients and families were encouraged to actively participate in ensuring their own safety, but engagement strategies varied across the studies.[3]

Four of these 12 studies encouraged patients and families to directly address healthcare providers to point out lapses or remind them of safety behaviors. As authors Weissman et al., Taylor et al., and Weingart et al. note, the effectiveness of the approach depended on the patient's willingness and ability to participate in reporting clinical errors to healthcare providers. The study by McGuckin et al. found that, while 80–90 percent of patients expressed willingness to ask their healthcare providers to wash their hands, only 60–70 percent of patients did.[3]

In addition to directly approaching healthcare providers, several studies in the Berger et al. review highlighted patients' engaging in "direct activation" of a patient safety intervention, such as patients and/or families calling a rapid response system.[3] One observational study by Eden et al. (2017)

examined the use of a patient- and family-initiated rapid response system called Condition Help.[5] This system was designed to prevent medical errors and communication problems by encouraging patients and families to call the Condition Help hotline if they believed there was a breakdown in care or if their health was in immediate danger. Outcomes of interest included activation of a traditional rapid response team or transfer to an intensive care unit, inpatient mortality, and discharge against medical advice. Patient and family engagement as an outcome was not measured; rather, it was a component of the overall intervention.[3]

Berger et al. cited one systematic review that summarized the patient factors most associated with patient willingness to encourage healthcare providers to engage in hand hygiene. These factors included an extroverted patient personality, patient belief that they could control the healthcare provider's behaviors, younger age, awareness of healthcare-associated infections, and an invitation by the healthcare provider to discuss hand hygiene.[3]

Overall, Berger et al. found strength of evidence on this topic to be low because of the limited number of studies and the lack of studies that assessed the effectiveness of the interventions, and whether the interventions actually improved patient and family engagement and safety outcomes.[3]

17.1.4.2 Effectiveness of Patient and Family Engagement Implementation

In another recent systematic review, the goal was to provide comprehensive insight into the impact of patient and family engagement interventions on patient safety and related issues. Forty-two studies published from 2009 through 2018 were included in this review. Park and Giap used an adapted patient and family engagement framework to classify the level of engagement found in the studies. The study interventions described in this systematic review are of two types: direct care and organizational. Direct care occurs when healthcare providers partner with the patient and/or family in the processes of shared decision making. An organizational engagement can be in the form of quality and safety improvement initiatives or advisory councils that contain patient and/or families/caregivers as members.[1]

Most of the reviewed studies were conducted in hospitals, including 6 randomized controlled trials, 8 non-randomized controlled trials, 12 qualitative studies, and 11 surveys. Other settings included the community, nursing homes, private clinics, academic medical centers, and primary healthcare centers. Study outcomes of interest included satisfaction; perception and awareness of patient safety and risks; perception, attitude, and concerns; length of stay; depression or anxiety; performance of safety-related behaviors; and clinical deterioration.[1]

Six studies in the Park and Giap review showed positive effects in relation to PFE interventions preventing or reducing adverse events related to healthcare-associated infections, falls, pressure ulcers, and medication errors. In one randomized controlled trial (Chaboyer et al., 2016), patients received educational materials, including DVDs, brochures, and posters, that encouraged them to ask questions of their providers with an aim of reducing the incidence of pressure ulcers.[1] While the intervention led to a large reduction in the potential harm or hazard of pressure ulcers, the results were not considered statistically significant. Another study, by Lawton et al. (2017), used two engagement interventions—a questionnaire and incident reporting tool—to reduce the incidence of adverse events, measured via harm-free care scores. The interventions led to greater but nonsignificant improvement in the harm-free care scores.[1] In a quasi-experimental intervention study by Schwappach et al. (2011), the intervention

group, which received an educational pamphlet about how to prevent medical errors, was less likely to experience any adverse events and unsafe situations (odds ratio=0.57, confidence interval [CI]=0.38–0.87, P=0.009).[1] In another randomized controlled trial, by Van Gaal et al. (2011), the SAFE or SORRY? Programme, also known as essential guidelines for preventing adverse events, was implemented through education, patient involvement, and feedback on process and outcomes indicators. The results showed a statistically significant reduction in the rate of adverse events in the intervention group (rate ratio=0.57, 95% CI=0.34–0.95).[1]

The same six studies also showed that patients and families were satisfied with interventions when they played a role as a partner in the healthcare process, as described in two studies (Pokrywka et al., 2017 and Pokrywka et al., 2014), which encouraged patient and family hand hygiene to reduce the spread of *Clostridium difficile*.[1] In Pokrywka et al. (2017), an educational intervention study focused on providing patients with opportunities to wash their hands saw a significant decrease (p=.05) in *C. difficile* infection 6 months after the intervention. In the other study by Pokrywka et al. (2014), a bundle strategy including patient hand hygiene significantly reduced the rate of *C. difficile* infection.[1] Regarding clinical outcomes such as length of stay, depression, anxiety, clinical deterioration, physical and mental health, and lifestyle changes, however, most studies found no statistically significant differences between study outcomes.

Although nine of the reviewed studies found that patients and families expressed willingness to engage in care processes, several studies (Longtin et al., 2010, Pittet et al., 2011, and McMurray et al., 2011) found that some patients and families were not comfortable with asking their healthcare providers questions about their medical care and preferred passive engagement rather than active engagement.[1]

Five studies implemented interventions with a positive effect on healthcare providers in terms of perception of and attitude toward the role of patient and family engagement in patient safety and the provider relationship with the patient and/or family. This was especially relevant in the studies in which patient feedback was used to develop an educational intervention (Langer et al., 2016, and Schwappach et al., 2011).[1] Only two studies (Lawton et al., 2017, and Jha et al., 2014) showed that healthcare providers' perception and attitude to PFE did not change after a PFE intervention.[1]

Park and Giap found that only 12.5 percent of the reviewed randomized controlled studies and 11.1 percent of non-randomized controlled studies were assessed as high quality, while 69.2 percent of the qualitative studies and 75 percent of the surveys were considered high quality. The authors concluded that obtaining insight into the impact of patient and family engagement on patient safety is difficult; less than half of the reviewed articles evaluated a patient and family engagement intervention, and less than a quarter of the studies measured direct outcomes related to patient safety events. Overall, the authors found that patients and families, along with healthcare providers, do not have a strong understanding of the effects of patient and family engagement on patient safety.[1] Therefore, strategies are needed to help foster a better understanding of potential benefits of patient and family engagement as it relates to patient safety among patients and families as well as providers.

17.1.4.3 Barriers

Both systematic reviews found barriers related to the patient-provider relationship. Although many patients were willing to participate in an intervention, some expressed fear that this might affect the care they receive from their providers. Lack of patient awareness about the severity of potential harms

also affected patients' willingness to participate in interventions aimed at improving patient and family engagement. The effectiveness of interventions was also limited if they did not receive sufficient support from hospital administration, physicians, and staff.

17.1.4.4 Facilitators

When patients received encouragement to participate in their healthcare at the direct invitation of a provider, they were more likely to participate in patient and family engagement practices. Healthcare providers were more likely to engage patients when hospital leadership strongly endorsed patient and family engagement interventions.

17.1.5 Resources To Assist Implementation

AHRQ developed *The Guide to Improving Patient Safety in Primary Care Settings by Engaging Patients and Families* (2018) to support collaboration among primary care practices, patients, and their families to improve patient safety: https://www.ahrq.gov/patient-safety/reports/engage.html.

AIR developed a unified vision, or roadmap, for improving patient and family engagement across the healthcare system. The roadmap is based on information from a diverse group of stakeholders, including patients, advocates, clinicians, researchers, payers, funders, and policymakers—*A Roadmap for Patient and Family Engagement in Healthcare Practice and Research*: https://www.air.org/project/roadmap-guides-patient-and-family-engagement-healthcare.

17.1.6 Gaps

The overall evidence for improving patient safety through patient and family engagement is suggestive and mostly case-based. The AHRQ environmental scan, *Guide to Improving Patient Safety in Primary Care Settings by Engaging Patients and Families* (2018), noted that few interventions are reviewed in the literature. The environmental scan found 33 peer-reviewed articles and 60 grey literature sources that described an evaluated intervention. Berger et al. (2014) found few individual studies that assessed the effectiveness of interventions, particularly whether or not an intervention actually improved patient and family engagement and safety outcomes.[2]

The review by Park and Giap revealed gaps between the healthcare provider and the healthcare system. as exemplified by healthcare providers who expressed a favorable view of patient and family engagement but a lack of knowledge about how to implement such practices. This may be due to inadequate training or limited knowledge and culture of healthcare systems that support the patient and family engagement strategy. Park and Giap also noted that more observational studies are needed to assess the effectiveness of patient and family engagement and any links to improvements in patient safety outcomes.[1]

17.1.7 Conclusion

Patient safety in primary care continues to evolve, and so do the practices used to engage patients and families in their care. Strategies are needed to help patients and families understand the role of PFE in their safety. Healthcare providers also need to understand the importance of engaging patients in their care. In order to accomplish this, Berger et al. and Park and Giap recommend that stakeholders become more involved in the process to address the following: (1) building consensus on the definition and guidelines for implementing patient and family engagement, whether it is through an independent intervention or as part of another intervention within an existing PSP; (2) widening the research scope

for patient and family engagement and patient safety; and (3) addressing priority areas for implementing patient and family engagement.[1, 2]

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17.2 Safety Culture

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17.2.1 Practice Description

As evidenced in the current review, many patient safety practices are available to reduce harms. However, these practices sometimes fail to achieve their intended results. Even when implemented properly, contextual factors and organizational characteristics can reduce their effectiveness. For example, the patient safety culture can affect the degree to which patient safety practices are adhered to, or not. Patient safety culture, which is part of the overall culture, has been described as "the beliefs, values, and norms that are shared by healthcare practitioners and other staff throughout the organization that influence their actions and behaviors."[1] Patient safety culture helps inform staff about the behaviors that are acceptable, are worthy of praise, or are punishable (formally and/or informally) by the organization. A positive patient safety culture can be characterized as one where:

Key Findings:

- Strategies for improving patient safety culture have been tested.
- Studies of patient safety culture strategies have demonstrated some improvements in perceptions of safety culture using validated measures.
- Studies of safety culture interventions are generally of low to moderate quality and rely on self-report measures.
- More robust studies are needed that demonstrate the usefulness of these practices on perceptions of safety culture, as well as on clinical outcomes and patient harms.

- Safety has been articulated as an organizational priority.
- Staff work as a team to accomplish their tasks and reduce error.
- There is open communication and transparency in discussing near-misses and adverse events.
- There is an emphasis on learning from mistakes.

Leaders in healthcare quality improvement, such as The Joint Commission, the National Quality Forum, and the Agency for Healthcare Research and Quality (AHRQ), have recognized the importance of safety culture and encouraged its measurement. Several safety culture survey instruments have been developed, and research has established their psychometric properties. For instance, AHRQ sponsored the development of Surveys on Patient Safety Culture™ (SOPS™) in multiple healthcare settings, such as hospital, medical office, nursing home, community pharmacy, and ambulatory surgery center. As part of this program, survey instruments and support materials are available, as are voluntary databases to which users of the Hospital, Nursing Home, Community Pharmacy, Medical Office, and Ambulatory Surgery Center SOPS™ can voluntarily submit data from patient safety culture surveys. (Please refer to Section 17.2.5, Resources, for more information on SOPS™.) These, as well as other safety culture surveys (e.g., Safety Attitudes Questionnaire)[2] reliably measure multiple dimensions of safety culture, including teamwork, safety climate, communication, and error reporting.

Using such measures, studies have demonstrated a relationship between safety culture and a variety of patient outcomes. For instance, evidence suggests that perceptions of safety culture are related to readmission rates of cardiac patients,[3] length of stay for intensive care unit patients,[3] postoperative complication rates,[4] medication errors,[5,6] patients' perceptions of care,[7] and safety incidents.[8,9] Further,

a positive safety culture may be a prerequisite for attaining safety goals, such that organizations with a favorable safety culture in place may be more likely to adopt new safety practices and have a better chance that those practices will take hold.[10,11] As such, there is increasing interest in identifying the practices that lead to improved safety culture and evaluating their effectiveness.

17.2.2 Methods

The question of interest for this review is, "What are the most effective methods to improve safety culture?"

To answer this question, two databases (i.e., CINAHL® and MEDLINE®) were searched to identify studies published between 2008 and 2018 that implemented practices to improve safety culture. Search terms included "patient safety culture," "organizational culture," and related synonyms, as well as terms such as "performance improvement." More specific terms such as "Leadership WalkRounds," "comprehensive unit-based safety program," and "team training" were also searched, since these practices were identified in the previous Making Healthcare Safer project and in initial scans of the safety culture literature. The initial search yielded 1,052 results. After duplicates were removed, 916 were screened for inclusion and 77 full-text articles were retrieved. Of those, 21 were selected for inclusion in this review; 19 of them are single studies and 2 are systematic reviews: 1 of safety culture[12] and 1 on teamwork, communication, and safety climate.[13] Articles were excluded if the article was out of scope (including not quantitative), the study design was insufficiently described, the study did not evaluate a practice/method to enhance safety culture, the primary goal was not on improving safety culture, the study did not report statistical analyses, or the study was conducted outside of the United States. Key findings are located in the box above.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

17.2.3 Review of Evidence

The practices used to improve safety culture fell into four main categories: Leadership WalkRounds, Team Training, Comprehensive Unit-based Safety Program (CUSP), and those that implemented multiple methods. Across these categories, the majority of the studies took place in a hospital setting (18 out of 19) and one study was conducted in a subacute rehabilitation unit of a long-term care facility. Safety culture was most frequently measured using AHRQ's 2004 Hospital Survey on Patient Safety Culture (HSOPS)[a] or Sexton et al.'s (2006) Safety Attitudes Questionnaire (SAQ),[2] which was cited as the most frequently used measure in Sacks et al.'s 2015 review.[13] (Refer to Table 1, where each column lists the safety culture measures used in the reviewed studies, their associated dimensions, and brief descriptions of each. Please note that this table is not meant to compare the dimensions of each scale against one another, nor is it an exhaustive list of the safety culture measures available. Additional

[a]In October 2019, AHRQ published HSOPS 2.0. Please refer to the Resources section for the link to both versions of this survey. [c]The Joint Commission: Advancing Effective Communication, Cultural Competence, and Patient- and Family-Centered Care: A Roadmap for Hospitals—https://www.jointcommission.org/assets/1/6/ARoadmapforHospitalsfinalversion727.pdf.

measures have been included in the Resources section.) Moderate changes in safety culture, along with some mixed results, were reported following the implementation of safety culture practices.

Table 1: Safety Culture Survey Instruments—Dimensions and Descriptions

Hospital Survey on Patient Safety Culture (HSOPS)	Nursing Home Survey on Patient Safety Culture	Safety Attitudes Questionnaire (SAQ)	Teamwork and Safety Climate Questionnaire (TSCQ)	Safety, Communication, Operational Reliability, and Engagement (SCORE)
Communication Openness: Staff freely speak up if they see something that may negatively affect a patient and feel free to question those with more authority. **Feedback and Communication About Error:** Staff are informed about errors that happen, are given feedback about changes implemented, and discuss ways to prevent errors. **Frequency of Events Reported:** Mistakes of the following types are reported: (1) mistakes caught and corrected before affecting the patient, (2) mistakes with no potential to harm the patient, and (3) mistakes that could harm the patient but do not. **Handoffs and Transitions:** Important patient care information is transferred across hospital units and during shift changes. **Management Support for Patient Safety:** Hospital management provides a work climate that promotes patient safety and shows that patient safety is a top priority. **Non-Punitive Response to Error:** Staff feel that their mistakes and event reports are not held against them and that	**Communication Openness:** Staff speak up about problems, and their ideas and suggestions are valued. **Compliance With Procedures:** Staff follow standard procedures to care for residents and do not use shortcuts to get their work done faster. **Feedback and Communication About Incidents:** Staff discuss ways to keep residents safe, tell someone if they see something that might harm a resident, and talk about ways to keep incidents from happening again. **Handoffs:** Staff are told what they need to know before taking care of a resident or when a resident's care plan changes, and they have all the information they need when residents are transferred from the hospital. **Management Support for Resident Safety:** Nursing home management provides a work climate that promotes resident safety and shows that resident safety is a top priority. **Non-Punitive Response to Mistakes:** Staff are not blamed when a resident is harmed, are treated fairly when they make mistakes, and feel safe reporting their mistakes.	**Teamwork Climate:** Perceived quality of collaboration between personnel. **Job Satisfaction:** Positivity about the work experience. **Safety Climate:** Perceptions of strong and proactive organizational commitment to safety. **Working Conditions:** Perceived quality of the work environment and logistical support (staffing, equipment, etc.). **Stress Recognition:** Acknowledgement of how performance is influenced by stressors.	**Teamwork:** Perceived quality of collaboration between personnel. **Safety Climate:** Perceptions of strong and proactive organizational commitment to safety. **Perceptions of Management:** Approval of managerial action.	**Teamwork Climate:** Extent to which norms of local interaction are effective, such as speaking up, resolving conflicts, and asking questions to clarify ambiguities. **Safety Climate**: Extent to which local patient safety norms are proactive and positive, such as discussing, handling, and learning from errors. **Improvement Readiness**: Extent to which quality improvement is supported within a work setting through continuous learning through both strengths and deficits in quality. **Local Leadership:** Extent to which leaders communicate with and are available to healthcare workers. **Personal Burnout:** Extent to which a respondent personally experiences unhealthy or negative emotions related to his/her work, such as frustration. **Burnout culture:** Extent to which a group or multiple groups experience unhealthy or negative emotions related to their work, such as frustration.

Hospital Survey on Patient Safety Culture (HSOPS)	Nursing Home Survey on Patient Safety Culture	Safety Attitudes Questionnaire (SAQ)	Teamwork and Safety Climate Questionnaire (TSCQ)	Safety, Communication, Operational Reliability, and Engagement (SCORE)
mistakes are not kept in their personnel file. **Organizational Learning—Continuous Improvement:** Mistakes have led to positive changes, and changes are evaluated for effectiveness. **Overall Perceptions of Patient Safety:** Procedures and systems are good at preventing errors, and there is a lack of patient safety problems. **Staffing:** There are enough staff to handle the workload and work hours are appropriate to provide the best care for patients. **Supervisor/Manager Expectations and Action Promoting Patient Safety:** Supervisors/managers consider staff suggestions for improving patient safety, praise staff for following patient safety procedures, and do not overlook patient safety problems. **Teamwork Across Units:** Hospital units cooperate and coordinate with one another to provide the best care for patients. **Teamwork Within Units:** Staff support each other, treat each other with respect, and work together as a team.	**Organizational Learning:** There is a learning culture that facilitates making changes to improve resident safety and evaluates changes for effectiveness. **Overall Perceptions of Resident Safety:** Residents are well cared for and safe. **Staffing:** There are enough staff to handle the workload, meet residents' needs during shift changes, and keep residents safe, because there is not much staff turnover. **Supervisor Expectations and Actions Promoting Resident Safety:** Supervisors listen to staff ideas and suggestions about resident safety, praise staff who follow the right procedures, and pay attention to safety problems. **Teamwork:** Staff treat one another with respect, support one another, and feel that they are part of a team. **Training and Skills:** Staff get the training they need, have enough training on how to handle difficult residents, and understand the training they get in the nursing home.			

17.2.3.1 Practice: Leadership WalkRounds

Leadership WalkRounds is a tool that executives and leaders can use to: increase awareness of safety; demonstrate their commitment to (and the importance of) safety; reinforce safety behaviors and concepts such as speaking up and non-punitive reporting; and gather and help solve patient safety–related issues. As the term implies, this tool involves leaders "walking around" to engage in face to face, candid discussions with frontline staff about patient safety incidents or near-misses. Leadership WalkRounds vary in the way they are implemented, including the composition of the WalkRound team, the frequency with which WalkRounds are used, the degree of structure that each WalkRound follows (e.g., whether a standard set of questions is used), and the degree to which the WalkRound team communicates the issues raised and the potential solutions identified to the rest of the staff.

The systematic review conducted by Weaver et al. (2010), as well as four individual studies, examined the use of Leadership WalkRounds for enhancing patient safety culture. All four individual studies were conducted in a hospital setting, with three implementing WalkRounds in multiple units and one study focusing specifically on the neonatal intensive care unit (NICU).[14]

17.2.3.1.1 Process Measures

Eight studies reviewed by Weaver et al. (2010) reported that perceptions of safety culture improved (to varying degrees) following the use of WalkRounds, and three reported perceived improvements in care processes. All four studies of Leadership WalkRounds in the review collected process measures. Three studies evaluated the impact of Leadership WalkRounds by administering the SAQ or specific subscales of the SAQ. One study used the Safety, Communication, Operational Reliability, and Engagement (SCORE) survey (Table 1). All studies reported some improvement (and in some cases, significant improvement) on individual items, or on one or more dimensions of safety culture (e.g., teamwork climate, error reporting).[14]

Frankel et al. (2008) examined the impact of a weekly WalkRound project on the safety climate dimension of the SAQ. The project, conducted in two hospitals, yielded some positive improvements approximately 18 months following implementation. One hospital increased its "overall safety climate" score from 62 percent to 77 percent (p=0.03), while the other hospital had an increase from 46 percent to 56 percent (p=0.06).[15]

Another study found that greater exposure (i.e., where a minimum of 60% of the unit had been exposed to 1 WalkRound) was related to significantly higher SAQ dimension scores of "safety climate."[16] "Safety climate" scores were 73.5 percent for the high-exposure group, 64.1 percent for the moderate-exposure group, and 61.2 percent for the low-exposure group. Between-group comparisons indicated significant differences between high- and moderate-exposure groups (p=0.000) and between moderate- and low-exposure groups (p=0.149). Greater exposure to WalkRounds was also associated with significantly greater likelihood of reporting a reduction in patient safety risks (54.9% reduction for high-exposure group, 30.9% for moderate, and 13.3% for low; p=0.000 for all between-group comparisons) and significantly greater odds of reporting that they had more feedback about actions taken as a result of the Leadership WalkRounds (52.5% for high-exposure group, 27.4% for moderate, and 11.3% for low; p=0.000 for all between-group comparisons).[16]

Two additional studies conducted by Sexton and colleagues focused on the provision of feedback following the WalkRound process. Sexton et al. (2014) reported that NICU respondents in the high

WalkRound feedback quartile had significantly higher “safety climate” ($p<0.001$) and “teamwork climate” ($p=0.01$) scores on the SAQ than the low-feedback quartile. Respondents in the high WalkRound feedback quartile also reported less burnout than those in the low feedback quartile, although this difference was not statistically significant ($p=0.07$).[17]

Similarly, Sexton et al. (2018) found that staff who received more feedback (i.e., were told what problems were discussed during the WalkRounds and what actions were taken to address them) had more positive perceptions of all safety culture dimensions (improvement readiness, local leadership, teamwork climate, safety climate; $p<0.001$), higher engagement scores on four of six subscales (advancement, growth opportunities, job uncertainty, participation in decision making; $p<0.001$), and lower reports of burnout (personal burnout, burnout climate, $p<0.001$).[18]

17.2.3.1.2 Outcome Measures

In their systematic review, Weaver et al. (2013) reported on one study that examined WalkRounds and found an improvement in a patient outcome. Specifically, the frequency of serious adverse events significantly decreased after WalkRounds were introduced. None of the four studies in the review of Leadership WalkRounds collected patient outcome measures.[12] However, a more proximal outcome is the effectiveness of Leadership WalkRounds in resolving and/or correcting issues. Saladino et al. (2013) conducted structured, monthly WalkRounds within a critical care unit as part of a CUSP intervention. The WalkRounds focused on a set of three questions: consider which processes within the unit are cumbersome; discuss the delays that were experienced in care delivery; and identify any communication issues that occurred between team members. Using this approach, 77 safety issues were identified during the study period, with 44 (57.1%) being resolved and communicated back to the staff.[19]

Building on the work of Sexton et al. (2014, 2018),[17,18] data could also be gathered regarding how well the issues uncovered and resolved are communicated back to the staff (e.g., what percentage of staff are aware of safety issues discussed during WalkRounds and specific solutions). Finally, in terms of patient-oriented outcomes, data related to delays in care, length of stay, and re-admission rates could be examined within the unit or across units participating in Leadership WalkRounds. However, selection of the most appropriate outcome(s) to be measured should be informed by the specific problems and issues identified in each department/unit through the WalkRounds process.

17.2.3.2 Practice: Team Training

Team training is another strategy that has been used to build a culture of safety. Team training programs focus on enhancing teamwork skills and communication between healthcare providers in order to foster a more positive work environment and safety culture. Most often, these programs include the delivery of a training workshop followed by the selection of specific tools that will be implemented to increase teamwork on the job.

In their systematic review, Sacks et al. (2015) reported that the majority of the included studies employed some form of team training or team building (23 out of 47, 49.9%) in their safety culture efforts. However, it should be noted that the inclusion criteria in their study differed from the criteria employed in the current review. They also included studies in which safety culture was measured but was not the primary focus, while in this review it is. Eight studies in the current review examined the use of team training for enhancing patient safety culture. Studies were conducted in a variety of settings including five hospitals, two Department of Veterans Affairs (VA) medical facilities, and one subacute

rehabilitation unit in a long-term care facility.[13] A total of 20 studies in Weaver et al.'s (2013) systematic review studied team training to improve safety culture.[12]

17.2.3.2.1 Process Measures

Weaver et al. (2013) included 20 studies that implemented team training or tools to enhance teamwork in an effort to improve safety culture. The majority (16 out of 20, 80%) reported significant improvement in staff perceptions of safety culture, and five reported improved care processes. All of the individual studies included in the review collected data on perceptions of safety culture. Four studies evaluated the effectiveness of their team training effort by administering the HSOPS, three used the SAQ, two used the Teamwork and Safety Climate Questionnaire (TSCQ), and one used the Nursing Home Survey on Patient Safety Culture (Table 1). All studies found some pre to post improvement on individual items, or on one or more dimensions of safety culture (e.g., teamwork climate, error reporting) after implementing their team training program.[12]

Three studies incorporated Crew Resource Management (CRM) training into their safety culture efforts, all of which specifically examined differences in safety culture perceptions by role types. For instance, Budin et al. (2014) examined the differential impact of CRM training on nurses and physicians working in a labor and delivery unit. Perceptions of "teamwork climate" and "safety climate" subscales of the SAQ significantly improved for all respondents following the training, with physicians having more positive perceptions than nurses on both the baseline and follow-up assessments (physician teamwork climate scores: T1=66.49 vs. T2=85.44, p=0.000; physician safety climate scores: T1=60.48 vs. T2=77.70, p=0.000; nurse teamwork climate scores: T1=55.60 vs. T2=102.86, p=0.000; nurse safety climate scores: T1=56.64 vs. T2=76.68, p=0.000).[20]

Similarly, Hefner et al. (2017) reported a statistically significant increase on 10 of 12 HSOPS dimensions across all respondents and eight departments within a medical center ($p<0.05$), with no changes observed for 2 dimensions, "supervisor promotes patient safety" and "staffing," which were not the emphasis of the training program. As noted in this study, practitioners (which included physicians and advanced-practice registered nurses) responded more favorably than other staff on all 12 HSOPS dimensions both prior to and after the CRM training.[21]

In contrast, only minor improvements on the SAQ following CRM training were documented in a study conducted by Gore et al. (2010). The most notable improvement in this study was observed for nurses' perceptions of "teamwork climate," with statistically significant improvements related to 3 of 4 items on this subscale, 3 of 11 items on the "safety climate" subscale, and only 1 of 13 items on the "error reporting" subscale. However, no significant improvements were reported for faculty physicians, and significant improvement was found on only one item (related to error reporting) for resident physicians.[22]

Two studies in the review researched team training programs within the VA. The first, conducted by Carney et al. (2011), studied the use of the Medical Team Training program applied in operating rooms of high- and medium-complexity VA facilities. They found that respondents had improved perceptions of all seven SAQ safety climate domain items measured following training.[23]

In the second study, Schwartz et al. (2018 examined the VA's Clinical Team Training program and measured changes in safety culture perceptions over time. At an 8-month follow-up, statistically significant improvement was found on 8 of 27 items (29.6%) on the TSCQ ($p<0.05$). Five of these items

related to teamwork and three items related to safety climate. A total of 11 of the 27 items (40.7%) showed statistically significant improvement at the 12-month follow-up (6 items related to teamwork, 4 items related to safety climate, and 1 item related to perceptions of management, $p<0.05$).[24]

One study included in the review evaluated AHRQ's Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS®) program. Using a static group for comparison, Jones et al. (2013) reported that the TeamSTEPPS® training was associated with more positive perceptions of three HSOPS dimensions: "organizational learning" (76% vs. 71% for static group), "teamwork between departments" (82% vs. 80% for static group), and "teamwork across hospital departments" (67% vs. 62% for static group). Moreover, they examined differences across adopter categories (early, early/late majority, and laggard) and concluded that early adopters had significantly more positive scores than early/late majority adopters, followed by "laggard" hospitals, on three of the HSOPS dimensions: "frequency of events reported" (71% vs. 65% vs. 56%), "staffing" (76% vs. 70% vs. 64%), and "hospital management support for patient safety" (89% vs. 83% vs. 75%).[25] The Sacks et al. (2015) review reported one study, in which TeamSTEPPS® training was associated with a significant increase on the "communication" dimension of the HSOPS.[13]

Lastly, two additional studies tested the effectiveness of their own team training effort. Using a unit-based, multidisciplinary team training program, Blegen et al. (2010) found statistically significant improvements in two hospitals on 10 out of 11 HSOPS survey dimensions (tests of mean scores, $p<0.05$). No significant change was observed on the "frequency of error reporting" dimension. Interestingly, in contrast to other studies of safety culture, nurses in this sample consistently provided *more* favorable responses on the post-training safety culture items than did the physicians and pharmacists.[26]

Finally, a study conducted by Berkowitz et al. (2012) evaluated biweekly patient safety conferences for frontline staff over the course of a year in a nursing home facility. In these conferences, cases involving a near-miss or adverse event were discussed within 2 weeks of their occurrence and the team identified solutions for avoiding similar situations in the future. Overall mean scores of patient safety culture significantly increased over time (mean=3.3 at baseline, mean=3.5 at 6 months, mean=3.9 at 1 year, $p<0.005$). An examination of dimension scores confirmed that positive improvements were made in all areas.[27]

17.2.3.2.2 Outcome Measures

Five team training studies included in Weaver et al.'s (2013) systematic review reported improvement in patient outcomes such as reduced errors resulting in harm and decreased safety events.[12] None of the individual studies reviewed on team training interventions used to improve safety culture measured outcomes. Future research should examine the degree to which such interventions enhance perceptions of safety culture while also improving patient outcomes, such as the frequency of mistakes caught and corrected, frequency of undetected errors, length of procedures, or rates of readmission.

17.2.3.3 Practice: Comprehensive Unit-Based Program

A final practice used in safety culture improvement efforts to address unit-related issues is CUSP. While there is flexibility in tailoring the CUSP method, the original work of Pronovost and colleagues[28] included eight steps: (1) A baseline assessment of safety culture, (2) educating staff on the "science of safety," (3) identifying safety concerns within the unit, (4) identifying a champion for the unit, (5) implementing improvements, (6) sharing stories, (7) documenting results, and (8) reassessing the unit's safety culture.

The systematic review conducted by Weaver et al. (2013) included eight studies that examined the impact of CUSP on safety culture. In addition, six individual studies were identified that used CUSP in their safety culture efforts, and all were conducted in a hospital setting.[12]

17.2.3.3.1 Process and Outcome Measures

Six of the eight CUSP studies reviewed by Weaver et al. (2013) reported significant improvements in safety culture perceptions. Two of the eight studies reported improved care processes (care during second stage of labor, timely resolution of safety concerns), and two reported improvements in patient outcomes (reduced length of stay, reduction in infection rates). All six individual studies in the review collected process measures to evaluate the effect of CUSP on safety culture. Five measured the impact on safety culture by administering the SAQ, and one study collected data via the HSOPS (Table 1). Additionally, data on care processes were collected in one study, and three studies collected outcome data in the form of infection rates. [12]

CUSP can be implemented within a unit/department, as well as on a larger scale. A study conducted by Hsu and Marsteller (2016) evaluated the changes in safety culture perceptions for intensive care units (ICUs) adopting CUSP against a non-CUSP comparison group. ICUs in the CUSP group significantly improved their SAQ scores on four dimensions ("teamwork climate" T1=45.2, T2=52.5; "safety climate" T1 41.7, T2=52.5; "job satisfaction" T1=52.8, T2=60.2; "working conditions" T1=29.7, T2=37.4; all $p<0.05$) from the baseline to the follow-up administration of the SAQ, whereas no significant difference was found in SAQ scores in the non-CUSP ICUs. While this study also collected data on central line-associated blood stream infection (CLASBI) rates, no significant between-group differences were found.[29]

However, another study in a critical care unit with a Magnet-designated community hospital found somewhat different results. Examination of pre- to post-implementation SAQ data indicated safety culture perceptions did not significantly change following the CUSP implementation. In fact, the only improvement was the "stress recognition" dimension (T1=61.50, T2=65.60). Scores on the other six dimensions decreased on the post-intervention assessment. The authors speculated that the 6-month period between the pre and post SAQ measurement was not sufficient to measure "real" or meaningful change.[19]

A study in an obstetrics unit found increased scores on several SAQ dimensions following the introduction of CUSP. The most pronounced improvements were related to "job satisfaction" (65% vs. 75%), "working conditions" (48% vs. 69%), and "perceptions of hospital management" (36% vs. 54%). No changes were observed for the "teamwork climate" or "safety climate" dimensions. This study did, however, demonstrate significant improvements on all six care processes ($p<0.05$).[30]

A slightly different approach was taken by Vigorito et al. (2011), in which the CUSP program encouraged units to develop an action plan based on their SAQ baseline measurement. Those that submitted a SAQ action plan bettered their scores on all SAQ dimensions except for "working conditions" by 4.5 percent to 25.9 percent. In comparison, the scores for units without a SAQ action increased by 3.4 percent and declined by as much as -6.6 percent across dimensions. Units with a SAQ action plan also decreased their CLASBI rates by 10.2% (compared with 2.2% for units without a SAQ action plan, $p=0.59$) and ventilator-associated pneumonia rates by 15.2%, as compared with 4.8% for units without a SAQ action plan ($p=0.39$).[31]

In a broader implementation, Paine et al. (2010) applied CUSP throughout the Johns Hopkins Hospital and measured changes in attitudes toward safety over a 2-year period. They reported significant improvement on all dimensions of the SAQ except for "stress recognition." Mean score increases on the safety culture dimensions ranged from 5.60 for "job satisfaction" ($p=0.000$) to 8.36 for the "safety climate" ($p=0.000$).[32]

Lastly, a recent study found positive results in a statewide implementation of CUSP throughout hospitals in Hawaii. First, pre- to post-intervention scores on 10 of the 12 HSOPS dimensions increased significantly, ranging from 4 percent on "handoff/transitions" ($p<0.05$) to 11 percent on "organizational learning and continuous improvement" ($p<0.001$). Moreover, they found that surgical site infection rates decreased from 12.08 percent to 4.63 percent ($p<0.01$).[33]

17.2.3.4 Multiple Practices

One study in the review implemented multiple practices to improve safety culture in two pediatric hospitals. After receiving baseline HSOPS results (Table 1), a series of interventions were chosen to address the low scores on "non-punitive response to error" and "handoffs and transitions." The interventions included: safety rounds, an enhanced self-reporting system, situation background assessment recommendation (SBAR), transfer or care check sheets, and a staged implementation of an electronic medical record system. Post-intervention scores significantly increased on 6 of the 12 HSOPS dimensions, including "non-punitive error," which had been a focus. However, perceptions of "teamwork across hospital units" decreased (3.28 to 3.23 percent) and perceptions of "handoffs and transitions" decreased significantly (3.29 to 3.09 percent, $p<0.001$) over the course of the study, which was discouraging. Further analyses revealed that perceptions of both these HSOPS dimensions decreased slightly at the academic hospital, while scores at the participating community hospital remained stable for "handoffs and transitions" and slightly improved on "teamwork across units." Follow-up discussion pointed to some unintended consequences of the new electronic medical record system, which seemed to impede handoffs.[34]

17.2.4 Conclusion and Comment

17.2.4.1 Implementation

A great deal of variation was found in the studies aimed at improving safety culture. Some studies targeted a smaller group and were applied at a department or unit level (e.g., operating room, NICU, ICU), while others sought to introduce a practice throughout the organization. Generally, the studies compared baseline and post-intervention measures of safety culture. Evaluation periods ranged from 6 months to 2 years across studies and practices, with the majority allowing a year for the intervention to take effect. Consistent with quality improvement efforts, leadership support and project champions were often cited as critical to achieving results. Reluctance to participate was frequently noted as a barrier and also contributed to the fluctuations in response rates observed across studies. Finally, implementing any of the practices reviewed here is an ongoing process. If efforts lose momentum or importance priorities shift, improvements in safety culture may begin regressing toward the mean.

17.2.4.2 Gaps and Future Directions

Although the most frequently used measures of safety culture (i.e., SAQ, HSOPS) incorporate a 5-point Likert-type scale, there is a disparity in how these data are reported across studies. For instance, some studies reported mean scores, while others reported the percentage of favorable responses

(i.e., percentage of respondents who “agree” or “strongly agree”). Some studies reported dimension scores, as well as item-level scores, while others included bar graphs with no specific data points labeled. There were also studies that failed to report the results of their statistical analyses and only indicated which scores were significant. These inconsistencies make it more difficult to judge results obtained from single studies, interpret trends across studies, and identify where further effort is needed.

The changes in safety culture dimension scores reported varied from study to study. For instance, Carney et al. (2011) reported significant increases on all SAQ dimensions following CRM training,[23] whereas Gore et al.’s (2010) study of CRM failed to produce significant changes in dimension scores.[22] Rather, statistical improvements were found only at the item level and only for nurses. These mixed results are consistent with those reported in the Sacks et al. (2015) review, in which 30 out of the 47 studies (63.8%) reported improvements on one dimension of safety culture, but no improvements on any other dimensions measured. Sacks et al. also noted that significant improvements occurred in some groups of providers, but not in others.[13] Future research is needed to identify why these disparities exist. Perhaps organizations need to tailor these broader, more widely implemented interventions such as CRM more to their own specific environment. Or perhaps they are measuring too much and should focus only on elements that the intervention “should” improve versus “might” improve. Furthermore, since post-intervention data were collected 6 months to 2 years following safety culture interventions, it is difficult to draw firm conclusions about whether it is the intervention that is resulting in changes in safety climate or whether other factors (e.g., personnel changes, other quality improvement efforts) are having an impact as well.

Small sample sizes, lack of study details, reliance on correlational data comparisons, and lack of outcome measures also affect the quality of studies in this area, with more robust studies clearly needed. While all of the studies included in the review collected process measures, additional outcome data are needed to determine the degree to which safety culture practices add any value above and beyond more specific clinical practices. The CUSP was the only practice for which clinical outcome measures were reported.

17.2.5 Resources

AHRQ’s Surveys on Patient Safety Culture:
https://www.ahrq.gov/sops/index.html

AHRQ’s Hospital Survey on Patient Safety (version 1.0 from 2004 and 2.0 from 2019):
https://www.ahrq.gov/sops/surveys/hospital/index.html

AHRQ’s Medical Office Survey on Patient Safety:
https://www.ahrq.gov/sops/surveys/medical-office/index.html

AHRQ’s Nursing Home Survey on Patient Safety:
https://www.ahrq.gov/sops/surveys/nursing-home/index.html

AHRQ’s Community Pharmacy Survey on Patient Safety:
https://www.ahrq.gov/sops/surveys/pharmacy/index.html

AHRQ’s Ambulatory Surgery Center Survey on Patient Safety:

https://www.ahrq.gov/sops/surveys/asc/index.html

CUSP Tools and Resources from Johns Hopkins Medicine Center for Innovation in Quality Patient Care: https://www.hopkinsmedicine.org/armstrong_institute/training_services/workshops/cusp_implementation_training/cusp_guidance.html

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17.3 Clinical Decision Support

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This review provides a summary of evidence published from 2008 to 2018 on clinical decision support (CDS) as a cross-cutting factor in efforts to improve patient safety. First, we provide a brief practice description. The review then explores evidence for employing CDS to improve patient safety. Key findings are highlighted in the text box at right.

Key Findings:

- CDS is widely believed to have the potential to positively impact patient safety; this belief has face validity.
- The most consistent impact of CDS in the literature reviewed was on improving medication safety.
- While some results are promising, more evidence is needed to clearly establish the significant role CDS could play in increasing patient safety.

17.3.1 Practice Description

HealthIT.gov, the website for the Office of the National Coordinator for Health Information Technology (ONC), describes CDS as follows:

> CDS provides clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and healthcare. CDS encompasses a variety of tools to enhance decision-making in the clinical workflow. These tools include computerized alerts and reminders to care providers and patients; clinical guidelines; condition-specific order sets; focused patient data reports and summaries; documentation templates; diagnostic support, and contextually relevant reference information.[1]

ONC also asserts that CDS "promotes patient safety," contributing to "increased quality of care and enhanced health outcomes" and "avoidance of errors and adverse events."[1]

To achieve these patient-safety goals across clinical conditions and healthcare settings, it is essential that CDS be well designed and successfully implemented. Osheroff et al.'s "Five Rights" are near-universally cited as a necessary framework for any CDS tools to succeed: getting the *right information* to the *right people* in the *right intervention formats* through the *right channels* at the *right times* in workflows.[2]

In its 2016 Final Report, *Identification and Prioritization of Health IT Patient Safety Measures*, the National Quality Forum (NQF) points to the potentially significant and positive patient-safety impacts of CDS:

> CDS can help guide clinicians in diagnosis and decision making by providing access to information at the point of care, including evidence-based best practices, guidance for treatment or preventive care (e.g., immunizations and routine screening visits), and information on potential allergies and medication interactions.[3]

Experts consulting with NQF prioritized key health information technology (HIT) patient safety measurement areas, and CDS was selected as the highest priority, as "one of the most promising functionalities of HIT."[3]

17.3.1.1 Methods

The question of interest for this review is, "What evidence exists regarding the employment of CDS to improve patient safety?"

To answer this question we searched the CINAHL® and MEDLINE® databases from 2008 to 2018 for "clinical decision support," "decision support systems, clinical," "decision making, computer-assisted," and related MeSH terms and synonyms, combined with "patient safety," "quality assurance, health care," and related terms. After duplicates were removed, the initial search yielded 763 results, all of which were screened for inclusion, and 107 full-text articles were retrieved. Of the total retrieved articles, 26 were selected for inclusion in this review. We also report on CDS-related effects on patient outcomes cited in a 2016 systematic review, "Effects of Health Information Technology on Patient Outcomes: A Systematic Review."[4]

Articles from the searches were excluded if the outcomes were not relevant or precisely reported and/or if the study design was insufficient.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

17.3.2 Review of the Evidence

The Committee on Patient Safety and Health Information Technology of the Institute of Medicine (now the National Academy of Medicine) published a 2011 report on health information technology and patient safety.[5] The report authors concluded that, while many studies suggested that CDS has a positive impact on patient safety, the evidence base at that time was not strong and study results were inconsistent. This Institute of Medicine (IOM) Committee recommended further research. In general, the evidence cited in the report was strongest for the relationship between CDS and medication safety. In the present review, we examine CDS and patient safety as broadly as possible. Consistent with the IOM report, however, a majority of the relevant primary research we review concerns CDS related to medication safety.

Brenner et al. (2016) systematically reviewed 40 studies about CDS: 15 studies had positive results in terms of CDS's impact on patient outcomes (e.g., reductions in adverse drug events or readmission rates), and 25 had non-significant or mixed results. None of the CDS studies reviewed showed negative results of CDS on patient safety. Findings from this systematic review are included in the sections below by subcategory.[4]

The sections that follow describe the literature in several categories of CDS impact: drug ordering and adverse drug events, prevention of deep vein thrombosis, antibiotic prescribing/stewardship, blood glucose control, reducing uninformative CDS alerts (reducing alert fatigue), and other potential patient-safety effects of CDS.

17.3.2.1 Medication Prescribing and Adverse Drug Events

In their 2016 review, Brenner et al. assessed several studies about CDS and adverse drug events (ADEs), many of which found no impact of CDS.[4] For example, a 2008 randomized controlled trial (RCT) conducted in two long-term care facilities found that computerized provider order entry (CPOE) with

CDS did not reduce ADEs or preventable ADEs.[6] A 2009 prospective cohort study in two Dutch hospitals similarly found that CPOE with CDS did not have a significant effect on rates of preventable ADEs.[7] The Brenner et al. review also mentions that Fleming et al. (2009) studied the use of order sets (i.e., prescribing guidelines) in a large multi-hospital U.S. health system for patients admitted with community-acquired pneumonia and found no impact on in-hospital mortality or 30-day mortality when order sets were used.[8] In contrast, a large ambulatory care–based prospective observational U.S. study (including adult primary care, pediatrics, psychiatry, and other specialties) found that CDS with alerts reduced preventable ADEs, hospitalizations, emergency department visits, and office visits.[9]

In a retrospective study with no baseline or comparison group, Abramson et al. (2013) studied e-prescriptions written by 20 community-based primary care providers in the United States after they all adopted a commercial electronic health record (EHR) with CDS to aid in prescribing. Errors were identified by chart review. Overall rates of prescribing errors were low at 3 months post-implementation (6.0 errors per 100 prescriptions), and this was sustained after 1 year (4.5 errors per 100 prescriptions). There is no indication of what the error rate would have been in the absence of the new EHR and CDS.[10]

Ahuja et al. (2018) studied the use of CDS tools to enhance patient safety related to direct oral anticoagulant (DOAC) ordering. These researchers retrospectively reviewed the records of 121 patients who received at least two doses of a DOAC and determined whether DOAC dosing was consistent with the CDS provided upon order entry. Adherence to the CDS-recommended dosing ranged from 75 to 87 percent for different DOACs. Most non-adherence was related to under-dosing of DOACs. The absence of any baseline or comparison group, however, makes it difficult to conclude whether DOAC dosing was better than it would have been without CDS.[11]

A cluster RCT was conducted in a U.S. academic medical center to assess the effects of an EHR CDS tool designed to improve appropriate prescribing of medications for patients with renal insufficiency.[12] The authors examined scenarios in which drug discontinuation or dosage adjustment was recommended by the CDS for adult patients with impaired renal function in the ambulatory and acute settings, both at the time of the initial prescription ("prospective" alerts) and by monitoring changes in renal function for patients already receiving one of the study medications ("look-back" alerts). These researchers found that appropriate discontinuation or dosage adjustments occurred in 17 percent of intervention patients (with CDS) versus 5.7 percent of the control group (with no CDS). Findings of this RCT suggest that clinicians responded more frequently to drug dose adjustment alerts than to alerts about contraindicated drugs. Further, prospective alerts appeared to have more impact on appropriate medication adjustments than look-back alerts did.[12]

A Canadian RCT (Field et al., 2009) examined CDS that provided specific dose recommendations for patients with renal insufficiency living in a long-term care facility. Medication alerts were displayed to prescribers in intervention units and hidden but tracked in control units. Overall, final drug orders were appropriate significantly more often in the intervention group, and CDS was also associated with reduced risk of prescribing drugs that should be avoided in the elderly.[13]

Chaparro and colleagues (2017) evaluated medication ordering in 21 U.S. pediatric hospitals to identify drug-drug interactions, dosing errors, and other ordering errors. They found that the CPOE systems with embedded CDS were able to identify and intercept (prevent) 62 percent of potential medication errors in test scenarios, but this ranged widely, from 23 to 91 percent, in the institutions tested. The highest

scoring categories included drug-allergy interactions, dosing limits (both daily and cumulative), and inappropriate routes of administration.[14]

Prewitt et al. (2013) evaluated patient-controlled analgesia (PCA) safety events in intermediate and step-down units before and after implementing CPOE/CDS with PCA smart pump technology for adults with acute pain. The researchers reviewed both voluntary reports of ADEs and ADEs identified via hospital surveillance systems. After implementation of the CPOE/CDS with smart pump technology, there were fewer PCA events per 1,000 PCA days, whether measured by surveillance (22% reduction) or voluntary reporting (72% reduction).[15]

At four U.S. Department of Veterans Affairs (VA) emergency departments, Stevens and colleagues (2017) conducted a pre-post study to assess the effectiveness of a multicomponent quality improvement initiative that combined provider education, CDS, and individual provider feedback to reduce the use of potentially inappropriate medications and improve medication safety for older adults. All four sites showed a significant and sustained reduction in use of inappropriate medications, and this was sustained over the course of the year-long study.[16]

Finally, Gill et al. (2011) conducted a large RCT in 27 primary care offices in 14 U.S. States. The intervention group received an EHR-based CDS coupled with clinician education about guidelines for reducing gastrointestinal risk for patients taking non-steroidal anti-inflammatory drugs. Results were mixed. Intervention patients (for whom CDS was employed during ordering) were more likely than usual-care patients to receive guideline-concordant care (25.4% vs. 22.4%, adjusted odds ratio = 1.19). Patients taking low-dose aspirin were more likely to receive guideline-concordant care with the intervention than with usual care (25.0% vs. 20.8%, adjusted odds ratio = 1.30). There was no significant difference, however, for patients in other high-risk groups.[17]

17.3.2.2 Preventing Venous Thromboembolism/Deep Vein Thrombosis

A subset of studies on medication ordering addressed the specific issue of preventing deep vein thrombosis (DVT) through CDS-enhanced medication ordering.

As described in Brenner et al.'s 2016 systematic review, Fiumara et al. (2010) found that a CDS effort to encourage DVT prophylaxis in a U.S. hospital had no significant impact on rates of venous thromboembolism (VTE).[18] Similarly, in a 2010 prospective observational study conducted in the surgical wards of a U.S. hospital after implementation of a VTE-prophylaxis CDS, rates of VTE at 30, 60, and 90 days declined, but not significantly, although DVT prophylaxis ordering increased.[19]

A few other studies in the 2016 systematic review found mixed or inconsistent impacts of CDS on VTE. Researchers in Spain found that alerts to physicians had no impact on hospital VTE rates; however, a sub-analysis of surgical patients found a significant reduction in VTE events.[20] Maynard et al. (2010) found that the rate of hospital-acquired VTE was reduced after implementation of CPOE with CDS.[21] Further, Parente and McCullough (2009) found that rates of hospital-associated infections significantly decreased, but neither post-operative VTE nor post-operative hemorrhage rates were reduced with a CDS intervention.[22]

A large retrospective study at three U.S. academic medical centers tested the impact of a message-based CPOE with CDS to improve VTE prophylaxis. The CPOE-CDS intervention significantly increased the use of "recommended" and "any" prophylaxis at all three hospitals.[23]

17.3.2.3 Antibiotic Prescribing/Stewardship

Three articles included in the systematic review by Brenner et al. (2016) examined the impact of CDS on antibiotic prescribing and antibiotic stewardship.[4] In a prospective study conducted in an Australian hospital, Buising et al. (2008) examined the impact of CDS on appropriate antibiotic prescribing for gram-negative bacteremia. They found no impact of CDS on in-hospital mortality or length of stay.[24] Linares et al. (2011) conducted a prospective study in a U.S. hospital focused on computerized-alert CDS and found decreased complications associated with asymptomatic bacteriuria and culture-negative pyuria.[25] In a retrospective observational U.S. hospital study based on chart review, implementation of an EHR with CDS had no effect on rates of nosocomial *C. difficile* infection, but rates of nosocomial Methicillin-resistant *Staphylococcus aureus* (MRSA) infections decreased significantly.[26]

In a more recent article on this topic, not covered in the 2016 systematic review, Burgess et al. (2016) compared initial antibiotic regimens prescribed for patients with lower extremity cellulitis with the regimens prescribed for similar patients after implementation of a CDS prescribing tool. When the optional CDS prescribing tool was used, these researchers found improved adherence to antibiotic prescribing guidelines.[27]

17.3.2.4 Blood Glucose Control

CDS to improve blood glucose control was addressed in two studies we reviewed.

Bode et al. (2017) conducted a small pre-post study to improve blood glucose control for patients for whom insulin therapy was not effective. These researchers assessed an intervention with Bluetooth-capable blood glucose meters and insulin dose titration guided by CDS. After an initial 3-day titration, the CDS recommended new insulin doses, as well as a new dose titration at intervals of 3, 7, 14, or 28 days based on a patient's glucose control. The authors found that the intervention helped high-risk patients achieve and maintain glucose targets over a 1-year follow-up period.[28]

In the intensive care units of two U.S. hospitals, Flanders and colleagues (2009) prospectively tested a CDS tool for intravenous insulin dosing, with automated calculation of intravenous insulin drip rates. After 3 years, ICU patients were more than twice as likely to have safe blood glucose levels of less than 150 mg/dL (odds ratio = 2.28; 95% confidence interval = 2.25-2.30; $P < .001$) compared with the baseline period.[29]

17.3.2.5 Inconsequential Alerts

Genco et al. (2016) conducted a large retrospective chart review in a U.S. academic medical center focused on clinically inconsequential alerts related to opioid prescriptions. They found that CDS prevented some ADEs, but at the expense of generating a large volume of inconsequential alerts. To prevent one ADE, providers dealt with more than 123 unnecessary alerts. When providers ignored or over-rode the unnecessary CDS opioid alerts, there was no impact on ADEs. The authors concluded that refining CDS alert systems to eliminate inconsequential alerts is essential for preventing alert fatigue and maintaining patient safety.[30]

A Dutch pre-post study in an academic medical center sought to determine whether adding CDS to CPOE could improve compliance with Dutch guidelines for prophylaxis for patients at increased risk of gastrointestinal bleeding in both inpatient and outpatient settings. Before CDS implementation, gastrointestinal prophylaxis was co-prescribed in 84.0 percent of prescriptions. After implementation,

this percentage increased to 94.5 percent ($p < 0.001$). The CDS also improved the appropriateness of drug safety alerts. The total number of drug safety alerts decreased by 78.2 percent. The authors concluded that CDS for gastrointestinal prophylaxis improved adherence to Dutch guidelines, most likely due to a reduction in the number of irrelevant drug safety alerts.[31]

Harinstein et al. (2012) studied whether CDS could detect drug-induced thrombocytopenia in critically ill ICU patients. The CDS used information from both laboratory values and drug ordering systems, alerts were generated when the patient had a low platelet count and was ordered a potentially causal drug, and patients were evaluated in real time for ADEs. The CDS was not used to prevent these events, but in this study it was tested to determine its accuracy in detecting the ADEs. Sixty-four patients met the inclusion criteria, for whom 350 alerts were generated by the CDS. There were 137 ADEs identified in the 350 alerts, with heparin, vancomycin, and famotidine as the three most common potential causes. The authors concluded that, compared with previous studies, the drug–laboratory combination alert performed better than alerts based exclusively on laboratory values and should be considered to reduce alert fatigue.[32]

17.3.2.6 Other Patient-Safety Impacts

A variety of studies addressed other uses of CDS, beyond those described above.

Brenner et al. addressed other potential benefits of CDS in their 2016 systematic review and generally found little or no improvement in patient safety. For example, in an RCT in four U.S. hospitals, use of a CDS fall-prevention tool was associated with decreased falls, with the greatest reduction among patients over age 65, but no impact of CDS was observed in falls resulting in patient harm.[33]

Boustani and colleagues (2012) conducted an RCT in a U.S. academic medical center to evaluate the efficacy of a screening program with CDS aimed at improving several aspects of hospital care for older adults with cognitive impairment. They found that CDS did not change physician prescribing behavior and did not increase physicians' orders for Acute Care for Elders (ACE)—a continuous quality improvement program of care—consultation, discontinuation of Foley catheters, or discontinuation of physical restraints. CDS also had no significant impact on patient outcomes such as mortality.[34]

A Canadian prospective cohort study in two academic medical centers cited in the 2016 systematic review reported that a real-time laboratory alerting system with concurrent CDS had no significant impact on rates of adverse events.[35]

The systematic review also identified several studies with mixed results. For example, investigators in a U.S. hospital found that CPOE with CDS was associated with a reduction in in-hospital bleeding among patients with chronic kidney disease admitted with acute coronary syndromes, but there were no effects on length of stay or 90-day mortality.[36] In a prospective observational study in a U.S. hospital, CDS with CPOE decreased the length of stay for patients with diabetes but had no effect on patient-days of hypoglycemia.[37]

In a small cluster RCT conducted in the United States, Abdel-Kader et al. (2011) studied whether an educational intervention coupled with CDS versus an educational intervention alone could enhance care for patients with chronic kidney disease. Approximately 10 percent of patients in the intervention group were referred to a nephrologist versus 17 percent in the control group ($P=0.1$). Just over 39 percent of patients in the intervention group had a proteinuria assessment versus 30 percent in the control group

(P=0.1). Chronic kidney disease was documented in the EHR in 37 percent of patients in the intervention group versus 21 percent in the control group (P=0.008). Despite the improvement in these process measures, there were no significant differences in angiotensin-converting enzyme (ACE) inhibitor/angiotensin-receptor blocker (ARB) use, optimal blood pressure management, or limiting use of non-steroidal anti-inflammatory drugs to protect renal function.[38]

In an RCT, Schnipper et al. (2010) assigned primary care physicians (PCPs) in 10 ambulatory practices to usual care or to CDS for their patients with coronary artery disease and diabetes, and measured the proportion of deficiencies in care that were addressed within 30 days after a patient visit. The CDS they tested required substantial additional documentation on the part of physicians ("smart forms") to trigger elements of the CDS. Patients of PCPs assigned to the intervention arm were more likely to have care deficiencies addressed in their next visit, and the measures that improved included documentation of smoking status and prescription of antiplatelet agents when appropriate. However, rates of voluntary completion of the documentation underlying the CDS were very low.[39]

Milani et al. (2011) studied patients admitted to a major U.S. academic medical center cardiac service. On admission (73% through the emergency department), the admitting physician had the choice of using pre-printed paper orders with check boxes that followed national guidelines for standard orders or CPOE-CDS software that generated printed/paper orders. The CDS also included drug dosing based on clinical risk, weight, calculated creatinine clearance, and guidelines. Numerous performance measures were combined to assess attainment of "perfect" care. The authors concluded that use of CPOE with CDS markedly increased the likelihood of achieving perfect care.[36]

Felcher and colleagues (2017) studied whether CDS implemented in the EHR of a large U.S. integrated group-model health system could decrease unnecessary vitamin D testing. The CDS included a new vitamin D screening guideline, an alert that required clinician acknowledgment of current guidelines to continue ordering the test (a "hard stop"), and removing the test from standard order sets so that a physician would need to separately/explicitly order the vitamin D test. This three-part CDS led to significantly reduced rates of vitamin D testing, a significant increase in the proportion of vitamin D screening that was appropriate, and substantial cost savings for the health system.[40]

Fitzgerald et al. (2011) conducted an RCT at a U.S. Level 1 trauma center to test whether CDS implemented during the first 30 minutes of trauma resuscitation could reduce errors. They found that CDS increased protocol compliance and error-free resuscitations, and reduced morbidity from avoided shock management, blood use, and aspiration pneumonia.[41]

Kharbanda et al. (2016) examined the effects of EHR-linked CDS in reducing costly imaging for pediatric patients admitted to two U.S. academic medical centers with suspected appendicitis. The electronic CDS included three components: a standardized abdominal pain order set, a risk stratification tool, and a "time of ordering alert." The order set specified options for pain medications and laboratory tests. For high-risk patients, surgical consultation was recommended before diagnostic imaging; imaging was ordered at the discretion of the surgeon (not the admitting emergency department physician). Low-risk patients were recommended for discharge without imaging but with outpatient or emergency department follow-up in 12 to 24 hours. A focused abdominal ultrasound was recommended for medium-risk patients, and computed tomography (CT) imaging was to be considered only if the ultrasound was equivocal or at the request of the surgeon. The authors found a significant decrease in

CT imaging with equivalent patient outcomes (and no difference in rates of negative appendectomies or missed appendicitis).[42]

In New Zealand, Lavin and Ranta (2014) assessed a transient ischemic attack (TIA)/stroke CDS tool in primary care settings to aid general practitioners in the timely management of TIAs. They retrospectively reviewed all patients managed with the help of the CDS tool and any subsequent morbidity and mortality. They found no evidence of serious preventable harm due to misdiagnosis, inappropriate triage, or over/undermedication prompted by the CDS.[43] Using the same tool, Ranta and colleagues (2014) conducted a prospective observational study focused on diagnostic accuracy by PCPs, limiting emergency department referrals, and improving secondary prevention of TIAs/strokes. The authors concluded that the availability of TIA/stroke CDS support in the primary care setting was associated with reductions in TIA treatment delays without compromising patient safety.[44]

Mishuris et al. (2014) retrospectively analyzed data from the National Ambulatory and National Hospital Ambulatory Medical Care Surveys for adult primary visits to understand the association between the use of CDS (problem lists, preventive care reminders, lab results, lab range notifications, and drug-drug interaction warnings) and quality measures (blood pressure control, cancer screening, health education, influenza vaccination, and visits related to ADEs). The survey databases contained an estimated 900 million adult outpatient primary care visits to clinics with EHRs from 2006 to 2009. The presence of CDS was associated with improved blood pressure control (86% vs. 82%; odds ratio 1.3) and more visits not related to ADEs (99.9% vs. 99.8%; odds ratio 3.0); these associations were also present when comparing practices with CDS against practices that had disabled their CDS. The authors concluded that the use of CDS was associated with improvement in several primary care quality indicators.[45]

Olsho and colleagues (2014) conducted a small interrupted time series study assessing impact of the On-Time Quality Improvement for Long-term Care tool in U.S. nursing homes selected because they used team-based care and had leadership support for quality improvement. On-Time is a CDS intervention for pressure ulcers that uses risk reports embedded in nursing home health information technology systems to identify recent changes in patient risk status and integrate these reports into routine care. The authors found large and statistically significant reductions in pressure ulcer incidence associated with implementation of On-Time, amounting to approximately 2.6 pressure ulcers avoided per 100 nursing home residents per month, with substantial associated cost savings.[46]

17.3.3 Gaps and Future Directions

Our results, almost a decade later, are quite similar to those cited in the IOM's 2011 report on HIT and patient safety: the evidence is not very strong, and results are inconsistent.

CDS was defined differently in almost every study we reviewed and applied to many different care processes and settings, from laboratory testing to medication prescribing, and from emergency department admission protocols to nursing home fall prevention. The range of problems and settings studied and the diversity of CDS interventions make it impossible to draw broad conclusions about the impact of CDS on patient safety, other than to observe that it has been most thoroughly evaluated as a tool to improve medication safety.

Additionally, it is very challenging to link patient safety outcomes or improvements directly to the use of CDS. To support the often-cited assertion and widely held belief that "clinical decision support promotes patient safety," more high-quality data regarding "increased quality of care and enhanced health

outcomes" and "avoidance of errors and adverse events" achieved through the use of CDS are needed.[1] Furthermore, it remains a challenge to tie process outcomes (CDS use and adherence) to patient outcomes. There may be useful outcomes measures—outside of mortality and length of stay—that would be more proximal in timing and more specific to CDS guidance.

The Five Rights of CDS—delivering the right information to the right people using the right formats via the right channels at the right times in the workflow—discussed previously highlight the need for CDS interventions to meet specific criteria as a critical element to improve case processes and outcomes. Despite an emphasis on EHR usability, little progress has been made to protect end-users from inadequately designed workflows and unnecessary interruptions. The potential solution that CDS represents may be limited by problems associated with improper design, implementation, and local customization. This contributes, in part, to low acceptance rates for some forms of CDS, with alerts being overridden or ignored by clinicians because of time constraints, perceived misleading alerts, or believing that patients did not meet certain criteria for use of CDS (such as age or condition). By identifying factors that predict clinically insignificant alerts and inappropriate responses, informatics personnel can improve alert logic to account for factors such as workflow and patient complexity, increasing the specificity of alerts.

In a three-meeting series convened by the National Academy of Medicine (2017), U.S. experts met to discuss realizing the untapped potential of CDS. A common theme that emerged from these efforts was: "Current CDS lacks measurement practices and standards. Evaluation of current and future CDS should assess whether it measurably improves quality, health outcomes, safety, cost, and physician productivity."[47]

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17.4 Cultural Competency

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This review includes a summary of evidence published from 2008 onward on cultural competency as a patient safety practice.

We start by defining cultural competency and discussing standards, measures, and related practices. We then provide background on the links between safety and cultural competency, and major policy impacts. We review the evidence for the estimated impact of cultural competency interventions on patient safety, touch briefly on cultural competency implementation considerations, and finally discuss research gaps and future directions for cultural competency as a safety practice.

Key Findings:

- Existing evidence supports the use of language services to improve patient safety.
- With the exception of studies on language services and community health workers, there is limited research on cultural competency initiatives to improve patient safety.
- Prompt access to language assistance has shown promise in the areas of preventable hospital readmissions, medication adherence, length of stay, advance care planning, and informed consent.

It should be noted that our focus is not on cultural competency and healthcare *quality* (e.g., patient satisfaction, health, and access), but rather on healthcare safety as the prevention of patient harm (or potential harm) as a result of error or negligence in medical care.[1] In the review of studies, we focus on research that examines patient safety and safety-related process and outcome measures. Outcomes in the reviewed studies include patients' use of emergency services, medication adherence, comprehension of medication instructions, advance care planning, and informed consent. In cases in which there are gaps in the literature with regard to safety, we look more broadly at the literature on cultural competency. Specifically, given that we found no systematic reviews *exclusively* devoted to cultural competence and patient safety, we instead provide an overview of several reviews that examine cultural competency to improve a range of healthcare outcomes—highlighting safety-related findings (e.g., provider communication) when possible. We take a similar approach for the section on implementation. Key findings are located in the box above.

17.4.1 Practice Definition and Standards

While there is not a single definition of cultural competency,[2] a frequently cited definition, referenced by the Agency for Healthcare Research and Quality (AHRQ),[3] U.S. Department of Health and Human Services (2016),[4] and others, comes from an early article by Cross et al. (1989),[5] who described the practice as, "A set of congruent behaviors, attitudes, and policies that come together in a system or agency or among professionals that enables effective interaction in a cross-cultural framework."

To operationalize cultural competency at the organizational and provider level, there are a number of guidelines and recommended practices, some of the most recent of which are provided as resources later in this section. Cultural competency includes linguistic competency and, in part, centers on effective communication and language services. At the healthcare professional level, cultural competency can be defined as the ability to communicate with, and effectively provide high-quality care to, patients from diverse sociocultural backgrounds.[6,7] Historically, cultural competency consisted of teaching providers about different cultural groups.[8] More recent pedagogy takes into account the

dynamic nature of culture, in addition to intragroup variability, and social determinants of health such as socioeconomic status. Rather than categorizing and learning about different cultural groups, a more effective strategy is to teach providers skills that can be applied in any cross-cultural situation.[8] Additionally, in recent years, there is greater focus on provider and organizational self-reflection, current and historical racism (and other forms of oppression), as well as structures of power and privilege, and how biases impact care [9-11]

A number of tools have been developed to measure aspects of clinician cultural competency.[12,13] AHRQ's Consumer Assessment of Healthcare Providers and Systems (CAHPS®) is made up of a number of validated survey instruments measuring patient experience of care in different healthcare settings, with providers, and with health plans. It includes optional supplemental items on interpreter services. These optional items can be used in conjunction with both the adult and pediatric versions of the CAHPS Clinician & Group Survey and the CAHPS Health Plan Survey, as well as the CAHPS Hospital Survey (adult only). Patients are asked about their experiences with using interpreters in these settings and in communications with their health plan.[14] Additional measures in the literature that are safety specific include patient comprehension and adherence.[11] There are also a number of self-assessments available online for providers in different settings and different fields;[15] these assessments can be used to help measure a provider's understanding, acceptance of, and respect for other cultures, as well as the provider's communication skills and styles.

Lie et al. (2011), in their review, note that provider training alone may not be adequate to create change without system changes to reduce errors, improve efficiency, and include language services.[16] While early understanding of cultural competency was limited to the provider/interpersonal level, the scope of cultural competency now includes the organizational and systems domains. [17] For example, the U.S. Department of Health and Human Services established a framework for cultural and linguistic competency: The National Standards for Culturally and Linguistically Appropriate Services (CLAS) standards. According to the CLAS standards, organizations that are culturally competent provide "effective, equitable, understandable, and respectful quality care and services that are responsive to diverse cultural health beliefs and practices, preferred languages, health literacy, and other communication needs."[18]

This principal standard is followed by additional standards in three areas: Governance Leadership and Workforce; Communication and Language Assistance; and Engagement, Continuous Improvement, and Accountability. The full list of standards can be found on the Office of Minority Health website.[18] To paraphrase, the Governance Leadership and Workforce standards include: promoting CLAS and health equity through policy, practices, and allocated resources to recruit, promote, and support a diverse leadership and workforce, and to regularly educate and train leadership on culturally and linguistically appropriate policies. The standards for Communication and Language Assistance consist of offering limited English proficient (LEP) patients professional or qualified language assistance and providing easy-to-understand print and multimedia materials and signage in the languages commonly used by the populations in the service area. For Engagement, Continuous Improvement, and Accountability, the standards are to: establish culturally and linguistically appropriate goals; conduct ongoing assessment and improvement of CLAS activities; collect accurate demographic data; conduct community needs assessments to inform services and service delivery; partner with the community to design and evaluate practices; **c**reate conflict- and grievance-resolution processes that are culturally and linguistically

appropriate; and communicate the organization's progress in implementing and sustaining CLAS to all stakeholders.

It is important to note that the studies we review in this section (as well as some of the measures of cultural competency discussed above) include similar and analogous practices, including patient-centeredness and efforts to address health literacy. For example, an intervention to provide language-concordant medication labels for LEP patients is described as "patient centered."[19] The links between patient-centeredness and cultural competency are evident—both focus on building rapport, seeing the patient as a unique person, exploring patient beliefs, and finding common ground regarding treatment plans.[9] In providing patient-centered care, "an individual's specific health needs and desired health outcomes are the driving force behind all healthcare decisions and quality measurements."[20] "Health literacy" is an important concept, as it indicates the degree to which a patient has the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions.[21] The American healthcare system can be confusing, and contains many cultural assumptions.[22] Disparities in patient health literacy are recognized as contributing to racial/ethnic health disparities[23] and patient safety disparities.[24] Two of the interventions evaluated in the studies included in this section involve efforts to improve patient "health literacy" as part of cultural competency interventions.

17.4.2 Cultural Competency as a Patient Safety Practice

Cultural competency is often framed as a best practice and as an achievable response to health and healthcare disparities in minority populations; it is also deemed an important practice in the context of increasing diversity in the U.S. population.[18,25-27] The literature on cultural competency as a patient safety practice is limited; however, evidence suggests a link between provider and organizational cultural competency and patient safety. As with many healthcare quality outcomes, studies have found disparities in adverse safety events between cultural and racial/ethnic groups in the United States. Safety outcomes in which certain groups experience disproportionately high adverse events include: healthcare-associated infections, diagnostic errors, adverse birth outcomes, medication errors (e.g., polypharmacy and adverse medication events), inappropriate care transitions; and failure to obtain patient directives.[28-35] One study found that 49.1 percent of adverse events for LEP patients resulted in physical harm, whereas 29.5 percent of adverse events for patients who speak English resulted in harm.[36] Patient–provider communication challenges and cross-cultural issues are at the root of many adverse events.[11,37,38] Conversely, patients of physicians reporting greater cultural competency were more satisfied, and reported seeking and sharing more information during the medical visit.[39,40] In one study, provider cultural competency was linked to higher prescribing of antiretroviral medications, patient medication adherence, and viral suppression in non-white HIV patients.[41] Tools specifically developed to mitigate potential adverse events, such as patient suicide, may be more effective when tailored to a patient's culture,[42] and language services and language concordance between providers and patients have been associated with improved patient outcomes.[2,43]

External drivers related to cultural competency date back to the Civil Rights Act of 1964, which outlawed discrimination in federally assisted programs. Other significant legislation includes the Americans with Disabilities Act in 1990, which prohibits discrimination based on disability, and Executive Order 13166 in 2000, which requires Federal agencies to examine the services they provide and identify any need for services to those with LEP. Additional drivers for cultural competency to specifically improve patient

safety are financial, including the threat of malpractice suits as well as penalties for adverse safety events.[44,45] Mandates and standards for culturally competent care include requirements for training and CLAS-related services at the State level in many States; incorporation of cultural competency into medical curriculums; and cultural competency guidelines from several national accreditation agencies (e.g., the Joint Commission).[c,26,18] Most recently, the Affordable Care Act of 2010 was implemented in part to reduce healthcare disparities. It includes provisions for workforce diversity and funding for demonstration projects for cultural competency training in healthcare.[6,46] Between 2013 and 2017, health insurance coverage for minority groups increased due to the Affordable Care Act. For example, the proportion of Hispanics who were uninsured dropped from 30 percent to 19 percent.[47] It has been noted that, as the diversity in the insured population increases utilization, there is a need for continued efforts for culturally competent care.[47]

17.4.3 Methods

The question of interest for this review is, "Is culturally competent care effective in improving patient safety?"

To answer this question, we searched the databases CINAHL® and MEDLINE® from 2008 to 2019 for "patient safety" and related medical subject headings, terms, and synonyms; "cultural competency;" and related terms, including, "transcultural nursing," "cultural diversity," "cultural intelligence," "cultural proficiency," "cultural competencies," "cultural sensitivity," "cultural humility," "limited English proficiency," "multicultural health," "linguistically appropriate approach," and "cultural safety." After duplicates were removed, the initial search yielded 552 results, all of which were screened for inclusion, and 80 full-text articles were retrieved. We included papers that discussed cultural competency and patient safety outcomes (or safety-related process measures) and excluded studies whose outcomes were exclusively provider attitudes or knowledge. Studies were excluded from the evidence summary if outcomes were not precisely reported, if outcomes were qualitative, or if the methods were not clearly described. Nonsystematic reviews were not included in the evidence summary but are used to provide background and context. To ensure thoroughness, reference lists of included articles were also screened, as well as articles and reference lists from articles found while researching background information for the introductory sections. An additional 25 papers were reviewed. A cursory search using Google Scholar was conducted, yielding three additional systematic reviews. Experts were also consulted and an additional seven, previously undiscovered studies were provided. Of the total retrieved articles, four reviews and eight studies were selected for inclusion in this review.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

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[c]The Joint Commission: Advancing Effective Communication, Cultural Competence, and Patient- and Family-Centered Care: A Roadmap for Hospitals—https://www.jointcommission.org/assets/1/6/ARoadmapforHospitalsfinalversion727.pdf.

17.4.4 Review of the Evidence

In this evidence summary, we examine four systematic reviews on cultural competency studies in healthcare and highlight findings related to patient safety. We then review eight studies on cultural competency and patient safety. Reviews and studies examined a variety of healthcare settings and contexts, including hospitals and outpatient settings. When describing the target population in the studies and reviews, we use the same terminology as the authors of the articles.

17.4.4.1 Reviews

A vast number of reviews examine cultural competency and patient/provider outcomes, although we found none that addressed safety specifically. Due to this gap, we choose here to include a brief overview of systematic reviews of studies on cultural competency interventions at the systems, organizational, and provider levels, addressing a variety of outcomes. Two of the reviews[2,48] take a broad approach, looking at interventions at the provider, facility, and policy levels, and two articles focus specifically on provider training.[16,49]

In a systematic review of reviews on interventions to improve provider, organizational, or system cultural competency, Truong et al. (2014) examined 19 reviews published between January 2000 and June 2012.[2] The reviews focused on provider education, as well as on policy and practice modifications. The majority of them found moderate evidence of improvement in provider outcomes (e.g., cultural competency knowledge, skills, and attitudes). Healthcare access and utilization outcomes improved following cultural competency interventions. The evidence was not as strong for improvements in patient outcomes: satisfaction and trust, decision making and communication, and physiological outcomes (e.g., measures of diabetes management). Interventions that showed promise included the use of patient navigators and community health workers (CHWs), appropriate and competent linguistic services, culturally adapted patient education, and intercultural staff trainings. Forsetlund et al. (2011), in their review of studies to improve healthcare services for racial/ethnic minority groups, found 19 studies going back to the 1990s.[48] Interventions included education for health personnel and/or patients, treatment and screening reminders for providers, remote professional interpreter services, ethnic matching between provider and patient, and additional follow-up support for patients. Overall study quality was low. Five of the six studies that examined computerized reminders showed statistically significant positive effects for the selected outcome. The reminders were for mammography or Pap smears and diabetes care for racial/ethnic minority populations. Studies of professional remote interpreters had positive findings. Followup support interventions and patient–therapist ethnic matching had mixed results.

Two reviews looked specifically at provider training and found that, while provider knowledge and patient satisfaction improved, there was sparse evidence on other outcomes. Horvat et al. (2014) examined randomized controlled trials, cluster randomized controlled trials, and controlled clinical trials published up to 2014[49] and include five studies. They found that patient involvement in care and use of services improved, while care quality was mixed. The quality and paucity of evidence was such that the reviewers were unable to draw generalizable conclusions. Lie et al. (2011) conducted a review of studies published between 1990 and 2010 on cultural competency educational interventions and patient outcomes; seven studies met their inclusion criteria.[16] The studies were of low to moderate quality, and many studies lacked important information on patient and provider variables (e.g., race, language concordance). In general, the studies showed that, following provider training, patient satisfaction and

sense of provider concern improved, whereas clinical outcomes were mixed. The authors found it was difficult to draw conclusions about cultural competency trainings given the lack of robust and consistent evidence.[16]

17.4.4.2 Studies

We found eight studies that measured associations between cultural competency and patient safety outcomes or safety-related process measures. Most were intervention studies and one was a measurement study. The studies were all at single sites and primarily observational. The studies are organized by outcome type: medication adherence and healthcare utilization, advanced care planning and informed consent, and patient comprehension. Studies were observational, before and after, randomized/controlled, or cross-sectional.

17.4.4.2.1 Language Services: Medication Compliance, Length of Stay, Emergency Services Utilization

Four studies examined the impact of additional language services, culturally-competent education, and/or lay health worker support on medication adherence and/or service utilization in LEP patients.[50-52] The studies indicate that professional or qualified interpretation and cultural and language concordance improve patient medication adherence and decrease preventable hospital admissions. These four studies are summarized below and outcomes are provided in Table 2.

In a retrospective study of a 3-year period, Lindholm et al. (2012) found that hospital length of stay and the percentage of patients readmitted within 30 days were lower for those who received a professional interpreter than for those who did not receive professional interpretation at admission and/or discharge ($p<0.001$).[50] In another study on interpreter services, Karliner et al (2017) examined hospital outcomes, including 30-day readmission rates, length of stay, and hospital expenditures before and after implementation of highly accessible professional interpreter services.[51] The study took place on a medicine floor of an academic medical center where interpreter services at baseline consisted of in-person staff interpreters who had to be scheduled during business hours and were not always available. The intervention consisted of a dual-handset interpreter telephone at the bedside of every patient with LEP. These 66 telephones had a programmed button that allowed 24-hour access to a professional (trained and tested) medical interpreter for more than 100 languages. During the 8-month intervention period, the number of interpreter encounters went from less than one per patient to over four per patient. As shown in Table 2, during the intervention there was a decrease in the number of 30-day readmissions for LEP patients; there was no change in length of stay. The intervention was found to be cost-effective in terms of preventing the cost of readmissions.[51]

Woerner et al. (2009) examined a multi-pronged intervention that aimed at reducing hospitalizations and use of emergency services, and increasing medication adherence among Hispanic home care patients served by a home care agency in Rochester, New York.[52] Despite the use of interpreters and Spanish-speaking providers at baseline, compared with the non-Hispanic patients, the Hispanic participants in the study had higher numbers of diagnoses (e.g., hypertension, diabetes mellitus, depressive disorder, gait abnormality), medications, emergency department visits, and hospitalizations. The intervention evaluated in this study involved several components, including recruiting Hispanic home health aides, conducting trainings in Spanish for LEP workers, allowing aides to share their personal cell phone numbers with patients, and creating educational materials for patients in a

telenovela (soap opera) video format. Aides wrote down patients' questions to ask during physician visits. Local foods were incorporated into diabetic nutrition education. Data from a year prior to the intervention and post-intervention were compared for 125 Hispanic patients. As shown in Table 2, after a year the acute hospitalization rate and emergency department visit rate dropped for Hispanic patients. Oral medication adherence rates increased. Data were collected on patient characteristics and all non-Hispanic patients also received the intervention but p-values were not calculated. A follow-up inquiry on barriers to medication adherence found a number of discrepancies between what the patient was taking and what had been prescribed and/or discontinued by a physician. This led to development of a communication notebook, kept by patients and their aides, with notes from providers to improve communication between providers.[52]

Finally, Cardarelli et al. (2018) examined the use of lay health workers to help reduce 30-day readmissions in high-risk patients at an Appalachian hospital. Lay health workers such as CHWs are members of the patients' community and intended to provide culturally sensitive community-based services. Most of the participating patients were Caucasian with only a high school education. In this case, the lay health workers served a rural Appalachian population, a population with unique psychosocial needs and stressors. The intervention began with the patient and lay health worker, working together to develop an individualized post-discharge plan prior to hospital discharge. The plan was provided to the patient upon discharge along with the lay health worker's contact information. The lay health worker conducted a follow-up call 24–48 hours after discharge to review any issues during the interim post-discharge period, assess patient follow-through in engaging with identified community resources, and review plans for appropriate follow-up visits. Compared to pre-intervention outcomes, the program was associated with an insignificant decrease in 30-day readmission rates but significant decrease in odds of being readmitted within 30 days when adjusted for education, transportation cost, and a positive anxiety screen. The authors assert that the lay health worker model may be a cost-effective way to prevent hospital readmissions in rural settings.[53]

Table 2: Studies of Cultural Competency: Language Services and Clinical Safety

Article	Setting	Intervention/ Exposure	Outcome
Cardarelli et al., 2018[53]	A hospital in Northeast Appalachia Kentucky	Use of lay health workers for post-discharge follow-up calls for high-need patients.	Thirty-day readmission rates decreased from 28.3 to 14.8% (p = 0.09) between the baseline and intervention phases. When adjusted for education, transportation cost, and a positive anxiety screen, the odds of being readmitted within 30 days further decreased to 77% (odds ratio [OR] 0.33; 90% confidence interval [CI] 0.14–0.81; p=0.04) among those exposed to the lay health worker program.
Karliner et al., 2017[51]	A medicine floor of an academic medical center	Increased access to professional interpreters by providing a dual-handset telephone with a direct connection to interpreter services at each hospital bedside	There was a significant decrease in observed 30-day readmission rates for the limited English proficiency (LEP) group during the 8-month intervention period compared with the 18 months pre-intervention (17.8% vs. 13.4%). At the same time, English-proficient patients' readmission rates increased (16.7% vs. 19.7%). Results remained significant in adjusted analyses (pre-intervention OR=1.07; 95% CI, 0.85 to 1.35; intervention CI=0.64; 95% CI, 0.43 to 0.95). There was no significant change in length of stay. After accounting for interpreter services costs, the estimated 119 readmissions were associated with estimated monthly savings of $161,404.

Article	Setting	Intervention/ Exposure	Outcome
Lindholm et al., 2012[50]	A tertiary care, university hospital, MA	Professional language interpretation for LEP patients at admission and discharge	Of the 3,071 patients included in the study, 39% received language interpretation on both admission and discharge date. Patients who did not receive professional interpretation at admission or both admission/discharge had higher length of stay of between 0.75 and 1.47 days compared with patients who had an interpreter on both day of admission and of discharge ($p<0.02$). Of the patient admissions who did not have an interpreter present at admission or admission/discharge, 24.3% were readmitted within 30 days, compared with 16.9% of patients with an interpreter at admission only, 17.6% of those with an interpreter at discharge only, and 14.9% with an interpreter at both admission and discharge (Chi square=19.5, degrees of freedom=3, $p<0.001$).
Woerner et al., 2009[52]	Home nursing care for 125 Hispanic patients, NY	Delivery of home nursing care using a culturally congruent approach; hiring of Hispanic nurses; staff education; culturally competent patient education	Acute hospitalization for Hispanic patients/all patients pre-intervention: 43%/30%; post-intervention: 24%/17%. Emergency department rate pre-intervention: 23%/24%; post-intervention: 21%/26%; oral medication adherence pre-intervention: 22%/42%; post-intervention: 28%/42%. (no p-values provided).

17.4.4.2.2 Language Services: Informed Consent and Advance Care Planning

Two studies showed that increasing language services for LEP patients was associated with improvements in patient participation in advance care directives.[54,55] To mitigate literacy, cultural, and language barriers to advance care planning, Sudore et al. (2018) studied an online tool for creating advance directives available to English- and Spanish-speaking patients at four safety-net primary care clinics.[54] Among the 986 participants (603 women and 383 men), the mean age was 63.3 years, 387 of 975 (39.7 percent) had limited health literacy, and 45 percent were Spanish speaking. The intervention materials were written at a fifth-grade level and designed for patients to use without needing assistance. As outlined in Table 3, compared with the advance directive alone, the tool resulted in a higher rate of advance care planning documentation. The researchers report the results were significant among both English and Spanish speakers.[54]

Lee et al. (2017) examined the impact of having 24 dual-handset interpreter phones at patient bedside on several surgery floors of a hospital.[55] Subjects included Chinese- and Spanish-speaking patients with LEP who were undergoing invasive procedures. Informed consent understanding was measured by patient-reported understanding of the reasons for and risks of the procedure and having had all questions answered. Understanding was measured before and during the 6 months after the phones were installed, with post-implementation patients more likely to demonstrate adequate informed consent. While disparities in comprehension between English-speaking and LEP patients still existed after the installation of the headsets, compared with pre-implementation, patients with LEP were more likely to meet criteria for adequate informed consent. Outcomes are provided in Table 3.[55]

Table 3: Studies of Advance Care Planning and Informed Consent

Article	Setting	Intervention/ Population	Outcome
Lee et al., 2017[55]	Cardiovascular, general surgery, orthopedic surgery floors of a hospital	Installation of dual-handset interpreter phones at every bedside enabling 24-hour immediate access to professional interpreters	During post-implementation (vs. pre-implementation) patients with limited English proficiency (LEP) were more likely to meet criteria for adequately informed consent (54% vs. 29%, p=0.001) and, after propensity score adjustment, had significantly higher odds of adequate informed consent (adjusted odds ratio [OR] 2.56; 95% confidence interval [CI], 1.15 to 5.72) as well as of each consent element individually. However, compared with post-implementation English speakers, post-implementation patients with LEP still had significantly lower adjusted odds of adequately informed consent (adjusted OR 0.38; 95% CI, 0.16 to 0.91).
Sudore et al., 2018[54]	Four safety-net, primary-care clinics, San Francisco	Easy-to-read advance directives and a patient-directed, online advance care planning program called PREPARE For Your Care (PREPARE) were created in English and Spanish	Compared with the advance directive alone, PREPARE resulted in a higher rate of advance care planning documentation (unadjusted: 43.0% [207 of 481] vs. 33.1% [167 of 505]; p<0.001; adjusted: 43.0% vs. 32.0%; p<0.001) and higher self-reported advance care planning engagement scores (98.1% vs. 89.5%; p<0.001). Results were significant among English speakers and Spanish speakers.

17.4.4.2.3 Process Outcomes: Language Services—Patient Comprehension, Translation Accuracy

Two additional process studies illustrate the importance of language interpretation, both in helping patients to comprehend written medication instructions[19] and in using professional interpreters (vs. ad hoc or no interpretation) to maximize accuracy of oral translation.[56] Quantitative outcomes are presented in Table 4.

Bailey et al. (2012) examined the efficacy of multilingual prescription drug label instructions on 202 LEP adults who spoke five non-English languages (Chinese, Korean, Russian, Spanish, and Vietnamese).[19] Participants were recruited from nine clinics and community organizations in San Francisco and Chicago. As shown in Table 4, participants who received the language-concordant instructions showed greater understanding and medication adherence compared with patients who received standard English prescription instructions.[19] Flores et al. (2012) conducted a cross-sectional error analysis of pediatric emergency department visits over 30 months.[56] Participants were Spanish-speaking LEP patients and their care-givers who received services with a professional interpreter, ad hoc interpreter, or no interpreter. Professional interpreters had a lower percentage of errors with potential clinical consequence than ad hoc interpreters and no interpreters. The number of errors by professional interpreters with more training was significantly lower than the number of errors by professional interpreters with less training.[56]

Table 4: Studies of Language Services: Patient Comprehension and Professional Translation Accuracy

Article	Setting	Intervention/ Population	Outcome
Bailey et al., 2012[19]	Nine clinics and community organizations in San Francisco and Chicago	Multilingual prescription instructions	Subjects receiving the ConcordantRx instructions demonstrated significantly greater understanding of their prescription (Rx), regimen dosing, and regimen consolidation than those receiving standard instructions (incidence rate ratio [IRR]: 1.25; 95% confidence interval [CI], 1.06 to 1.48; p=0.007 for Rx understanding, IRR: 1.19; 95% CI, 1.03 to 1.39; p=0.02 for regimen dosing, and IRR: 0.76; 95% CI, 0.64 to 0.90; p=0.001 for regimen consolidation).
Flores et al., 2012[56]	Two largest pediatric emergency departments in MA	Comparison of professional interpreter, ad hoc interpreter, or no interpreter	Fifty-seven encounters included 20 with professional interpreters, 27 with ad hoc interpreters, and 10 with no interpreters; 1,884 interpreter errors were noted, and 18% had potential clinical consequences. The proportion of errors of potential consequence was significantly lower for professional (12%) versus ad hoc (22%) versus no interpreters (20%) (p<0.01). The median number of errors by professional interpreters with at least 100 hours of training was significantly lower, at 12, versus 33 for those with fewer than 100 hours of training.

17.4.5 Implementation

Certain recommendations and challenges are repeatedly discussed in the literature for cultural competency in healthcare. In this section, we highlight these recommendations and challenges, drawing from a range of sources, including reviews and studies on healthcare quality, as well as safety articles and initiatives. We discuss organization-, provider-, and patient-level considerations.

17.4.5.1 Implementation: Facilitators and Recommendations

At the facility level, multiple reviews discussed the importance of self-assessment, data collection,[2] and root-cause analyses to identify factors, gaps, and systems in the organizational context that impact healthcare disparities and safety of patients from minority culture and language backgrounds.[11,57] Implementation efforts may benefit from analyses of the "organizational culture," biases, and readiness to change, as well as how the organization is embedded in policy frameworks, organizational arrangements, and physical settings.[2,17] Successful efforts also require commitment by leadership, allocation of resources, and performance indicators to improve accountability.[2,17,58] Experts recommend consultation/collaboration with the communities they serve on implementation (and development) of cultural competency initiatives.[17,59-61] For cultural competency efforts in general, any additional services should be fully integrated into existing systems of care.[59,60]

A number of studies and reviews from the quality literature discuss creating roles for and use of culturally similar CHWs as facilitators of implementation, in addition to their being a crucial component of an intervention for working with LEP or certain racial/ethnic groups.[52,60,61] McElmurry et al. (2009) suggest thoughtful recruitment of CHWs, ensuring that they are appropriately trained and that other staff are aware of the CHWs' roles and level of knowledge.[62] Henderson et al. (2011) note it is important to appropriately match CHWs with patients—taking into account gender norms and customs of culturally and linguistically diverse communities.[63] Further, McElmurry et al. and Henderson et al. recommend efforts to support and improve retention of CHWs.[62,63]

Intercultural communication is not just an exchange of words, but an exchange of shared meanings.[56] Clinicians, bilingual staff, and interpreters should verify understanding of meaning across cultures and language.[57] Providers should be trained in how to work with interpreters. When using professional interpreters, experts have found that interpreting accuracy decreased when clinicians use long sentences, medical jargon, or terms that are unfamiliar to the interpreter. It is suggested that interpretation is best when the message is short, simple, and clear. Additionally, interpreters perform best when, at the onset of the encounter, introductions are made that set up a collaborative relationship among the clinician, the interpreter, and the patient and family.[64] Suggestions for implementing interpreter services (e.g., augmenting in-house interpreters with phone interpreters, incorporating interpreters into rounding protocols, developing visual cues to remind hospital staff to attend to language and cultural needs) can be found in AHRQ's Improving Patient Safety Systems for Patients With Limited English Proficiency: A Guide for Hospitals.[65]

17.4.5.2 Implementation: Challenges

Several barriers to implementing cultural competency practices have been identified, including translating training into practice[16] and understanding the best methods for providing performance feedback to physicians.[66] Another challenge is identifying patients' language needs. One small study found that nurses misclassified 27 percent of self-identified Spanish-speaking patients as being English proficient in the triage process.[67] To assist in this process, protocols exist for helping to identify LEP patients.[68]

A specific implementation issue is the underuse of professional interpreters in the clinical setting. This is despite the fact that language services are legally mandated and that providers have reported a preference for working with professional interpreters over ad hoc interpreters (family, friends, or untrained staff).[69] One study found that use of professional interpreters by physicians was less than 20 percent at admission and since admission. In this study, LEP Spanish- and Chinese-speaking patients reported they either "got by" without an interpreter or were less frequently spoken to by physicians and nurses.[70] Another study found that 65.8 percent of LEP patients never had a documented interpreter visit.[71]

There are structural and provider-level reasons for underuse of interpreters, such as the fact that not all States provide reimbursement.[72] For example, pediatricians in States with reimbursement had twice the odds of using a formal interpreter versus those in nonreimbursing States (odds ratio [OR] 2.34; 95% confidence interval [CI], 1.24 to 4.40).[73] Barriers to interpreter use at the clinician level include lack of convenience and time pressures,[74] as well as concerns about the quality of interpretation and resource constraints.[75] While physicians have expressed a preference for in-person interpreters,[76] use of telephone and video conferencing increases efficiency and may help to increase use of interpreters.[73,77] To improve utilization, some have called for organizational resources and guidelines that are consistent with institutional policies and professional norms.[75] Additionally, educational campaigns could help shift clinician culture away from ad hoc interpreters.[55] Despite the cost of interpreter services, studies show that, ultimately, providing the service is cost-effective in terms of improved care[77,78] Sharing of resources across organizations has helped some facilities to overcome cost barriers.[78] Finally, to address need, more effort could be made to recruit bilingual clinicians with appropriate training and certification.[55]

17.4.6 Resources

A number of resources provide practice guidance for working with diverse populations, such as LEP patients, patients from different racial/ethnic backgrounds, immigrants, people with disabilities, people with HIV, and sexual and gender minorities. Below is a sample of resources from Federal agencies.

AHRQ: Improving Patient Safety Systems for Patients With Limited English Proficiency: A Guide for Hospitals:
https://www.ahrq.gov/health-literacy/systems/hospital/lepguide/index.html

AHRQ: Re-Engineered Discharge (RED) Toolkit. Tool 4: How To Deliver the Re-Engineered Discharge to Diverse Populations:
https://www.ahrq.gov/hai/red/toolkit/redtool4.html

AHRQ Team STEPPS®: Patients With Limited English Proficiency:
https://www.ahrq.gov/teamstepps/lep/index.html

Centers for Disease Control and Prevention (CDC): Culture & Health Literacy:
https://www.cdc.gov/healthliteracy/culture.html

CDC Effective Communication for Healthcare Teams: Addressing Health Literacy, Limited English Proficiency and Cultural Differences:
https://www.train.org/main/training_plan/3985

CDC, National Prevention Information Network: Cultural Competence:
https://npin.cdc.gov/pages/cultural-competence#1

CDC: Practical Strategies for Culturally Competent Evaluation:
https://www.cdc.gov/dhdsp/docs/cultural_competence_guide.pdf

Centers for Medicare & Medicaid Services: A Practical Guide to Implementing the National CLAS Standards:
https://www.cms.gov/About-CMS/Agency-Information/OMH/Downloads/CLAS-Toolkit-12-7-16.pdf

Georgetown University National Center for Cultural Competence:
https://nccc.georgetown.edu/

Health Resources & Services Administration: Culture, Language, and Health Literacy Resources:
https://www.hrsa.gov/cultural-competence/gender.html

Office of Minority Health: A Blueprint for Advancing and Sustaining CLAS Policy and Practice:
https://www.thinkculturalhealth.hhs.gov/clas/blueprint

Office of Minority Health: Multi-Cultural Resources for Health Information:
https://sis.nlm.nih.gov/outreach/multicultural.html

Office of Minority Health: The Guide to Providing Effective Communication and Language Assistance Services:
https://www.thinkculturalhealth.hhs.gov/education/communication-guide

The Joint Commission: Advancing Effective Communication, Cultural Competence, and Patient- and Family-Centered Care: A Roadmap for Hospitals: https://www.jointcommission.org/assets/1/6/ARoadmapforHospitalsfinalversion727.pdf

17.4.7 Gaps and Future Directions

Based on the research presented in this review, there is promise for cultural competency as a way to reduce adverse safety events in target populations. However, limiting our focus exclusively to patient safety outcomes resulted in a small number of studies from which to draw conclusions. Additionally, our search terms did not include certain key terms, such as *language assistance, bilingual, bicultural, interpretation, language concordance*, and *cultural brokers*. Still, there is a clear need for studies that are robust and that look specifically at associations between race and culture in the study of patient safety.[28,79] Since most of the small group of studies on safety were limited to language services and LEP populations (studies in the category were still minimal—perhaps due to standardization of these practices), there is a need for studies that examine the link between patient safety and other elements of organizational and provider cultural competency. There also is a need for studies that examine cultural competency interventions to improve safety for a wider range of populations (e.g., Native Americans, transgender patients) and patients who belong to more than one priority population. As the body of research grows, it will be important to see interventions that address a broader range of safety issues, such as birth outcomes, pressure ulcers, and adverse events in mental and behavioral health. Future cultural competency research should include more detailed information about patient populations and subpopulations, comorbidities, geographic and hospital-level variations, provider demographics, cost-effectiveness, links between provider knowledge and behavior, and the content and presentation of cultural competency trainings.[8,16,17,25,28] Longitudinal studies and studies that incorporate patient participation in research development could be considered.[49]

Given the paucity of research on cultural competency and patient safety, there are many opportunities for future research—for example, in-depth research on the association between CLAS and diagnostic errors. Proposed approaches to improving patient safety could also be studied. For example, Mattox (2010) recommends identifying patients at heightened risk for medical error, including patients with low health literacy, LEP, and certain racial/ethnic minority groups (e.g., African Americans).[80] Errors may be avoided with these patient groups by proactively ensuring meaningful communication, use of interpreters, and/or carefully evaluating latent and overt health risks. Other practices that address safety and could inform cultural competency include patient and family engagement, which has shown some promise, although study quality is low.[81]

Some outcomes and practices have been studied that are provider based and conceptually related to safety, and could help inform future safety research. These practices include quality patient–provider communication and trust in culturally discordant encounters.[82] As noted in our discussion of systematic reviews, studies have shown a link between provider cultural competency and communication skills, and patient trust and adherence. Other outcomes that are related to safety include provider initiation of routine screenings for minority populations. This outcome is similar to provision of appropriate medications, as it addresses whether providers are consistently following recommended practices. For example, two studies have shown that combining physician training and patient education has helped to increase colorectal cancer screening among high-risk racial/ethnic minority patients.[83,84] Finally, more could be done to explore the link between adverse safety events and provider bias and/or racism.

Several studies show a link between providers' implicit bias and patient communication challenges, as well as healthcare and health outcomes.[85,86] Given structural changes, population changes, shifting priorities, and increased understanding, in the future the meaning/framework of cultural competency will continue to shift focus and evolve. [87]

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17.5 Monitoring, Auditing, and Feedback

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17.5.1 Practice Description

Audit and feedback methods provide information to clinicians and others about performance to motivate and measure change, and are broadly defined as "any summary of clinical performance over a specified period of time."[1]

Audit and feedback interventions can be targeted to physicians, other clinicians, or entire care teams. Audits rely on chart review, direct observation, analysis of electronic data, or other clinical and non-clinical sources. Feedback can be delivered during meetings, or via email or other modes of communication. Feedback often includes a dashboard to visually show performance over time or against a benchmark, and may include an indicator of underachieving, reaching, or exceeding a predetermined threshold or benchmark. Feedback is often combined with education about the intended practice improvement and suggestions about workflow or other care process redesign.

17.5.2 Methods

Two databases (CINAHL® and MEDLINE®) were searched to identify studies published from 2008 to 2018 describing audit and feedback interventions. We included search terms for "feedback," "clinical audit," "medical audit," "quality assurance, health care," and "benchmarking." In total, 2,472 studies were identified. Abstracts from 2,335 studies were assessed and 127 full-text articles were reviewed. Thirty-one articles are included in this review, including three systematic reviews and one nonsystematic review. Studies were included if they were in English, and had an audit and feedback intervention directed at clinicians, whether individuals or clinical groups/units within a setting. We focused on research conducted in the United States and Canada, but studies conducted in the United Kingdom and the Netherlands were also reviewed. We selected studies that focused on improving patient safety and had measurable outcomes. All clinical settings and patient populations were included. Studies were excluded if the intervention was focused only on administrators or top-level executives and did not reach clinicians, or if the focus was on quality improvement without a patient safety benefit, was not health focused, or was a government-run initiative. Uncertainties were discussed with authors of other cross-cutting topics.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

17.5.3 Review of Evidence

Key findings are highlighted in a text box below.

17.5.3.1 Clinical Outcomes

Few of the reviewed articles studied the association between audit and feedback methods and clinical outcomes, and even fewer of those found significant impacts. An example of the association includes a study by Mahant and colleagues (2008). They conducted a pre/post observational study at a tertiary care pediatric hospital in Canada to audit the appropriateness of hospital days for all admissions and to provide feedback to attending physicians. A nurse used a utilization review tool to rate hospital days as

"qualified" or "nonqualified" on the basis of the nature of the inpatient services. The intervention consisted of (1) weekly feedback to attending physicians about which patients had nonqualified hospital day, and (2) dissemination of summary reports to attending physicians. The intervention was associated with a significant reduction in inappropriate hospital days (33% versus 47% in the baseline; p=0.0001). The authors calculated that 7.35 hospital days would have to be reviewed, combined with weekly feedback, to prevent 1 nonqualified hospital day. There was no significant impact on the hospital readmission rate.[2]

Key Findings:

- Audit and feedback is a somewhat common strategy for improving compliance with patient safety processes.
- Audit and feedback appears to be most effective when it employs both written and oral feedback.
- Studies show more significant improvements when performance was lower at baseline.
- Research on audit and feedback predominantly focuses on process improvement, and more research is needed to measure the impact of audit and feedback on patient outcomes.

In another study with significant patient outcomes, Hubner et al. (2017) evaluated the impact of standardized postresuscitation feedback on quality of advanced life support (ALS) for patients experiencing an out-of-hospital cardiac arrest and whether such feedback could improve patient outcomes. Feedback delivered to the emergency medical services teams included detailed process information about ALS performance, such as ventilation rate, chest compression during defibrillator loading phase, and post-arrest oxygen saturation, and outcomes such as survival and neurological outcomes for survivors. ALS performance was evaluated by trained personnel and the feedback highlighted both good performance/guideline conformity (green) and poor performance (red). Over the course of the 2-year intervention period, the standardized postresuscitation feedback protocol was associated with significant improvements in the quality of ALS, and there was a strong linear increase in both survival until hospital discharge (+6.3%) and favorable neurological outcome in survivors (+16.0%).[3]

Several other studies measured patient outcomes without finding any statistically significant impacts of audit and feedback. For example, Boet and colleagues (2018) studied the incidence of inadvertent perioperative hypothermia in a Canadian hospital. They compared benchmarked feedback (individual performance outcomes and a reminder of the target temperature) with ranked feedback (individual performance and ranking within the anesthesiology department); they also included a control group that received no feedback. They found no evidence that benchmarked or ranked feedback was more effective than no feedback in influencing anesthesiologists' performance related to patient temperature.[4] For another example of a study that found no impact of audit and feedback, van der Veer et al. (2013) studied a multifactorial quality improvement program in Dutch hospitals that included educational sessions, monthly reports to monitor performance over time, and quarterly benchmark reports. They found no significant impact on hospital length of stay, duration of mechanical ventilation, or in-hospital mortality.[5]

17.5.3.2 Care Processes Outcomes

Seventeen of the 31 reviewed studies measured whether the audit and feedback approach improves compliance with patient safety care processes. Ivers et al. (2012) conducted a systematic review of articles published from 1950 to 2010 about the impact of audit and feedback on patient outcomes, and factors that explain variation in effectiveness of audit and feedback. In their meta-analysis of 49 studies with dichotomous outcomes, in which audit and feedback was compared with usual care, they found an

average 4.3-percent absolute increase in healthcare professionals' compliance with the desired practice (interquartile range [IQR] 0.5% to 16%), and for 5 studies with continuous patient outcomes, the average percent change was 17% (IQR 1.5% to 17%). For 6 studies with dichotomous patient outcomes compared with controls, the average difference was -0.4%, and in 21 other studies with continuous outcomes, they found that the average percent change relative to controls was 1.3% (IQR 1.3% to 28.9%). Ivers and colleagues concluded that audit and feedback generally leads to small but potentially important improvements in professional practice, and that improvement is greatest when baseline performance was low.[6]

Tuti et al. (2017) conducted a systematic review of nine studies of electronic audit and feedback, ranging from antibiotic prescribing to cholesterol measurement, and completeness of records regarding lifestyle factors. Of these studies, three showed a positive impact of audit and feedback on quality of care. Five of the studies were similar enough in the outcomes studied to conduct a meta-analysis; the weighted pooled odds ratio (OR) of compliance with desired practice was 1.93 (95% confidence interval [CI], 1.36 to 2.73) when comparing audit and feedback with usual care. However, the authors considered this average effect to be unreliable, due to likely biases in this small selection of studies.[7]

Coleman et al. (2013) studied several interventions to reduce missed antibiotic doses among hospitalized patients, including: (1) the ability of doctors to pause medication doses; (2) clinical dashboards; (3) visual indicators for overdue doses; and (4) root cause analysis meetings to investigate overdue/delayed doses. Rates of both missed antibiotics and missed non-antibiotic doses decreased significantly after the introduction of clinical dashboards (0.60, p=0.001), as well as following instigation of executive-led root causes analysis meetings. However, a visual indicator for overdue doses was not associated with significant decreases in the rates of missed antibiotic or non-antibiotic doses.[8]

Diamantouros et al. (2017) studied a multifactorial, multihospital intervention to improve prescribing for venous thromboembolism (VTE) prophylaxis. Chart audits were used to identify VTE prophylaxis, and feedback included written summary reports presented at group meetings with each clinical team. The authors found a significant improvement in the rate of appropriate thromboprophylaxis for a patient subgroup with moderate risk of VTE (67% vs. 62% at baseline; p=0.048). Scales et al. (2011) randomized intensive care units in Canadian hospitals and tested audit and feedback (versus usual care) to improve six specific care processes. Overall, adoption of the targeted practices was greater in intervention intensive care units than in controls (2.79 OR; 95% CI, 1.00 to 7.74); it was greatest for semi-recumbent positioning to prevent ventilator-associated pneumonia (90.0% of patient-days in last month vs. 50.0% in first month; OR 6.35; 95% CI, 1.85 to 21.79) and for precautions to prevent catheter-related bloodstream infection (70.0% of patients receiving central lines vs. 10.6%; OR 30.06; 95% CI, 11.00 to 82.17). Adoption of other practices, many that started with high baseline adherence, changed little.[9]

Several other studies found mixed results. Langston (2011) evaluated a peer-monitoring and feedback intervention that all clinical staff could use to observe the hand hygiene practices of other health care professionals, and when hand hygiene was not performed appropriately, provide feedback to that staff member. The intervention significantly improved hand hygiene compliance among nurses after nonpatient contact in a patient's room (16.9% improvement over baseline; p=0.003) but had no impact on physicians, nursing assistants, or ancillary staff.[10]

Timing of feedback may affect its impact on compliance with patient care best practices. Zoutman and Ford (2012) randomly assigned physicians to receive monthly versus "delayed" feedback about their

antibiotic prescribing. Monthly feedback did not influence the rate of prescribing antibiotics when compared with baseline prescribing or delayed feedback; however, monthly feedback increased the appropriateness of first-line antibiotic choices when compared with baseline prescribing or delayed feedback. In addition, physicians receiving monthly feedback prescribed fewer broad spectrum antibiotics compared with baseline prescribing and the delayed feedback group, when these drugs were not the first-line choices.[11]

Some audit and feedback studies address completeness of documentation in medical records. Gilkes et al. (2017) enlisted medical students to audit the case notes completed by their supervisors (general practitioners) to identify whether the notes documented 11 specific preventive care practices for every patient encounter. Supervisors agreed to this audit and received feedback about the completeness of their case note documentation. The audit and feedback led to significant improvements in documentation of patients' alcohol consumption (24% to 36%; OR 1.19; 95% CI, 1.10 to 1.29) but did not improve documentation of patients' smoking status.[12] As another example, Dinescu et al. (2011) studied completeness of discharge summaries, which can influence the receipt of appropriate post-acute care. They found that discharge summaries were more likely to be thorough and complete following the audit and feedback intervention (91% vs. 71%, $p<0.001$).[13]

17.5.3.3 Economic Outcomes

One study (Johri et al., 2017) addressed economic impacts of audit and feedback. Researchers randomly assigned 32 Canadian hospitals to intervention or control; in the intervention group, hospital audit committees assessed the appropriateness of caesarean childbirth deliveries and provided feedback to clinicians about best practices. The authors found a significant average cost reduction of $190 (per patient); this was associated with less frequent neonatal complications in the intervention group (95% CI, -$255 to -$125, $p<0.001$).[14]

17.5.3.4 Unintended Consequences

The 31 reviewed studies mentioned no unintended consequences of audit and feedback on patient outcomes or care processes.

17.5.3.5 Summary of Evidence on Implementation

The 31 studies varied in terms of the format of the audit and feedback intervention, who provided feedback, and the frequency and timing of feedback. It has been noticed that, for the most part, studies reviewed focus on feedback as opposed to audit; audit is typically mentioned only as the first part of an audit and feedback intervention.

Colquhoun and colleagues (2017) conducted a nonsystematic review to identify audit and feedback design elements. They reviewed 17 audit and feedback interventions and found that feedback was primarily given to individuals only (51%), rather than to groups (18%) or a combination of both individual and group (16%). Feedback was rarely given on patient outcomes (14%); instead, feedback was mostly about care processes (79%). The most common comparison in the feedback was to peers' performance or "others''' previous performance (49%). Fifteen percent included a standardized guideline as a comparator, and 4% measured change against the person's own previous performance. Lag time (the time between the collection of data for audit and the resulting feedback) was most commonly a few to several months (33%), and rarely a fast turnaround such as days or weeks. Feedback was given in person

in less than half of the studies (44%). Feedback was delivered just once in 24 percent of the studies, twice in 15 percent, three times in 9 percent, and more in 28 percent.[1]

Le Grand Rogers et al. (2015) reviewed 24 studies published from 1994 to 2014 related to audit and feedback of physicians in hospital emergency departments. In 5 of the 24 studies, electronic feedback was provided, and the remaining 19 studies used a combination of oral, written, and electronic feedback. Twenty of the 24 (83%) provided feedback with explicit, measurable instructions and with a plan for change. Seventeen gave feedback in intervals greater than 1 week, four gave feedback at intervals ranging from 1 day to 1 week, and three gave feedback less than 24 hours after the audit.[15] Zoutman and Ford (2012) surveyed 40 physicians who completed an audit and feedback intervention related to antibiotic prescribing, and the preferred frequency for feedback was quarterly (53% of respondents).[11]

In their large systematic review, Ivers et al. (2012) found that feedback is most effective when provided by a supervisor or colleague, when feedback is provided more than once, and when feedback is delivered in both oral and written formats.[6] Many studies were structured with a supervisor, peer, or independent researcher providing feedback, but there were exceptions. For example, Gilkes et al. (2017) used medical students to audit their general practitioner physician supervisors.[12] Langston (2011) had all nurses, nursing assistants, and unit coordinators complete audits and give feedback to other clinicians on the unit about hand hygiene.[10]

17.5.3.6 Barriers and Facilitators

Dawson et al. interviewed 30 healthcare professionals involved in a hand hygiene audit and feedback study about perceptions of the usefulness of the feedback. Interviewees raised concerns about how data generated by the audit process were used to engender change, and found it hard to perceive any change stemming from the audit process. Interviewees also felt unable to relate the feedback data they received to the training program for hand hygiene, or to understand how the results of the audit could inform strategies to improve hand hygiene.[16] Ivers et al. (2014) tested whether audit and feedback could improve the proportion of patients meeting quality targets for chronic disease management. They found that family physicians did not readily act upon the feedback reports they received for a number of reasons, including competing organizational level priorities, difficulty with patient-level (and personal) priority setting, and concern about potential flaws in the data or targets used in the feedback.[17]

Locus of control can affect the perceived credibility of and reactions to feedback. Redwood et al. (2013) studied whether a weekly dashboard providing feedback on prescription warning information and laboratory alerting acceptance rates was effective in changing the prescribing behavior of junior physicians. Nineteen of the junior physicians participated in follow-up interviews. While interviewees confirmed that the dashboard was helpful in stimulating reflection on their clinical behaviors and responsibilities, they felt the feedback did not reflect their own clinical practice because actions that generated alarms, alerts, and warnings were often ordered by senior physicians. They felt that the feedback could better motivate behavior change if directed to the ordering physician, not to the junior physician carrying out the order.[18]

Several studies interviewed or surveyed clinicians about their attitudes regarding the audit and feedback intervention. Jeffs and colleagues (2014) interviewed 56 nurses and unit managers about the feedback dashboards used in six hospital units. The majority of interviewees found the visual cues in the

dashboard to be useful, understandable, and motivating, and valued seeing feedback about the performance of the individual unit where they work.[19] In the Zoutman and Ford antibiotic study (2012), 40 physicians responded to a survey about the audit and feedback intervention and reported that feedback on antibiotic use was interesting (3.4 out of 4), useful (3.4), and influential (3.2).[11] The systematic review by Ivers et al. (2012) found that feedback was most effective when it included both explicit targets and an action plan.[6]

Two studies noted that effects of audit and feedback are greater when baseline performance is low. In the meta-analysis by Ivers et al. (2012), lower baseline performance was associated with greater improvement following audit and feedback intervention (p=0.007). Specifically, their regression model predicted that participants who were at 25 percent of desired practice at baseline would have an expected improvement of 9 percent, while those who were at 75 percent of desired practice at baseline would have an expected improvement of only 5 percent.[6] Similarly, Scales et al. (2011) found little improvement for care processes when baseline adherence to best practices was high.[20]

17.5.3.7 Resources To Assist With Implementation

Short descriptions of resources for implementing patient safety practices discussed in this review (e.g., tools/toolkits from the U.S. Centers for Disease Control and Prevention [CDC] and Agency for Healthcare Research and Quality) can be found in the following locations:

CDC presentation on giving infection prevention feedback:
https://www.cdc.gov/infectioncontrol/pdf/strive/CBT103-508.pdf

Patient Safety Network Patient Safety Toolkit for General Practice, which includes significant event audit:
https://psnet.ahrq.gov/resources/resource/30259/Patient-Safety-Toolkit-for-General-Practice?q=audit+and+feedback

Clinical Audit Tool from Royal College of Physicians and Surgeons of Canada:
http://www.royalcollege.ca/rcsite/documents/continuing-professional-development/clinical-audit-tool-e.pdf

17.5.4 Gaps and Future Directions

17.5.4.1 Gaps

Few of the 31 articles addressed the impact of audit and feedback on patient outcomes. Most studies compared performance on specific care processes with performance at baseline or to a control group, and some assessed performance against benchmarks or standards/guidelines, rather than measuring impact on patient outcomes. In the studies reviewed, many authors appear to assume that compliance with guidelines, or achieving care process targets, will yield better (unmeasured) patient outcomes.

There is some evidence[6, 15-18] that audit and feedback is most effective when clinicians understand and trust the data on which feedback is based, when feedback is actionable, and when there is a clear plan clinicians can follow to improve. There is also some evidence that it is important to select performance measures that are meaningful to clinicians and on which there is substantial room to improve (i.e., when baseline performance is low).

17.5.4.2 Future Directions

Based on this review, some evidence indicates that audit and feedback can yield small improvements in care processes, but more information is needed about whether this in turn improves patient outcomes. Future research should focus, ideally, on clinical outcomes, and also on care processes that are meaningful in the eyes of clinicians, where baseline performance is poor, where data are unambiguous and trusted by clinicians, and where it is possible to clearly connect feedback with action plans for improvement.

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17.6 Teamwork and Team Training

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17.6.1 Practice Description

Key Findings:

- The majority of studies conducted to improve teamwork and communication occurred in a hospital setting.
- CRM and TeamSTEPPS® were the most frequently studied team training programs. They led to immediate improvements in learning; longer term transfer of knowledge, skills, and attitudes (KSAs) to the job; and some patient outcomes.
- Psychological fidelity is more important than physical fidelity when using simulation to improve non-technical skills such as teamwork.
- Performance support tools (e.g., briefings, checklists, and handoffs) have been implemented to enhance team performance, resulting in a variety of improved processes and some improved outcomes for patients.

Failures in communication and teamwork have been identified as contributing factors in approximately 68 percent of adverse events.[1] Considerable effort has been made to improve teamwork within healthcare settings through the use of team training programs and performance support tools. According to Weaver et al. (2014), "team-training is defined as a constellation of content (i.e., specific knowledge, skills, and attitudes (KSAs) that underlie targeted teamwork competencies), tools (i.e., team task analysis, performance measures) and delivery methods (i.e., information, demonstration and practice-based learning methods) that together form an instruction strategy."[2] Some of the earliest healthcare team training programs were based on Crew Resource Management (CRM), an established and validated strategy within the aviation community. Subsequently, the Veterans Health Administration introduced its own team training program, called Medical Team Training (MTT). Similarly, the Agency for Healthcare Research and Quality (AHRQ) partnered with the Department of Defense to develop a team training program specifically designed for healthcare providers called Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS®). Introduced in 2006, TeamSTEPPS aims to improve a common set of team KSAs that providers can apply when working in any healthcare team. Four specific, trainable skills are highlighted in the program: leadership, situation monitoring, mutual support, and communication.

Since its inception, TeamSTEPPS has become the national standard for team training in healthcare.[3] In 2015, it was estimated that over 1.5 million individuals had been trained in TeamSTEPPS.[4] In sharing their insights of 10 years of TeamSTEPPS work, Baker et al. (2017) recognized the immense spread of TeamSTEPPS, not only in the United States, where it is estimated that approximately 35 percent of all healthcare workers have been exposed to TeamSTEPPS in some form, but also around the world. One reason for this uptake is that TeamSTEPPS concepts are applicable across healthcare environments and the training (and associated support tools) are easily adaptable.[5] Moreover, evaluation data collected on TeamSTEPPS and other team training programs have demonstrated positive results.[6, 7]

Most studies have incorporated into their evaluation efforts Kirkpatrick's (1956; 1996) multi-level framework, which suggests that learning interventions be assessed on four criteria: reactions, learning, transfer, and results (Table 5).[8, 9] Studies that assess multiple criteria, collect measures at multiple levels (e.g., individual and team, team and organization), and/or incorporate multiple measurement methods (e.g., surveys and observations) provide the most meaningful evaluations and insights regarding an intervention's effectiveness.[10]

Table 5: Kirkpatrick's Evaluation of Learning

	Level	Criteria
Weakest to Strongest Indicators of Learning	1	Reactions: The degree to which participants like the training and feel it is relevant to their work.
	2	Learning: The extent to which knowledge or skill has changed as a result of the intervention.
	3	Transfer: The application of knowledge and skills gained during training back in the actual work environment.
	4	Results: The greater impact that the training has on important organizational outcomes.

Team training programs such as TeamSTEPPS also include a variety of tools to help ensure that teamwork skills are transferred from the training environment and integrated into daily practices. Toward that end, performance support tools such as checklists, briefings, and huddles have been implemented to increase communication and teamwork in a variety of healthcare environments. This review summarizes the practices used to improve teamwork in healthcare and presents evidence of their effectiveness based on Kirkpatrick's four criteria of learning.

17.6.2 Methods

The question of interest for this review is: "What are the most effective practices to improve teamwork?" To answer this question, two databases (i.e., CINAHL® and MEDLINE®) were searched to identify studies published from 2008 to 2018 that implemented practices to improve teamwork. Search terms included "teamwork," "team processes," "collaboration," "communication," "team performance," "team training," "team effectiveness," and related synonyms, as well as terms such as "training intervention" and "quality improvement." Based on previous reviews, specific team training programs such as "TeamSTEPPS," "VA Medical Team Training," "Crew Resource Management," and "MedTeams" were also searched. The initial search yielded 1,760 results. After duplicates had been removed, 1,231 were screened for inclusion, and 126 full-text articles were retrieved. Of those, 33 were selected for inclusion in this review, of which 29 are single studies, 3 are systematic reviews,[2,11,12] and 1 is a meta-analysis.[13] Articles were excluded if the article was out of scope (including not quantitative), the study design was insufficiently described, the primary goal was not improving teamwork, the study did not evaluate a practice/method to enhance teamwork, the study was conducted with medical or nursing students, or the study was conducted outside of the United States. Key findings are located in the box on the previous page.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

17.6.3 Review of Evidence

The practices used to improve teamwork fell into seven categories: CRM, TeamSTEPPS, MTT, Simulation (either standalone or coupled with team training), briefings, checklists, and handoffs. Across these categories, the majority of the studies took place in a hospital setting (including academic teaching hospitals, community-based hospitals, and military hospitals), and one study was conducted in a psychiatric hospital. A variety of survey and observational data were gathered as indicators of effectiveness. These data are evaluated using Kirkpatrick's model of learning. For the purposes of this

review, we follow the criteria included in Table 5, noting that we consider learning as immediate changes in knowledge, skills (teamwork or clinical processes), or KSAs, whereas transfer refers to the longer term changes in KSAs demonstrated on the job. Measurements taken in the work environment at least 30 days following training will be treated as indicators of transfer. Also, organizational outcomes as well as patient outcomes are treated as results criteria.

Both the systematic reviews and meta-analysis provide data related to the four criteria in Kirkpatrick's evaluation framework (although not every study collected data on all 4 criteria), and findings are presented where applicable. Out of the 29 individual studies in the review, 6 reported data on participant reactions. Nineteen studies (66%) collected data immediately following the intervention to demonstrate participant learning. Fifteen of the 29 studies (52%) collected evidence of transfer of training, as most post-intervention measures of teamwork and clinical processes were collected approximately 3 months following the intervention. Results, in the form of clinical or patient outcomes, were reported in 11 studies. Measures of learning, transfer, and results were selected based on the environment where the intervention had been introduced. A wide variety of measures were incorporated and few studies used the same measures.

The following subsections summarize the evidence related to the seven practices identified for improving teamwork. Next, a summary of how these practices have been implemented is presented. Finally, areas for future research are proposed.

17.6.3.1 Practice: CRM

CRM Training was originally developed to improve teamwork within the aviation community. CRM programs focus on improving attitudes toward and knowledge about teamwork, as well as increasing the use of teamwork skills. CRM programs generally follow a workshop format (i.e., classroom training) that includes a didactic lecture, demonstration of both positive and negative examples of teamwork, hands-on practice using teamwork skills (e.g., in role play exercises or simulation exercises), and feedback regarding the effectiveness of teamwork skills demonstrated by participants. A considerable amount of research on improving teamwork and communication within healthcare has applied CRM as an instructional strategy.[2]

17.6.3.2 Process Measures

Studies included in Weaver et al.'s (2014) systematic review and Hughes et al.'s (2016) meta-analysis of team training collected process measures related to reactions, learning, and transfer. Additionally, the five individual studies of CRM collected process measures of three criteria included in Kirkpatrick's framework. One study collected reaction criteria as part of their evaluation. Three studies collected data immediately following the training to assess participant learning. All five studies collected pre- and post-training measures of team behaviors (e.g., perceptions of teamwork, communication) a few months after the training, which represent Kirkpatrick's transfer criteria. Clinical processes relevant to the setting (emergency department, an obstetrics/neonatal unit, and operating room) provide additional data on transfer criteria in two of the studies.

17.6.3.2.1 Process Measures: Reactions Criteria

Six of the nine CRM studies reviewed by Weaver et al. (2014) measured participant reactions as part of their evaluation efforts. Only 5 of the 126 studies included in the meta-analysis conducted by Hughes et al. (2016) reported reactions to team training. Overall, the studies that used CRM report positive

reactions to the training. Similarly, Hughes et al. reported that healthcare team training programs result in positive participant reactions (corrected standardized mean difference in a repeated measures metric=.53 and the 95% confidence interval [CI] excluded zero: 95% CI, .33 to .73).[13]

Of the individual CRM studies identified, Halverson et al. (2009) demonstrated positive reactions to preoperative briefings that were introduced as part of CRM training. Survey data indicated that respondents had positive reactions toward the preoperative briefings and felt that they were useful in setting the stage for good communication (approximately 75% favorable), understanding the plan for care (approximately 70% favorable), and teamwork (approximately 75% favorable).[14]

17.6.3.2.2 Process Measures: Learning Criteria

Four of the CRM studies reviewed by Weaver et al. (2014) collected measures of learning. All studies reported that participants were more confident in using teamwork skills and dealing with critical events following the CRM training. In addition, one study also demonstrated increased knowledge of teamwork as a result of the training. Further evidence of learning was provided by the meta-analysis published by Hughes et al., which found that healthcare team training increased learning (affective, cognitive, and skill-based learning) from pre- to post-training (corrected standardized mean difference in a repeated measures metric=.89, *k* =79, 95% CI, .66 to 1.11).[13]

In an individual study conducted by Levy et al. (2014), CRM training was delivered in the emergency departments at three different hospitals to improve acute coronary syndrome (ACS)-centered care. Positive results were reported in participant learning. Specifically, immediately following the training, participants were significantly more confident in their ability to identify processes that could lead to errors (pre-training=12% reported being extremely confident vs. post-training=32%, p<0.001); apply CRM techniques (pre-training=4% reported being extremely confident vs. post-training=35%, p<0.001); and implement recommended treatment strategies for ACS (pre-training=18% reported being extremely confident vs. post-training=38%, p=0.002). Additionally, scores on a knowledge test significantly improved from the pre- to post-test (pre-training=61% correct vs. post-training=73%, p=0.003).[15]

Measures of participants' confidence and knowledge were also used as an indicator of learning in a study conducted by Tapson et al. (2011). They delivered CRM training to 160 surgical staff and surgeons with privileges at the participating hospital in an effort to increase teamwork and decrease venous thromboembolism (VTE). Following training, participants were significantly more confident in their ability to identify processes that could lead to errors (pre-training=35% reported being extremely confident vs. post-training=68%, p<0.001); use CRM techniques (pre-training=16% reported being extremely confident vs. post-training=62%, p<0.001); and identify surgical patients who should receive VTE prophylaxis (pre-training=20% reported being extremely confident vs. post-training=55%, p<0.001). In addition, substantial improvement was found in knowledge, as participants answered 43 percent of the questions correctly prior to the training and 72 percent immediately following the CRM training. Finally, significant improvements were also reported in three clinical processes. Specifically, a review of patient charts showed that significantly more cases met American College of Chest Physicians guidelines for standards in care for timing (pre-intervention=81% vs. post-intervention=94%, p=.024); inpatient duration (pre-intervention=89% vs. post-intervention=94%, p=.022);, and prophylaxis use beyond hospital discharge (pre-intervention=84% vs. post-intervention=96%, p=.0264). These findings suggest that the training had a positive impact on participant learning.[16]

Sax et al. (2009) also found positive results in learning following CRM training. Pre to post data indicated that participants felt significantly more empowered to speak up immediately after the CRM course. For example, they reported being significantly more comfortable communicating that an error was about to occur (pre-training mean=3.0 vs. post-training mean=3.4, p<.05); confronting mistakes made by a technician (pre-training mean=2.8. vs. post-training mean=3.7, p<.05); confronting mistakes made by a nurse (pre-training mean=2.8. vs. post-training mean=3.3, p<.05); and confronting mistakes made by a physician (pre-training mean=2.8. vs. post-training mean=3.2, p<.05). These findings suggest that trainees learned the importance of communication, which had been emphasized during the training.[17]

17.6.3.2.3 Process Measures: Transfer Criteria

The systematic review conducted by Weaver et al. (2014) included four studies that measured transfer of training on to the job. Collectively, the studies reported continued levels of confidence using CRM skills (sustained up to a 12-month followup), improvements in team skills on the job, and improvements in safety culture.[2] Similarly, the Hughes et al. (2016) meta-analysis found that team training resulted in a significant increase of KSAs demonstrated on the job (corrected standardized mean difference in a repeated measures metric=.67, *k*=63, 95% CI, .52 to .82).[13]

The individual CRM study conducted by Levy et al. (2014), which found improvements in learning, also found slightly longer term effects that support transfer. At a 30-day post-training check-in, the levels of increased confidence that participants had reported immediately after training had been sustained. Participants were significantly more confident in their ability to identify processes that could lead to errors as compared with in the pre-intervention period (pre=12% reported being extremely confident vs. follow-up=36%, p<0.001); apply CRM techniques (pre=4% reported being extremely confident vs. follow-up=37%, p<0.001); and implement recommended treatment strategies for ACS (pre=18% reported being extremely confident vs. follow-up=35%, p=0.002). Improvements in knowledge of CRM were also sustained at the 30-day post-intervention follow-up (61% vs. 66%, p=0.026). These data suggest that the CRM training resulted in positive transfer to the job.[15]

In their CRM effort, Mancuso et al. (2016) focused on improving communication surrounding cesarean births. CRM training and a pre-brief/debrief checklist for cesarean births were introduced to increase information shared by team members. Observational data collected during the pre-briefings and debriefings indicated that communication increased for both obstetric and neonatal teams. The number of team members who were fully engaged during the pre-brief in both teams increased following training, and was significant for the obstetrics team (number of obstetrics team members engaged before training=2.13, number after training=4.46, p<.001; number of neonatal team members engaged before training=2.78, number after training=3.18, p=.178). The amount of communication increased significantly for the obstetrics team during their within-team pre-brief (pre=31 vs. post=50, p<0.001); when they debriefed with the neonatal team (pre=10 vs. post=33, p<0.001); and during their within-team debriefings (pre=15 vs. post=36, p<0.001). Communication significantly increased for the neonatal team when they debriefed with the obstetrics team (pre=37, vs. post=48, p<0.001).Thus, this study provides partial evidence that CRM training resulted in increased participation and information sharing during briefings that occurred on the job.[18]

The study of CRM training conducted by Tapson et al. (2011) also collected data on Kirkpatrick's transfer criteria. Participants' confidence in their ability to use CRM techniques remained significantly higher at 30-day follow-up than at baseline (pre-training=21% reported being extremely confident vs. 30-day

post-training=55%, p<0.001). They also remained significantly more confident in their ability to identify which patients were appropriate candidates for VTE at the 30-day follow-up (pre-training=24% reported being extremely confident vs. 30-day post-training=48%, p=0.003). These findings suggest some longer term retention and transfer of training, although 30-day follow-up data were available only for a sample of 29 participants.[16]

Finally, Halverson and colleagues conducted two studies of a team-training program based on CRM principles and delivered to operating room staff. Both studies collected survey and observational data to assess whether the CRM training improved teamwork on the job. In the first study, Halverson et al. (2009) reported that perceptions of teamwork significantly improved on 14 of the 19 items measured 6 months following the training (p<.05); that is, respondents indicated that teamwork behaviors had increased following the CRM training. Some of the largest improvements were related to speaking up with persistence in the operating room (48% to 70%, p<.001) and leader communication/updates, especially during non-routine situations (46% to 63%, p<.001). However, results were mixed when evaluating transfer of training on clinical processes. Following the training, a substantial increase was observed in compliance with all required elements in time-outs (pre=47%, post=86%), indicating that the teams began conducting a more thorough pre-procedural verification process of the patient, surgical site, and planned procedure. However, there were no significant improvements in the timely administration of prophylactic antibiotics, nor in turnover times between surgical patients at the 6-month followup.[19] Together, these data (along with the positive participant reaction data reported) lend partial support for CRM training effectiveness, as improvements were observed in teamwork and in the one clinical process measured.

In their second study, also concerning the operating room, Halverson et al. (2011) examined the impact of CRM training on communication errors. Significantly fewer communication errors were observed in the post-training period, which occurred 6 to 9 months following the training, suggesting that participants applied what they had learned about communication from the CRM training (pre-training communication errors per hour=0.737, post-training communication errors per hour=0.270, p<0.001). Results concerning the consequences of the communication errors were mixed. On a positive note, errors were more frequently evaluated as having “no consequences” following the training (pre-training=12%, post-training=25%), as well as resulting in fewer inefficiencies (pre-training=24%, post-training=13%). However, the post-training period was associated with higher levels of tension due to the communication errors committed (pre-training=12%, post-training=17%), perhaps due to changes in expectations following the training.[14]

17.6.3.3 Clinical Outcomes: Results Criteria

The systematic review of team training conducted by Weaver et al. (2014) included nine studies of CRM. Four CRM studies in that review measured results through the collection of various clinical process and outcome measures. They reported that CRM was associated with improvements in clinical management scores, decreases in adverse outcome index (i.e., composite score of clinical outcomes), increases in standards in care (e.g., speed and completeness of resuscitations in the emergency department), and increased patient satisfaction.[2]

A meta-analysis conducted by Hughes et al. (2016) specifically examined the impact of healthcare team training on organizational results, such as safety climate and length of stay, and on patient outcomes, including patient satisfaction and mortality. Although they did not differentiate between specific team

training programs (such as CRM), they reported that team training had a positive impact on results (corrected standardized mean difference in a repeated measures metric=.37, k=47, 95% CI, .21 to .52) such as organizational outcomes (corrected standardized mean=.34, *k*=31, 95% CI, .19 to .49) and safety climate (corrected standardized mean difference in a repeated measures metric=.31, *k*=24, 95% CI, .14 to .48). Team training was also shown to improve patient outcomes (corrected standardized mean difference in a repeated measures metric=.38, *k*=20, 95% CI, .10 to .66).[13]

Overall, results from the systematic review, the meta-analysis, and individual studies demonstrated positive results on process measures. Specifically, trainees reacted positively to the CRM training across studies, improved their knowledge of teamwork, and reported greater confidence in using teamwork skills. Importantly, data also indicated that trainees increased their use of team KSAs back on the job. Finally, evidence that CRM resulted in improved patient safety (e.g., reduced length of stay, reduced mortality) was provided by one systematic review of CRM and one meta-analysis on team training programs in general.

17.6.3.4 Practice: TeamSTEPPS® Training

TeamSTEPPS is a team training program developed specifically for healthcare providers by the U.S. Department of Defense in collaboration with AHRQ. TeamSTEPPS training focuses on four trainable teamwork behaviors: communication, leadership, situation monitoring, and mutual support. The training imparts information on these behaviors, incorporates videos demonstrating positive and negative examples of the skills being used, and provides multiple tools that can be used to increase teamwork behaviors in healthcare settings. Although the TeamSTEPPS program has evolved over the years to include multiple settings (e.g., office-based care, long-term care), as well as online training modules, the studies in the current review followed the traditional TeamSTEPPS program for hospital settings.

17.6.3.5 Process Measures

Both the systematic review conducted by Weaver et al. (2014) and the meta-analysis conducted by Hughes et al. (2016) collected process measures related to reactions, learning, and transfer.[2,13] However, only the work of Weaver et al. reported findings by specific team training program/curriculum (e.g., TeamSTEPPS). The findings are presented in the following subsections. Additionally, six individual TeamSTEPPS studies were identified, which were conducted in an emergency department, a psychiatric unit, an obstetric unit, a pediatric intensive care unit (ICU), a surgical ICU, and among respiratory therapist staff. All of the studies reviewed collected process measures relevant to their setting. Two of the individual studies reported data on participant reactions and three collected measures of participant learning immediately following the training. Four studies collected post-training data at least 45 days following TeamSTEPPS training and are reported as indicators of Kirkpatrick's transfer criteria.

17.6.3.5.1 Process Measures: Reactions

One out of the seven TeamSTEPPS studies reviewed by Weaver et al. (2014) measured participant reactions as part of their training evaluations, with the majority of participants providing favorable reactions and indicating that the TeamSTEPPS training was useful to their work.[2] Likewise, Hughes et al. (2016) also reported that participants had positive reactions to team training efforts in healthcare (which included studies that used TeamSTEPPS).[13]

Evidence of reaction criteria was also provided by two individual TeamSTEPPS studies. Sonesh et al. (2015) delivered a condensed version of TeamSTEPPS training to obstetric (OB) clinicians. Overall, participants had positive feelings toward the training, with 85 percent indicating that they had enjoyed the training and 90 percent agreeing that they would likely apply the tools presented during the training on the job.[20]

Similarly, participants responded favorably when TeamSTEPPS training was delivered to operating room teams. For example, 94 percent of respondents indicated that the training content was appropriate and 81 percent believed that the training would help their organization improve patient safety.[21]

17.6.3.5.2 Process Measures: Learning

Two of the TeamSTEPPS studies reviewed by Weaver et al. (2014) collected measures of learning. The results were mixed: one of the studies found no changes in teamwork knowledge (i.e., no changes in cognitive-based learning) following the training, while the other study reported increased confidence in leadership and clinical management skills (i.e., increase in affective-based learning).[2] However, results from Hughes et al.'s (2016) meta-analysis provided full support for the hypothesis that team training in healthcare resulted in increased learning.[13]

In terms of individual studies reviewed, Sawyer et al. (2013) provided support of learning immediately following TeamSTEPPS training. They reported that immediately following the training, newborn intensive care unit personnel had significantly more positive attitudes toward teamwork (pre-training mean=4.4 vs. post-training mean=4.7, $p<.001$) and significantly greater knowledge of teamwork (pre-training mean=86.6% vs. post-training mean=92.6%, $p<.001$). In addition, significant improvements were noted in all five teamwork dimensions: team structure (pre-training mean=2.5 vs. post-training mean=4.2, $p <.001$); leadership (pre-training mean=2.6 vs. post-training mean=4.4, $p<.001$); situation monitoring (pre-training mean=2.5 vs. post-training mean=4.3 $p<.001$); mutual support (pre-training mean=2.9 vs. post-training mean=4.3, $p<.001$); and communication (pre-training mean=3.0 vs. post-training mean=4.4 $p<.001$).[22]

The effort by Sonesh et al. (2015), which delivered TeamSTEPPS training to OB clinicians, examined participants' knowledge of situation awareness and teamwork before and after the training as an indicator of learning. No significant improvements were reported in learning in this study ($p>.05$).[20]

Based on behavioral observations in the operating room (OR), Weaver et al. (2010) reported some improvements in learning in their TeamSTEPPS study. They reported that trained teams engaged in significantly more pre-briefings than the control group ($p<.001$) and that significantly more team members participated in the pre-briefings (i.e., shared information) compared with control teams ($p<.001$). Additionally, observations made during surgery indicated that trained teams significantly improved on two teamwork behaviors following the training: communication ($p<.05$) and mutual support ($p<.01$). Taken together, these studies provide some evidence of participant learning as result of TeamSTEPPS.[21]

17.6.3.5.3 Process Measures: Transfer

Weaver et al.'s (2014) systematic review included six studies that measured transfer of TeamSTEPPS training onto the job. Overall, the studies reported a variety of positive results related to transfer, including satisfaction with process improvements (maintained for up to 2 months), sustained use of performance tools to increase teamwork (at a 3-month followup), improved perceptions of teamwork

(some of which were sustained for up to 12 months), and some improvements in participants' perceptions of safety.[2] Further support of transfer of team training was provided by Hughes et al. (2016). Results of their meta-analysis, which included TeamSTEPPS studies, indicated a significant increase in KSAs on the job following healthcare team training programs.[13]

Four individual studies also collected measures to assess transfer of TeamSTEPPS training. The first study provided TeamSTEPPS training in an emergency department of an academic medical center.[23] Repeated measures of communication climate and knowledge of teamwork were taken prior to training and at two points (45 days and 90 days) following training. The communication climate subscale of AHRQ's Hospital Survey on Patient Safety demonstrated significant improvements on all subscale items at both 45 and 90 days after training (p=.05). Scores on the TeamSTEPPS Knowledge Test also significantly improved on 15 of the 21 items at the 45-day followup, and were sustained on 13 of the 21 items at the 90-day follow-up. Huddles and the CUS script ("I am Concerned," "I am Uncomfortable," "This is a Safety issue") were chosen as TeamSTEPPS strategies to implement following the training to improve communication. Huddles occurred 64 percent of the time, and 47 percent of survey respondents indicated that they had used the CUS technique at least once. Collectively, these data provide moderate evidence that KSAs had been applied on the job as a result of the TeamSTEPPS training.[23]

In their study of a psychiatric unit, Mahoney et al. (2012) reported significant improvement on five out of seven dimensions measured by the Team Assessment Questionnaire 12 months following TeamSTEPPS training. Significant improvements were found related to: team foundation (pre-training=3.76, post-training=4.10, p=.001); team functioning (pre-training=3.88, post-training=4.16, p=.003); team performance (pre-training=3.78, post-training=4.10, p=.001); team skills (pre-training=3.76, post-training=4.08, p=.001); and climate and atmosphere (pre-training=3.68, post-training=3.97, p=.004). While no significant change was found on team leadership (pre-training=4.07, post-training=4.23, p=.122) or team identity dimensions (pre-training=4.09, post-training=4.22, p=.156), the mean scores for these two dimensions were high prior to the training and increased over time. Given that the post-training measure was collected 12 months after the training, this study demonstrates sustained improvement in teamwork.[24]

A study of a customized 2.5-hour version of TeamSTEPPS training (delivered to all pediatric ICU, surgical ICU, and respiratory therapist staff) conducted by Mayer et al. (2011) also examined participant learning. They found significant improvements in observed teamwork skills, a clinical process, and safety climate. Using the Teamwork Evaluation of Non-Technical Skills observation tool, scores on all six teamwork dimensions significantly improved from baseline to 1 month after the training (p<.01). Moreover, scores on five of the six teamwork dimensions were significant (p<.01) at a 12-month assessment (with the exception of situation monitoring), indicating long-term behavioral change. Data gathered on clinical processes revealed improvement as a result of the TeamSTEPPS training as well. Specifically, the average time to place patients on an extracorporeal membrane oxygenation life support machine was significantly lower after training (pre-training=23.00 minutes, post-training=13.96 minutes, p=0.02). Mayer et al. reported that pre- to post-scores on the Hospital Survey on Patient Safety Culture significantly increased on two subscales (i.e., "overall perceptions of safety" and "communication openness") for participants in both units.[25]

Finally, Sonesh et al. (2015) also examined whether TeamSTEPPS training resulted in improved teamwork on the job. Data collected using the Teamwork Perceptions Questionnaire showed that self-

reported perceptions of teamwork had improved on all four TeamSTEPPS behaviors, but these increases were not statistically significant ($p > .05$). However, additional data from behavioral observations of patient-related decisions indicated that more-accurate decisions were made 1 to 3 months following the training (pre-training accuracy=61.54% vs. post-training=82.9%, $p<.05$).[20] Therefore, this study provides some evidence of improved performance on the job.

17.6.3.6 Clinical Outcomes: Results Criteria

Four studies in the Weaver et al. (2014) review used TeamSTEPPS and reported improved clinical outcomes such as reductions in surgical morbidity, lower infection rates, and decreases in adverse events reported. Hughes et al.'s (2016) meta-analysis found support that healthcare team training (including TeamSTEPPS) improves results. including organizational outcomes, safety climate, and patient outcomes.

Three of the individual studies of TeamSTEPPS in the review gathered outcome measures that align with results criteria from Kirkpatrick's evaluation framework. Mayer et al. (2011) delivered a customized, 2.5-hour version of TeamSTEPPS training to minimize the time that staff were away from clinical work. The training, delivered to all pediatric ICU, surgical ICU, and respiratory therapist staff, had a positive impact on the clinical outcome variable collected. Following the training, the rate of nosocomial infections was consistently lower in the pediatric ICU (i.e., in 7 out of 8 post-intervention months) and intermittently lower in the surgical care unit (i.e., in 4 out of 8 post-invention months).[25]

As part of their TeamSTEPPS study of OB clinicians, Sonesh et al. (2015) examined several patient outcomes in their study, including length of stay for infants, length of stay for mothers, transfer to the newborn intensive care unit, and morbidity of infants. The only outcome that approached statistical significance was length of stay for infants, which decreased from 3.85 days to 2.83 days ($p=.07$) over the course of the study.[20]

Weaver et al. (2010) measured the impact of TeamSTEPPS training on safety culture to demonstrate larger organizational results criteria. Pre- to post-comparisons on the Hospital Survey on Patient Safety Culture showed that the teams trained in TeamSTEPPS significantly increased their percentage of positive responses following the training. However, safety culture scores also increased over the pre- and post-assessment for the teams in the control group. The authors noted that their results should be interpreted cautiously, especially given that a total of only three teams had been trained (approximately 29 individuals).[21]

Taken together, the TeamSTEPPS studies reviewed provided positive support for this practice on process measures such as trainee reactions. Although the studies provided partial support for the idea that the TeamSTEPPS training increased participant learning, each study that collected data on longer term transfer of training provided moderate evidence that team KSAs were applied on the job. Likewise, moderate improvements in patient outcomes were associated with the TeamSTEPPS training.

17.6.3.7 Practice: MTT

In 2007, the Veterans Health Administration (VA) introduced its own team training program, MTT. MTT focuses on improving communication through a training workshop, as well as on the job through the implementation of team briefings before and after surgical cases.

17.6.3.8 Process Measures

In their systematic review, Weaver et al. (2014) included three studies of MTT that collected process measures, while Hughes et al. (2016) provided evidence on these criteria for healthcare team training programs in general.[2,13] In addition, the current review identified two individual studies of MTT. None of the individual studies identified reported data on participant reactions, nor did they collect measures of learning immediately following the training. One study collected process measures as an indicator of transfer of training.

17.6.3.8.1 Process Measures: Transfer

One study included in Weaver et al.'s (2014) systematic review measured transfer of training following the VA's MTT; significant improvements in teamwork climate items were reported for physicians and nurses.[2] Further support of transfer of team training was provided by Hughes et al. (2016), who reported significant increases of KSAs on the job following team training.[13]

In an individual study conducted by Wolf et al. (2010), MTT was delivered to OR personnel, and a standard briefing/debriefing protocol was developed. Based on follow-up data collected 12 to 17 months after the training, improvements were reported on all Safety Attitudes Questionnaire domains, with significant improvements noted on two domains: perceptions of management ($p=0.003$) and working conditions ($p=0.004$). In addition, case delays due to staffing issues, equipment problems, or patients not being fully prepped for surgery decreased significantly over the study period, signifying improved workflow and use of resources. At the 12-month follow-up, delays had dropped from 23 percent to 10 percent ($p<0.0001$); they were at 8 percent at the 24-month follow-up ($p=0.09$).[26] These data suggest the longer term impact that the team training program had on participants' attitudes and clinical processes.

17.6.3.9 Clinical Outcomes: Results Criteria

Two studies included in Weaver et al.'s (2014) systematic review measured patient outcomes as part of their evaluation of the VA's MTT program. One study, conducted by Young-Xu et al. (2011), was also identified in the current review and will be reported as an individual study. Since the meta-analysis conducted by Hughes et al. (2016) grouped all team training programs together, we remind the reader that they found that team training resulted in improved outcomes.

In the individual study conducted by Young-Xu et al. (2011), data collected on annual surgical morbidity rates after MTT were compared with the rates 1 year prior to the training. They showed a significant decrease (17%) in the observed annual morbidity rate for the facilities that had participated in MTT (rate ratio, 0.83; 95% CI, 0.79 to 0.88; $p=.01$), whereas the facilities that had not participated in MTT observed a decrease of 6 percent, which was not statistically significant (rate ratio, 0.94; 95% CI, 0.86 to 1.05; $p=.11$).[27] The second study of MTT included in Weaver et al.'s review found a reduction in risk-adjusted surgical mortality for the group that had participated in MTT, but this was not statistically significant.[2]

Unlike the CRM and TeamSTEPPS studies, none of the studies of MTT measured participant reactions or learning. Results from the few studies that evaluated MTT provide evidence that team KSAs learned during the training were later applied on the job and resulted in improved patient outcomes (i.e., decreased morbidity rates, reduced surgical mortality).

17.6.3.10 Practice: Team Simulation

Simulation is another method used to improve teamwork skills. Simulation provides teams with realistic scenarios that they may face, either routinely or in emergencies. These scenarios allow participants to practice critical teamwork behaviors and receive feedback. As noted in the review by Weaver et al. (2014), simulation is commonly used to train healthcare teams and can have high or low fidelity.[2] High-fidelity simulations refer to those that strongly mimic real life scenarios, the actions that should be taken by the participant(s), and the actual work environment, including equipment and patients. Low-fidelity simulations present realistic scenarios and require participants to react as they would in the real world but do not replicate all aspects of the environment (e.g., a doll could be used in place of a mannequin).

17.6.3.11 Process Measures

One systematic review[12] presented evidence that team simulation improves team processes such as communication and situational awareness. None of the individual studies in the current review reported participant reactions to simulation team training. Seven of the studies assessed participant learning immediately following the simulation intervention and reported improvements. One study of simulation team training reported data on transfer criteria.[12] The meta-analysis conducted by Hughes et al. (2016) also provided evidence that simulation improves processes.[13]

17.6.3.11.1 Process Measures: Learning

In their systematic review, Dietz et al. (2014) reported that five studies used simulation-based team training as a strategy to improve teamwork in the ICU. All five studies used high-fidelity simulators and reported positive impacts on learning such as improvement in teamwork skills.[12] Hughes et al. (2016) reported that high-fidelity simulation was not more effective than low-fidelity simulation when examining participant learning (high-fidelity: corrected standardized mean=.66, *k*=10, 95% CI, .23 to 1.08; low-fidelity: corrected standardized mean=2.76, *k* =4, 95% CI, .53 to 6.06).[13]

Lutgendorf et al. (2017) investigated the use of multidisciplinary obstetrics simulation to manage postpartum hemorrhage cases and collected measures of participant learning. For example, they examined the use of established protocols, as well as teamwork and communication during postpartum hemorrhage cases. After 16 simulations and corresponding debriefings following TeamSTEPPS principles, participants reported significantly higher comfort levels (1=very uncomfortable, 5=very comfortable) in dealing with hypertensive emergencies (pre-intervention mean=3.88, post-intervention mean=4.14, p=0.01); shoulder dystocia (pre-intervention mean=3.66, post-intervention mean=4.29, p=0.001); and postpartum hemorrhage (pre-intervention mean=3.86, post-intervention mean=4.35, p=0.001). Findings from this study suggest that the simulation exercises increased learning of and confidence in applying CRM material, and the participants were better prepared to address issues that occurred in postpartum hemorrhage cases.[28]

Paull et al. (2013) measured pre to post change following simulation-based CRM training. Following the training, participants from 12 VA facilities completed two simulated scenarios and were debriefed immediately afterward. Participants' confidence in their ability to engage in teamwork was measured before and after the training using the Self-Efficacy of Teamwork Competencies Scale (e.g., "All team members are committed to performing as a highly effective team," "The team has a shared understanding of its plan of action"). Significant changes in mean scores were reported for all eight items in the post-intervention period. Improvement on individual items ranged from 13 percent to 26

percent ($p<.05$). Significant improvement was also observed in the participants' use of the targeted teamwork skills from the first to second simulated scenario (improvement on teamwork skills ranged from 15% to 23%, $p<.05$). The only skill for which no significant change was noted was "resource allocation," a specific behavior under the situational awareness dimension.[29]

Another study delivered a team training workshop to two groups of 41 first-year interns working in a trauma department.[30] Following the didactic instruction, all interns completed four high-fidelity simulations and received feedback on their performance. Half of the interns completed the simulations on the first day (Group 1), while the other half completed the scenarios on the second day (Group 2). Pre- and post- Situational Judgement Tests indicated that participants in both groups increased their scores on the test following the training, suggesting that their decisions became closer to that of a subject matter expert. However, only the participants in Group 2 showed significant improvement (Group 1 pre-mean=15.63, post-mean=17.29, $p<0.10$; Group 2 pre-mean=13.77, post-mean=16.55, $p<0.01$). This study provides limited evidence that team training with simulation significantly increases participant learning.[30]

Similarly, Riley et al. (2011) tested the impact of using team training alone (i.e., didactic training only) or using team training with simulation (i.e., didactic training plus simulation) on neonatal outcomes and culture of safety within three small community hospitals. However, their findings did not support participant learning. There were no changes in safety culture scores (as measured by the Safety Attitudes Questionnaire) after either of the interventions.[31]

A slightly different approach was taken by Thomas et al. (2010). They examined the impact of low-fidelity skills stations (control group), team training with low-fidelity skills stations, and team training with high-fidelity skills stations on teamwork and the quality of resuscitation skills. The study was conducted with interns for pediatrics, combined pediatrics and internal medicine, family medicine, emergency medicine, and obstetrics and gynecology completing the Neonatal Resuscitation Program. Results suggested that the team training intervention had positive impacts on learning. Compared with the control group, interns in the station group with team training with high-fidelity skills exhibited significantly greater rates of teamwork behaviors (control group mean=9.0, team training with high-fidelity skills station=12.8, $p <0.001$). The groups that received team training and either form of simulation (i.e., high-fidelity or low-fidelity mannequins) handled workload management significantly better than participants in the control group ($p<.001$) and completed the resuscitation more quickly than the control group (control subjects=average of 10.6 minutes; team training with low-fidelity simulation=8.6 minutes, $p<.040$; team training with high-fidelity simulation=7.4 minutes, $p<.001$).[32]

One study in the review implemented stand-alone simulation training (i.e., without the use of team training) in acute-care medical units.[33] Participants completed 17 simulation exercises in which they responded to a cardiopulmonary arrest. Perceptions of only one of the five teamwork dimensions measured with the TeamSTEPPS Teamwork Perceptions Questionnaire (i.e., leadership) significantly improved following the simulation intervention (pre-training mean=2.167 vs. post-training mean=2.566, $p=.003$). However, as the authors noted, greater change might have resulted had the participants received TeamSTEPPS training prior to (or in conjunction with) the simulation training.[33]

17.6.3.11.2 Process Measures: Transfer

Four studies in Boet et al.'s (2014) systematic review of simulation team training collected data on transfer of training. Simulation team training was found to result in significantly greater transfer of KSAs on the job when compared with the group that had received only didactic team training or the no-intervention group.[11] Additionally, the use of high-fidelity simulation did not results in greater transfer of KSAs on the job than low-fidelity simulation in the Hughes et al. (2016) meta-analysis (high-fidelity: corrected standardized mean=.54, *k*=13, 95% CI, .27 to .80; low-fidelity: corrected standardized mean .71, *k*=8, 95% CI, .34 to 1.08).[13]

The individual study conducted by Thomas et al. (2010) collected data at a 6-month follow-up to assess whether longer term transfer of training had occurred. Participants who had received the team training with some form of simulation engaged in significantly more teamwork behaviors during neonatal resuscitation scenarios than participants in the control group (intervention group=11.8 teamwork behaviors/minute vs. control group=10 teamwork behaviors/minute). The significant improvements that had been achieved immediately following the intervention related to workload management and length of resuscitation were not sustained at the 6-month follow-up.[32]

17.6.3.12 Clinical Outcomes: Results Criteria

Several studies cited by Weaver et al. (2014) used simulation (both high- and low-fidelity) to improve knowledge, attitudes, and teamwork behaviors, as well as improve outcomes such as mortality and morbidity. In particular, two studies achieved significant improvements in clinical outcomes without the use of high-fidelity simulations.[2] A second systematic review of simulation team training (Boet et al., 2014) reported that five studies measured patient outcomes to provide evidence on results criteria. These studies found some improvements in efficiency of patient care and decreases in complication rates, and one demonstrated that simulation-based team training significantly improved patient mortality.[11]

Fifty (38.8%) of the 129 team training studies included in a meta-analysis conducted by Hughes et al. (2016) included simulation as part of their intervention (33 used high fidelity; 17 used low fidelity). They reported that high-fidelity simulation was not more effective than low-fidelity simulation (high-fidelity: corrected standardized mean=.80, *k*=30, 95% CI, .59 to 1.01; low-fidelity: corrected standardized mean=1.01, *k*=11, 95% CI, .09 to 2.10). As a result, the authors concluded that while high physical fidelity may be important in training technical skills, it is not necessary when attempting to improve non-technical skills such as communication. Thus, the authors suggested that greater emphasis should be placed on developing scenarios that have high psychological fidelity in team improvement efforts.[13]

Two of the five individual studies in the present review collected outcome measures to evaluate results in their simulation efforts. Riley et al. (2011) tested the impact of using team training alone (i.e., didactic training only) against using team training with simulation (i.e., didactic training plus simulation) on neonatal outcomes and culture of safety within three small community hospitals. They found that the group who received the full intervention (a condensed TeamSTEPPS didactic training course coupled with 11 simulation exercises over the course of 12 months) significantly decreased their Weighted Adverse Outcomes Score (WAOS) from 1.15 to 0.72 ($p<0.05$) over the study period. The WAOS for the group that received only the condensed TeamSTEPPS didactic training remained stable (pre-intervention mean=1.46, post-intervention mean=1.45, nonsignificant), and the WAOS for the control group

increased over the study period from 1.05 to 1.50. Thus, the simulation exercises seem to have been integral to the improvements observed in outcomes.[31]

Using a sample in which 92 percent of the participants had previously received TeamSTEPPS training, Lutgendorf et al. (2017) investigated the use of multidisciplinary obstetrics simulation to manage postpartum hemorrhage cases. Sixteen simulations were conducted over a 2-day period, each followed by a structured debriefing. The data suggested that simulation improves outcomes, as the length of time to prepare blood products decreased on the second day of exercises (6 minutes on the first day vs. 4 minutes on the second day). A downward trend was also observed in postpartum hemorrhage cases following the 2-day simulation intervention as compared with the baseline period.[28]

In summary, participant learning was the most commonly collected measure across the simulation studies reviewed. The majority of studies reported that participants had increased their confidence in using teamwork skills and demonstrated teamwork skills more frequently following the simulation intervention. The results on transfer of training were mixed, with some studies demonstrating that the use of team-related KSAs was sustained over time, while one study did not report sustained improvement. Lastly, the studies that measured results-level criteria reported some improvements in patient outcomes such as efficiency of patient care and decreased complication rates.

17.6.3.13 Practice: Briefings

Briefings have a long history of use in the field of aviation and have been included as a tool within healthcare CRM programs, as well as in the TeamSTEPPS training program. Prebriefings help set the stage for teamwork by reviewing tasks that need to be accomplished, identifying which team member(s) will be responsible for each task, and discussing any contingency plans. Debriefings then review (post-performance) what went well and what could have gone better, with the goal of improving performance in the future. As noted by Kessler et al. (2015), debriefings can cover a combination of individual and team performance as well as system issues.[34]

17.6.3.14 Process Measures

Two of the three studies that examined the effectiveness of briefings collected process measures. One study collected process measures immediately following the intervention, which are treated as measures of learning. In the second study, evaluation data were collected more than 30 days after the intervention had been introduced, and these data are treated as an indicator of transfer criteria.

17.6.3.14.1 Process Measures: Learning Criteria

A study of resuscitation teams examined the effectiveness of a debriefing program following pediatric cardiac arrest cases (Wolfe et al., 2014). Structured debriefings were conducted within 3 weeks of a chest compression event. During the debriefing intervention period, chest compressions were significantly more likely to meet quality targets associated with excellent cardiopulmonary resuscitation (95% CI, 2.9 to 10.6, $p<0.01$). Reviewing the cardiac arrest cases during the structured debriefings appeared to have led to increased learning and to the achievement of improved clinical processes.[35]

17.6.3.14.2 Process Measures: Transfer Criteria

One of the three studies of briefings collected process measures to assess transfer of KSAs on the job. Kleiner et al. (2014) introduced a coach to help improve communication during surgical briefings and debriefings. Observations of the frequency and quality of briefings and debriefings were collected. No

differences in the frequency of briefings and debriefings were observed in the OR prior to or after the coaching, as they occurred 100 percent of the time in both study periods. However, differences were reported in the quality of the briefings and debriefings. Following the coaching intervention, the average briefing score increased significantly, from 3.478 to 3.644 (p=.044), indicating increased use of a standardized checklist, and that team members were introduced more consistently, there was greater discussion about contingency plans, and team members were given the opportunity to ask questions. Similarly, the average debriefing score significantly increased from 2.377 to 2.991 (p<.0001). In the post-intervention period, a standard checklist was used more frequently, teams more often discussed what went well and what did not go well, and team members were thanked. Therefore, this study supports the idea that team communication can be improved during pre-briefings and debriefings and that changes were sustained on the job.[36]

17.6.3.15 Clinical Outcomes: Results Criteria

Two of the three studies of briefings assessed patient outcomes and provide evidence on Kirkpatrick's results criteria. First, the study of resuscitation teams conducted by Wolfe et al. (2014) examined the effectiveness of a debriefing program following pediatric cardiac arrest cases. A comparison of 60 historical control cases and 59 interventional cases showed improvement in survival to hospital discharge for cases in the debriefing intervention group (52% for debriefed cases vs. 33% for control cases, p=0.054). Survival with favorable neurological outcomes significantly increased for the cases in the debriefing intervention group as well (50% for debrief cases vs. 29% for control cases, p=0.036).[35]

Second, Murphy et al. (2015) assessed the effectiveness of roundtable debriefing on patient fall rates in the emergency department. Roundtable debriefings were held weekly to discuss patient falls that had occurred in the department over the previous week. They found that fall rates declined somewhat in the post-intervention period (14 months after the intervention had been introduced), but there were no statistically significant differences in the number of assisted falls (p=0.17) or unassisted falls (p=0.28) and the rate of falls per 1,000 patient encounters (p=0.28) as compared with the pre-intervention period. This finding was unexpected, since the authors had observed a decrease in falls in other inpatient acute areas as a result of using roundtable debriefings. They attributed the lack of consistent results to differences between the acute care and emergency department settings.[37]

Overall, the review included few studies of briefings. One study provided evidence that briefings led to increased participant learning, and another demonstrated that briefings led to transfer of team KSAs on the job. Two studies reported that briefings were associated with favorable patient outcomes; however, only one found significant improvements. Due to the limited number of studies, it is difficult to draw conclusions regarding the effectiveness of this practice.

17.6.3.16 Practice: Handoff Protocol

Handoff protocol is a tool that can be used to increase teamwork during patient transitions. Such transitions occur between shifts within a unit or when a patient is transferred from one unit to another (e.g., from the OR to the surgical ICU). During this time, critical information needs to be passed that, if missed, can affect the quality of care. A standardized handoff protocol can ensure that information is consistently exchanged between providers.

17.6.3.17 Process Measures

All three studies employing handoffs collected process measures as part of their evaluation. Two of the studies reported reaction criteria in the form of satisfaction with handoffs. Two of the studies collected measures of learning immediately following the introduction of their handoff protocol. Two studies reported data on the transfer of KSAs into the work environment following the handoff intervention.

17.6.3.17.1 Process Measures: Reactions Criteria

A study by Petrovic et al. (2015) provided training on a new handoff protocol in a perianesthesia care unit, and pocket-sized informational cards were distributed as job aids. The authors found that satisfaction with the new handoff protocol varied by team member role, with nurses in the unit reporting greater satisfaction than anesthesia providers. Nurses showed significant improvement on five of the nine satisfaction survey items, while satisfaction scores for anesthesia providers declined slightly (but not significantly) in the post-intervention period. Pre-intervention satisfaction data were not available for surgeons because they were not present at bedside handoff in the baseline period, but surgeons reported high levels of satisfaction with the new handoff protocol (ranging from 91% to 97% favorable on the post-satisfaction survey).[38]

Krimminger et al. (2018) studied a structured handover process between the OR and ICU to reduce information sharing errors. Data from this study indicated that satisfaction with handovers increased in the post period on all satisfaction survey items, with 8 out of the 12 items showing significantly greater satisfaction ($p<.05$).[39]

17.6.3.17.2 Process Measures: Learning Criteria

Mukhopadhyay et al. (2018) introduced a standardized handoff tool to improve communication during patient transfers from the OR to a surgical ICU. Key parts of the handoff included: presence of key caregivers, identifying the patient and members of the care team, a detailed surgical report, a detailed anesthesia report, and the duration or occurrence of key activities. Thirty-one handoffs were observed before and after the new protocol was introduced, with slight improvements in efficiency observed in the post-intervention period. Specifically, the average time for patients to be placed on the ventilator (pre-intervention mean=86 seconds, post-intervention mean=74 seconds) and time to complete transfer to ICU monitors slightly decreased (pre-intervention mean=133 seconds, post-intervention mean=106 seconds), but these changes were not statistically significant.[40] Therefore, the handoffs were associated with slight, but not significant, improvements in care processes.

Petrovic et al. (2015), in their study of a new handoff protocol introduced in a perianesthesia care unit, observed that surgery providers became significantly more involved in the handoff process 2 weeks following the handoff protocol (pre-intervention=21%, post-intervention=83%, $p<.01$). The total number of defects per handoff decreased following the handoff intervention (pre-intervention=9.92, post-intervention=3.68, $p<.01$), with a significant decrease in both communication errors and technical defects. Specifically, the average number of items missing dropped from 2.02 to 0.94 ($p<.01$) on the anesthesia reports and dropped from 7.75 to 2.64 on the surgery report ($p<.01$). These data suggest that the handoff protocol was effective in improving teamwork and information sharing. However, while the authors had expected that the handoff protocol would not increase transition times, the duration of the handoff did increase (pre-intervention period=9.0 minutes, post-intervention period=11.0 minutes, $p=.01$) due to the increase in items covered during the handoff process.[38]

17.6.3.17.3 Process Measures: Transfer Criteria

Two of the three studies employing handoffs collected process measures consistent with Kirkpatrick's transfer criteria. The study conducted by Mukhopadhyay et al. (2018) found that several elements of the handoff had demonstrated significant improvement 6 months after the handoff protocol implementation. First, the presence of a surgical team member at handoff significantly improved, from 32 percent to 84 percent of the time ($p<0.001$), and physician team member presence at handoff increased significantly, from 52 percent to 94 percent ($p<0.001$). Second, all information regarding the surgical procedure was relayed significantly more frequently in the post-intervention period, with the greatest increase observed on "further interventions" (4% to 81%, $p<.001$) and the smallest increase on "procedure performed" (29% to 84%, $p <.05$). Third, positive results were found on the anesthesia report, where all pieces of information increased from pre- to post-intervention, with 7 of the 15 elements increasing significantly.[40]

In the study of a structured handover process between the OR and ICU[39], data were collected to assess longer term changes related to the handover intervention. Observations made prior to and 6 months following the handover implementation showed a significant decrease in both the number of process errors (pre-intervention=6.1, post-intervention=2.8, $p<.001$) and information sharing errors in the post-intervention period (from 5.2 per handover to 2.3 per handover, $p<.001$). The duration of the handover increased from the pre- to post-intervention periods, from 13.2 minutes to 14.6 minutes, although this increase was not statistically significant. Therefore, the handover resulted in fewer information sharing and process errors.[39]

In sum, the small number of studies implementing handoff protocols provide limited evidence of their effectiveness. Two studies reported favorable reactions to the use of the handoff protocol. Evidence of participant learning was also provided by two studies, with the handoff protocol significantly improving the efficiency of care processes in one study, and resulting in greater information sharing and in fewer communication errors in the second study. Similarly, positive transfer of team KSAs on the job was reported for up to 6 months following the introduction of the handoff protocol. However, none of the studies that implemented handoff protocols collected data on patient outcomes.

17.6.3.18 Practice: Checklists

Checklists constitute another tool that has historically been used in the aviation industry, specifically during the pre-flight phase. Checklists are well suited for completing procedural tasks and have been implemented as a way to improve teamwork (especially to increase communication among team members) and to reduce technical errors.

17.6.3.19 Process Measures

Two of the three studies employing checklists collected process measures. One of the studies collected participant satisfaction with the checklist (i.e., reactions). Two studies incorporated measures of participant learning to evaluate the effectiveness of their checklist tool, and one study reported evidence of transfer.

17.6.3.19.1 Process Measures: Reactions

A study conducted by Fargen et al. (2013) introduced a checklist to improve communication in the neurointerventional suite. Opinion surveys gathered from 21 participants were positive, with 95 percent indicating that the use of the checklist should continue.[41]

17.6.3.19.2 Process Measures: Learning

A study conducted by Fargen et al. (2013) in the neurointerventional suite also collected a measure of learning over a 4-week period immediately following the introduction of the checklist. They reported that communication during procedures (as rated by staff) significantly improved in the cases where the checklist was used (baseline=38.8% were rated as excellent, 43% were rated as good; post-intervention=68.2% were rated as excellent, 28.8% were rated as good, $p<0.001$).[41]

Based on observations and audits of their OR, Porter et al. (2014) revised their preprocedural pause (PPP) checklist to increase participation and communication among all members of the operating team. The revised checklist (based on the World Health Organization surgical checklist) required that each team member be responsible for a specific section. Compliance with the PPP increased from an average of 78 percent of cases in the baseline period to 96 percent of cases in the period immediately following the revisions ($p<.0001$). Team member self-introductions also increased from an average of 44 percent in the baseline to 94 percent immediately following the intervention ($p<.0001$). The proportion of cases in which all checklist items were completed rose from 54 percent in the baseline to 97 percent of cases in the post-intervention period (no statistical analysis reported). These data suggest that participants learned the importance of using the checklist.[42]

17.6.3.19.3 Process Measures: Transfer

In addition to their measure of learning, Porter et al. (2014) also assessed transfer of KSAs to the job. Their finding that PPP compliance had significantly increased to 96 percent immediately following the introduction of the revised PPP checklist was sustained at an 18-month audit, in which compliance remained at 96 percent. Similarly, team member self-introductions, which were reported to occur 94 percent of the time immediately following the intervention, continued to increase slightly at the 18-month audit (97%, $p<.0001$). Thus, Porter et al. found support of sustained transfer of team KSAs as a result of the checklist intervention.[42]

Overall, very few studies in the review evaluated the effectiveness of checklists. The one study that collected participant reactions reported high satisfaction among users of the checklist. Improvement in participant learning was also reported in one study, in which greater compliance using the checklist was noted directly after the training, and sustained compliance with the checklist was reported up to 18 months following the intervention (i.e., positive transfer). While only two of the studies collected data on patient outcomes, both reported a decrease in adverse events in the post-intervention period.

17.6.3.20 Clinical Outcomes: Results Criteria

Two of the three studies reviewed tested the effectiveness of checklists by collecting data on Kirkpatrick's results criteria. Both studies provide evidence for the use of checklists for improving team performance. Fargen et al. (2013) introduced a checklist based on the World Health Organization surgical checklist to increase communication and reduce adverse events in their neurointerventional suite. The overall number of adverse events decreased after the implementation of the checklist as compared with in the baseline period (6 events with the checklist vs. 25 in the baseline/without the checklist, $p=0.001$). When examined individually, eight of the nine specific adverse events/near misses decreased after the checklist had been implemented (but these changes were not significant) and one adverse event/near miss remained the same (i.e., maximum contrast dose exceeded).[41]

Bliss et al. (2012) reported that cases in which a surgical safety checklist was used were associated with significantly lower adverse event rates. Data from three cohorts were evaluated: a historical control group; a cohort that had received team training but did not use a checklist; and a cohort that had received team training and used the checklist. Comparison of 30-day morbidity revealed that the adverse event rate was 23.6 percent for the historical control group, 15.9 percent for the team training only cohort, and 8.9 percent for the team training with checklist cohort (p=0.000). Thus, the cohort that received team training and used the checklist had the lowest rate of adverse events.[43]

17.6.4 Conclusion and Comment

17.6.4.1 Implementation

The majority of studies in the current review were conducted in a hospital setting and focused on improving teamwork among frontline staff. Studies varied in their approach, with some relying on team training programs to improve teamwork and some implementing tools aimed at enhancing teamwork directly in their work settings. In some instances, a teamwork intervention that had been successfully implemented in at least one unit or clinical area at a given institution was extended and tested in another.[18, 37] In other cases, the study reviewed served as a jumping-off point for the institution, with plans to introduce the training and/or tools in additional clinical areas in the future.[19,21]

In terms of team training programs, training was most often delivered in a 4- to 5-hour session and evaluated within a specific unit (e.g., obstetrics, ICU), although some studies conducted training at the hospital level.[15] Post-training measures were collected anywhere from 30 days to 18 months following the training. Interestingly, few studies reported reaction data, instead reporting measures of learning, transfer, and results, which are better indicators of training effectiveness.[8,9] Improvements were demonstrated on a variety of process measures (indicative of reaction, learning, and transfer criteria) and outcome measures (i.e., results criteria) relevant to the participants' settings.

Studies reviewed also used simulation and other performance support tools such as briefings, checklists, and handoff protocols to enhance teamwork. Consistent with Hughes et al. (2016) and Weaver et al. (2014), studies used simulation in conjunction with team training programs, and one study used simulation as a standalone strategy. Tools to foster teamwork and communication were introduced in a mixture of units/departments, including surgical units, ICUs, emergency departments, and perinatal units. Across studies, these low-cost tools demonstrated positive impacts on the processes and clinical outcomes measured, with sustained improvements reported 6 to 18 months following implementation.

As cautioned by Rosen et al. (2018), tools such as checklists and briefings may appear to require less time or fewer resources to implement than team training programs such as those described in the current review.[44] However, time and due diligence are needed to educate staff on why the selected tool is being implemented, how to use the tool, and how the tool fits into the established workflow. Once implemented, new protocols sometimes required greater time and participation by the entire team to ensure all elements were covered. For example, increases in the length of handoffs were reported by Krimminger et al. (2018) and Petrovic et al. (2015).[38,39] The protocol introduced by Porter et al. (2014) required that more members of the OR team take an active role in completing the PPP checklist.[42] While this can lead to resistance and dissatisfaction in some cases, the new protocols also led to more engaged teams, more information being exchanged, and fewer errors.

The importance of leadership involvement and project champions was stressed across studies regardless of the specific practice used to improve teamwork.[19,24,26,42] Leadership support is needed not only to help get a practice off the ground, but also to ensure compliance over time. For example, leaders may be involved in promoting or endorsing the training, as well as participating in (or being present during) team training workshops. In the case of implementing performance support tools on the job, leadership support can signal that the improvement tools are critical to quality and safety of care rather than merely an additional administrative task.[44] Additionally, leadership can provide reinforcement when staff use the tools as intended and help ensure that their use is sustained over time. As mentioned earlier, researchers suggest that studies that assess multiple criteria, measure KSAs at multiple levels, and/or incorporate multiple measurement methods provide the most meaningful evaluation data regarding an intervention's effectiveness. Additionally, the strength of evidence increases as the level of Kirkpatrick's framework moves from reaction data (the weakest) to learning, transfer, and then results (strongest). The majority of studies within the review assessed multiple levels of criteria. Transfer criteria were most often gathered, but some reaction, learning, and results-oriented data were reported as well. The studies reviewed used multiple methods of measurement, including surveys and observational data. Furthermore, these data were collected at the individual level (in the case of survey data) and at the team level (in the case of observational data). Collectively, the studies reviewed provide support for team training interventions and performance support tools for improving teamwork, sustaining those improvements on the job, and positively influencing clinical and patient outcomes.

17.6.4.2 Gaps and Future Directions

Both the systematic review conducted by Weaver et al. (2014) and the meta-analysis conducted by Hughes et al. (2016) focused on team training interventions. Weaver et al. provided evidence that programs such as TeamSTEPPS, CRM, and MTT can result in both improved processes (e.g., attitudes, knowledge, teamwork skills) and improved clinical outcomes. Based on a meta-analysis of 129 studies, Hughes et al. reported that medical team training programs can positively impact reactions, learning, and transfer of teamwork skills. Results from the individual studies reviewed in the current chapter provide evidence consistent with that reported by Weaver et al. and Hughes et al. Although specific settings were not included in the search strategy to identify articles, nearly all of the individual studies reviewed were conducted within hospital settings. However, efforts to improve teamwork have also been introduced in other healthcare settings, such as primary care, ambulatory settings, and long-term care. For example, AHRQ has developed tailored TeamSTEPPS programs for multiple nonhospital settings. (Please refer to the Resources section for more information.) While work may be under way in these settings, there is a lack of published studies to add to the evidence base (especially related to the impact on patient outcomes) and thus, this is an area requiring further research.

Neither the systematic review conducted by Weaver et al. (2014) nor the meta-analysis conducted by Hughes et al. (2016) examined the effectiveness of specific tools to sustain performance on the job (e.g., checklists). As evidenced by the individual studies in the current review, team training and support tools have been implemented in a variety of inpatient settings. The breadth of departments and specialty areas in which studies have been conducted helps demonstrate the importance of teamwork, as well as the applicability of team training and tools. However, this breadth also makes it more difficult to draw conclusions about what team intervention is most effective in specific settings. Additionally, some studies included small sample sizes. Further studies are needed to help understand which teamwork

interventions have the greatest impact in different healthcare environments including those outside of in-patient hospital settings.

Lastly, limitations to the current review should be noted, including the exclusion criteria followed in the search strategy. Specifically, the review focused on collecting evidence from studies that were conducted in the United States. However, numerous studies of teamwork and team training have been conducted abroad and provide additional evidence that team training programs such as CRM and TeamSTEPPS enhance team KSAs as well as patient outcomes. Additionally, studies in which improving teamwork was not the primary focus were excluded. While this made it easier to attribute desirable results to the teamwork intervention employed, in the future, researchers may wish to include studies in which improving teamwork was a secondary objective.

17.6.4.3 Resources

AHRQ's TeamSTEPPS® program:
https://www.ahrq.gov/teamstepps/index.html

AHRQ's TeamSTEPPS® 2.0 Online Master Training Course:
https://www.ahrq.gov/teamstepps/master-trainer-registration.html

AHRQ's TeamSTEPPS® for Office-Based Care:
https://www.ahrq.gov/teamstepps/officebasedcare/index.html

AHRQ's TeamSTEPPS® for Long-Term Care
https://www.ahrq.gov/teamstepps/longtermcare/index.html

VA MTT program:
https://www.patientsafety.va.gov/professionals/training/team.asp

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17.7 Education and Training Through Simulation

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17.7.1 Practice Description

Simulation is used in many high-stakes industries where it is too dangerous for individuals to practice and refine their skills on the job. According to Gaba (2004), simulation is a "technique, not a technology, to replace or amplify real experiences with guided experiences, often immersive in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion" (p. 12).[1] Within healthcare, simulation has been used at multiple points in the education and training continuum to improve technical proficiency, as well as teamwork skills, while not endangering the lives of actual patients. (For further discussion on the use of simulation to enhance teamwork, please refer to Section 17.6, Teamwork and Team Training.)

With a greater emphasis being placed on patient safety than ever before, a growing number of medical and nursing programs are adopting a simulation-based education curriculum to mitigate risk and better prepare students to treat patients. Simulation provides structured opportunities to practice skills in a safe environment without harming actual patients. Using simulation, participants can make mistakes, reflect upon them and receive feedback, and learn from their mistakes until mastery has been achieved. As a result of this deliberate practice and feedback, participants are better prepared to perform procedures when treating real patients. Data show that medical residents and nursing students who participate in simulation-based training as part of their curriculum have: high levels of satisfaction; greater confidence in their skills/abilities; and improved knowledge, attitudes, and clinical skills.[2,3]

While simulation can help inexperienced healthcare providers enhance their skills, simulation can also be incorporated into continuing education efforts for more experienced healthcare professionals. For example, simulation can be used as part of ongoing training for those who change departments or units, as refresher training on procedures and situations that occur infrequently, and to assess proficiency during recertification. Simulation can similarly be added to ensure readiness when new equipment and technology is introduced, as well as to practice new processes and protocols.

Although studies of simulation have demonstrated its efficacy for knowledge and skill development, fewer studies have examined the extent to which the knowledge and skills gained through simulation translate into improved patient outcomes.

17.7.2 Methods

The question of interest for this review is, "Does simulation training on individual skills in clinical practice improve patient outcomes?"

To answer this question, two databases (i.e., CINAHL® and MEDLINE®) were searched to identify studies of simulation published between 2008 and 2018. Search terms included "simulation training," "patient simulation," "computer simulation," "virtual reality," "serious games," and "serious gaming," as well as other similar terms. Terms such as "patient harm," "patient safety," and "medical errors" were also included. No attempt was made to focus on any particular provider type. The initial search yielded 1,750 results. After duplicates were removed, 1,119 were screened for inclusion and 27 full-text articles

were retrieved. Of those, 11 were selected for inclusion in this review: 7 are single studies, 3 are systematic reviews, and 1 is a meta-analysis. Articles were excluded if the article was out of scope (including not quantitative), the study design was insufficiently described, the study did not evaluate patient outcomes, the study was conducted with junior medical or nursing students, the study focused on improving teamwork (which is included in the Teamwork and Team Training section), or the study was conducted outside of the United States.

General methods for this report are described in the Methods section of the full report.

For this patient safety practice, a PRISMA flow diagram and evidence table, along with literature-search strategy and search-term details, are included in the report appendixes A through C.

17.7.3 Review of Evidence

All studies took place in hospital settings, the majority of which were teaching hospitals or tertiary teaching hospitals. Across studies, simulation-based training generally included some level of didactic instruction, practice via the simulation technology, and feedback. Studies varied in the type of simulation used, including high-fidelity computer-based simulations and full-body mannequins. All studies examined whether simulation-based training translated to improved treatment and outcomes of real patients. Evidence related to clinical/patient outcomes and clinical/patient care processes are presented in the sections that follow.

17.7.3.1 Clinical/Patient Outcomes

Three review articles and one meta-analysis were identified that reported patient outcomes related to simulation-based training efforts delivered to medical residents or fellows. Seven individual studies were identified, five of which provided simulation training to medical residents as part of simulation-based medical education (SBME) and two of which incorporated simulation as part of the continuing education of nurses. While the number of studies may be relatively low, results generally support the efficacy of simulation-based training as a patient safety practice.

In their systematic review, Griswold-Theodorson et al. (2015) limited their focus specifically to studies that provided evidence of the effects of SBME on patient care practices, patient outcomes, and value outcomes (e.g., costs). The majority of the 14 studies identified compared traditional training with simulation-based training and provided support for simulation training on various levels. Specifically, a portion of the studies demonstrated a reduction in complication rates (e.g., central line-associated blood stream infection or CLABSI rates, pneumothorax rates, intraoperative and postoperative complications). Cost savings were estimated in four of the studies reviewed, with significant savings associated with reductions in central-line infections, overnight hospital days, or additional hospital days.[4]

A systematic review of simulation-based training studies conducted by Schmidt et al. (2013) reported results related to diagnostic procedures, surgical procedures, and central venous catheterization. The studies of diagnostic procedures produced mixed results on patient discomfort, and one study reported decreased complication rates related to thoracentesis. For surgical procedures, fewer errors for laparoscopic cholecystectomy were reported after simulation training. Finally, three studies demonstrated decreased rates of catheter-related bloodstream infections related to central venous catheterization, and mixed results for complication rates and patient safety events.[5]

In their qualitative review, McGaghie et al. (2011) discussed two simulation research programs conducted in the United States that examined the impact of SBME on patient outcomes. One study reported an 85-percent reduction in catheter-related bloodstream infections after medical residents who had received SBME began working in the intensive care unit. The rate of catheter-related bloodstream infections was both significantly lower than it had been in the baseline period (post-SBME intervention=0.50 infections per 1,000 catheter-days vs. pre-SBME intervention=3.20 infections per 1,000 catheter-days, p=0.001) and also significantly lower when compared with another intensive care unit in the same hospital (0.50 infections per 1,000 catheter-days vs. 5.03 infections per 1,000 catheter-days, p=0.001). Another study, conducted in ophthalmology, reported that the sentinel complication rate for patients receiving cataract surgery significantly decreased from 7.17 percent to 3.77 percent (p=0.008) when performed by medical residents in the simulation-based curriculum.[6]

Five individual studies measured clinical or patient outcomes related to their simulation-based education efforts. Madenci et al. (2014) conducted a meta-analysis to evaluate the efficacy of simulation training on central venous catheter (CVC) insertion and/or catheter manipulation. Five randomized control trials and prospective two-group cohort studies were identified in which simulation training was used for invasive vascular procedures on real patients. While the group that received simulation training had a lower proportion of adverse events (3.8%), this difference was not statistically significant from the traditionally trained group (4.9%, p=0.15).[7]

Mosier et al. (2015) studied the impact of a simulation-based curriculum on improving airway management for fellows in pulmonary/critical care medicine. The fellows received high-fidelity simulation training twice a month over the course of 11 months. The scenarios progressively increased in difficulty and required participants to consider many factors related to endotracheal intubation, including anatomical and physiological characteristics that would make intubation difficult. Seven complications related to intubation were measured, including hypotension, desaturation, esophageal intubation, aspiration, airway trauma, peri-intubation arrest, and surgical airway. The only significant improvement was found for desaturation, which significantly decreased in the post-simulation period (from 25.9% to 16.8%, p=0.002). The study noted that a limited number of complications occurred in the pre- and post-simulation periods, making it difficult to find meaningful improvements.[8]

A study of advanced cardiac life support events conducted by Wayne et al. (2008) compared the events led by second-year simulation-trained medical residents with events led by third-year medical residents who had been traditionally trained. The authors reported no differences in patient survival of the advanced cardiac life support event between the simulation-trained and traditionally trained residents (simulation group=45%, traditional group=46.4%).[9]

Another study, conducted in orthopedics, evaluated the effectiveness of simulation for improving patient outcomes and reducing costs. Bae et al. (2017) introduced a simulation-based curriculum in pediatric orthopedics to improve the reduction of a distal radial fracture, to properly apply and mold a short-arm cast, and to remove the cast with a cast oscillating saw. The performance of medical residents who received simulation training was compared with that of traditionally trained residents. Results indicated that 8 out of 188 cases in the pre-simulation period resulted in a cast saw burn (4.3% of patients were injured), whereas 3 out of the 439 cases included in the post-simulation period resulted in cast saw injuries (0.7% of patients were injured). These data demonstrated a significant reduction in patient harm (p=0.002). Further, the authors estimated that costs associated with cast saw burns in the

pre-simulation period were approximately $32,320, which were substantially reduced to approximately $5,188 in the post-simulation period.[10]

Harting et al. (2008) examined whether the use of computer-based simulation translated into better pain management for cancer patients. Medical residents participated in the simulation intervention during the first week of their oncology rotation. Each resident received a half-hour lecture that outlined pain care principles, completed two to three simulated cases in which immediate feedback was given on actions taken, and participated in 1 day of followup rounds with actual patients. Results indicated that pain control within the first 48 hours of care significantly improved in the post-simulation period ($p<0.01$). Specifically, while patients' reported pain had increased over the first 48 hours of care in the pre-simulation period, reported pain levels decreased over the first 48 hours of care for patients treated after the simulation intervention was introduced. Nine out of the 20 patients (45%) in the pre-simulation group had described their pain as "worsening" or "unchanged" during their admission, whereas only 4 of the 20 patients (20%) in the post-simulation group described their pain this way.[11]

Barsuk et al. (2009) examined the use of simulation to improve CVC procedural skills. Seventy-six internal medicine and emergency medicine residents received the simulation intervention 1 to 2 months prior to their medical intensive care unit rotation. The simulation intervention included 1 hour of videotaped lecture followed by 3 hours of ultrasound training, deliberate practice, and feedback. Twenty-seven medical residents who had received traditional training served as a historical control group. Although several processes improved for those who received simulation training, no differences were found between the simulation and control groups when examining rates of pneumothorax (an important complication) due to the small sample size.[12]

Two studies provided simulation training to nurses as part of continuing education. Research conducted by Gerolemou et al. (2014) provided simulation training to critical care nurses on sterilization techniques during central venous catheterization. To establish a baseline, each nurse was asked to complete the steps in sterile technique preparation during CVC up until needle insertion on a full-body mannequin in a simulation laboratory. Observations were made of each nurse's performance and each participant was debriefed. During the 30–45 minute debrief, each nurse watched a video of his/her performance, received feedback on individual steps, and engaged in repetitive practice. Effectiveness was evaluated by examining infection rates prior to and following the simulation intervention. Infection rates decreased significantly in the post-simulation period (pre-simulation=2.61 infections per 1,000 catheter-days, or 6 catheter infections in 2,297 catheter-days; post-simulation=0.4 per 1,000 catheter-days, or 1 catheter infection in 2,514 catheter-days; $p<0.02$).[13]

In addition, Hebbar et al. (2018) used simulation in an effort to reduce medication administration errors made by nurses at three children's hospitals. A total of 1,434 nurses completed the 2-hour simulation training, which included two to three scenarios, after which each was debriefed. The authors reported that the rate of medication administration events significantly decreased following the simulation intervention (pre-simulation=average of 2.5 events per month, post-simulation=average of 1.4 per month, $p=0.029$). Further decreases were noted during the 7-month post-simulation period, indicating sustained improvement (pre-simulation=average of 2.5 events per month, 7-month follow-up=average of 0.86 per month, $p=0.014$). The reduction in medication administration events also decreased the length of stay by an average of 2 days at an annual cost savings of approximately $165,000 to $225,000 (based on an annual decrease of 15 medication administration errors).[14]

17.7.3.2 Clinical/Patient Care Process Measures

The three review articles and one meta-analysis identified in the current effort also reported data supporting the effectiveness of simulation-based training on clinical/patient care processes. Further, six out of the seven individual studies also provided data related to processes and provided findings consistent with the review articles.

Studies included in Griswold-Theodorson et al.'s systematic review demonstrated that simulation improved procedural skills (e.g., cardiac auscultation, hemodialysis catheter insertion) and success rates of procedures (e.g., colonoscopy, laparoscopic surgery). For example, the length of successfully performed procedures on actual patients was reduced as a result of simulation interventions for colonoscopies, laparoscopic surgery, and hernia repairs.[4]

Schmidt et al.'s (2013) systematic review reported that simulation-based training was associated with mixed results on procedure times for diagnostic procedures. Overall performance of surgical procedures (e.g., cholecystectomies, cataract surgery, prostate resection) improved following simulation-based training. Studies of central venous catheterization reported that simulation-based training resulted in fewer needle passes. Results of this review provided moderate support for simulation-based training in the development of technical skills.[5]

In their qualitative review, McGaghie et al. (2011) discussed two simulation research programs conducted in the United States that examined the impact of SBME on patient care practices and/or patient outcomes. Several studies used simulation to improve CVC insertion skills, reporting that medical residents who received SBME reported significantly fewer needle passes, catheter adjustments, and arterial punctures than traditionally trained medical residents.[6] The meta-analysis of simulation training on CVC insertion and/or catheter manipulation reported positive results on the clinical processes examined (Madenci et al., 2014).[7] In comparing groups that received simulation training with those that receive traditional training, the simulation-trained group had a significantly higher proportion of successful CVC insertions (89.8% vs. 81.2%; relative risk, 1.09; 95% confidence interval [CI], 1.03–1.16; $p<0.01$) and required significantly fewer attempts (weighted mean difference, -1.42; 95% CI, -2.34 to -0.49; $p<0.01$).[7]

Six individual studies in our review also provided evidence on improved clinical/patient care processes, four of which provided simulation as part of SBME and two as part of continuing education. In their study of a simulation-based curriculum to improve airway management, Mosier et al. (2015) calculated the success rate of first-attempt intubations, which significantly improved following the introduction of the simulation curriculum. Specifically, successful first attempts increased from 73.5 percent in the pre-simulation period to 81.6 percent in the post-simulation period ($p=0.006$).[8]

As part of their study to improve pain management for cancer patients, Harting et al. (2008) also reported that medical residents who received the computer-based simulation training administered long-acting oral medications earlier in care (90% of cases) than did residents in the pre-simulation period (35% of cases, $p<0.001$). This was encouraging, as interviews that had been conducted prior to the simulation revealed that residents often failed to administer long-acting pain medication, because they feared that it would induce respiratory suppression.[11]

Barsuk et al. (2009), who introduced simulation to improve CVC procedural skills, reported improvements on several quality indicators for the medical residents who received the simulation

training. Specifically, residents who received the simulation training reported significantly fewer needle passes (total, p<0.005; internal jugular, p <.0.005); arterial punctures (total, p<0.005; internal jugular, p<.0.005); and CVC adjustments (total, p=0.002; internal jugular, p=0.001); and higher successful CVC insertion rates (total, p=0.005; internal jugular, p=0.018) than residents in the control group. They noted no differences between the simulation and control groups when assessing the quality of subclavian CVCs.[12]

Wayne et al. (2008) reported that medical residents who received simulation training demonstrated significantly higher compliance with the American Heart Association standards as compared with traditionally trained residents when dealing with real advanced cardiac life support events (simulation group=68%, traditional group=44%, p<0.001).[9]

In sum, the six individual studies that incorporated simulation-based training for medical residents and fellows provide evidence that simulation improves technical skills and clinical processes.

The two studies of simulation training delivered to nurses that reported a positive impact on patient outcomes also reported improvements in processes. First, Gerolemou et al. (2014) reported nurses' performance of sterilization procedures significantly improved following the simulation intervention. The median score was 7 out of 24 for sterilization techniques in the pre-simulation period and increased to 23 out of 24 in the post-simulation period, indicating that nurses had more knowledge of and adhered more closely to the sterilization protocol (p<0.01).[13]

In addition, the study conducted by Hebbar et al. (2018) that reduced medication adverse events also collected a process measure. They reported that compliance with recommended medication administration practices significantly increased following the simulation intervention (from 51% at month 1 to 84% at month 18, p<0.001). Together, the two studies of continuing education for nurses demonstrate the efficacy of simulation for enhancing knowledge of protocols as well as improving compliance with established practices.[14]

17.7.4 Conclusion and Comment

17.7.4.1 Implementation

The majority of studies in the current review were conducted in a hospital setting. Simulation-based training (most often delivered in a simulation laboratory) was introduced as a strategy for improving patient outcomes related to a variety of procedures, including CVC insertion, tracheal intubations, advanced cardiac life support, cancer-related pain management, orthopedic fractures, and cataract surgery. Although many of the studies had relatively small sample sizes, improvements in patient outcomes and clinical processes were reported. Taken together, the evidence suggests that simulation-based training is an effective strategy that allows less experienced healthcare professionals such as medical residents to develop the skills needed to provide safer patient care. Only two studies utilized simulation as part of continuing education, with both demonstrating the efficacy of simulation for improving patient outcomes, as well as improving clinical/patient care processes. Although the costs associated with setting up a simulation laboratory can be substantial, [5,15] one individual study in the review found that their simulation program was associated with considerable savings.[10]

17.7.5 Gaps and Future Directions

Medical research has demonstrated the utility of simulation-based training for individual skill development, but a limited number of studies have examined whether this strategy impacts patient outcomes. The studies presented in the current review illustrate the potential of simulation-based training to improve patient safety outcomes. Moving toward a more simulation-based training curriculum for medical residents and nursing students, or providing simulation training as part of continuing education efforts is not without its challenges. As highlighted by Rodriguez-Paz et al. (2009), additional personnel and equipment, as well as assessment and evaluation methods, may be required. Studies are needed that weigh the costs of simulation against the costs associated with medical errors, complication rates, re-admissions, and lawsuits in order to identify the real return on investment.[15] Additionally, more studies are necessary to provide a more comprehensive evaluation of the long-term impact of simulation-based training on outcomes of interest.

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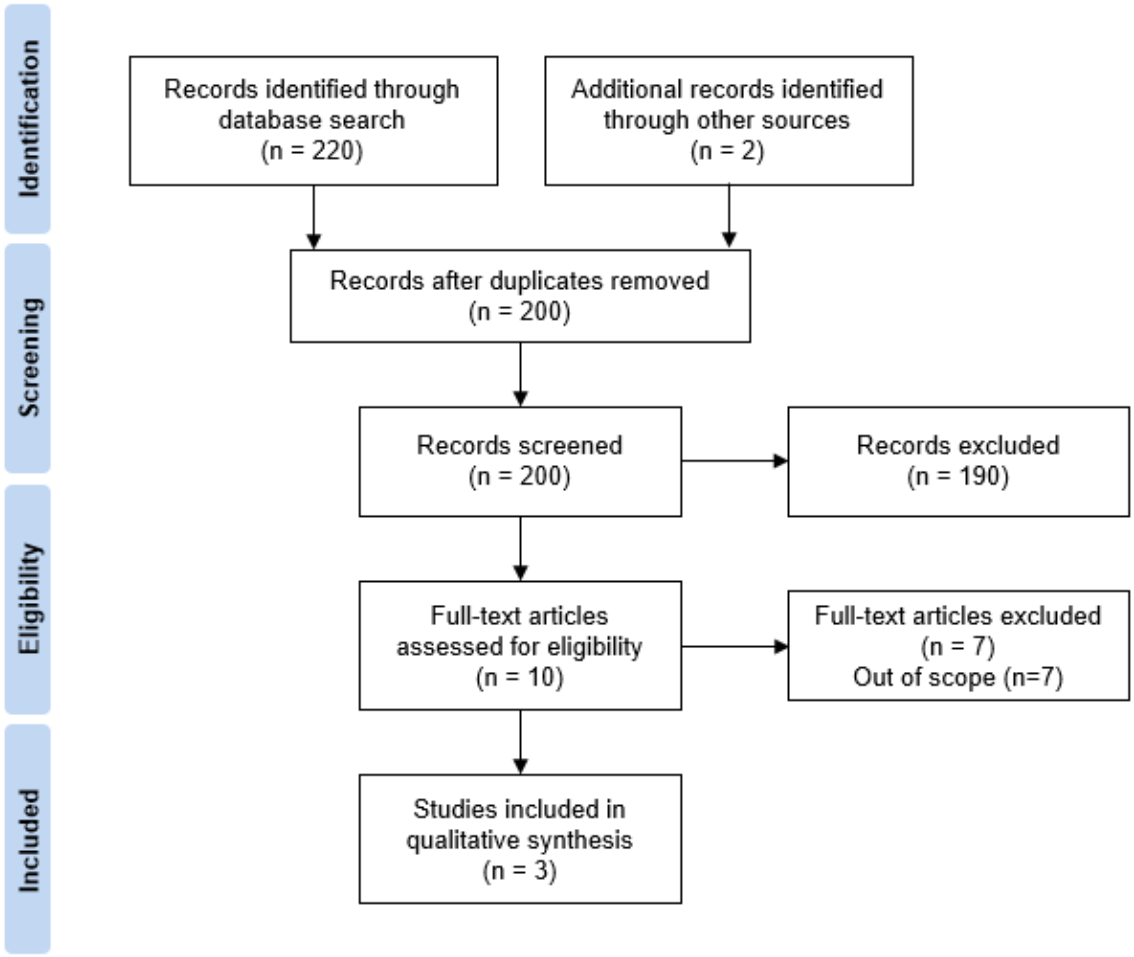
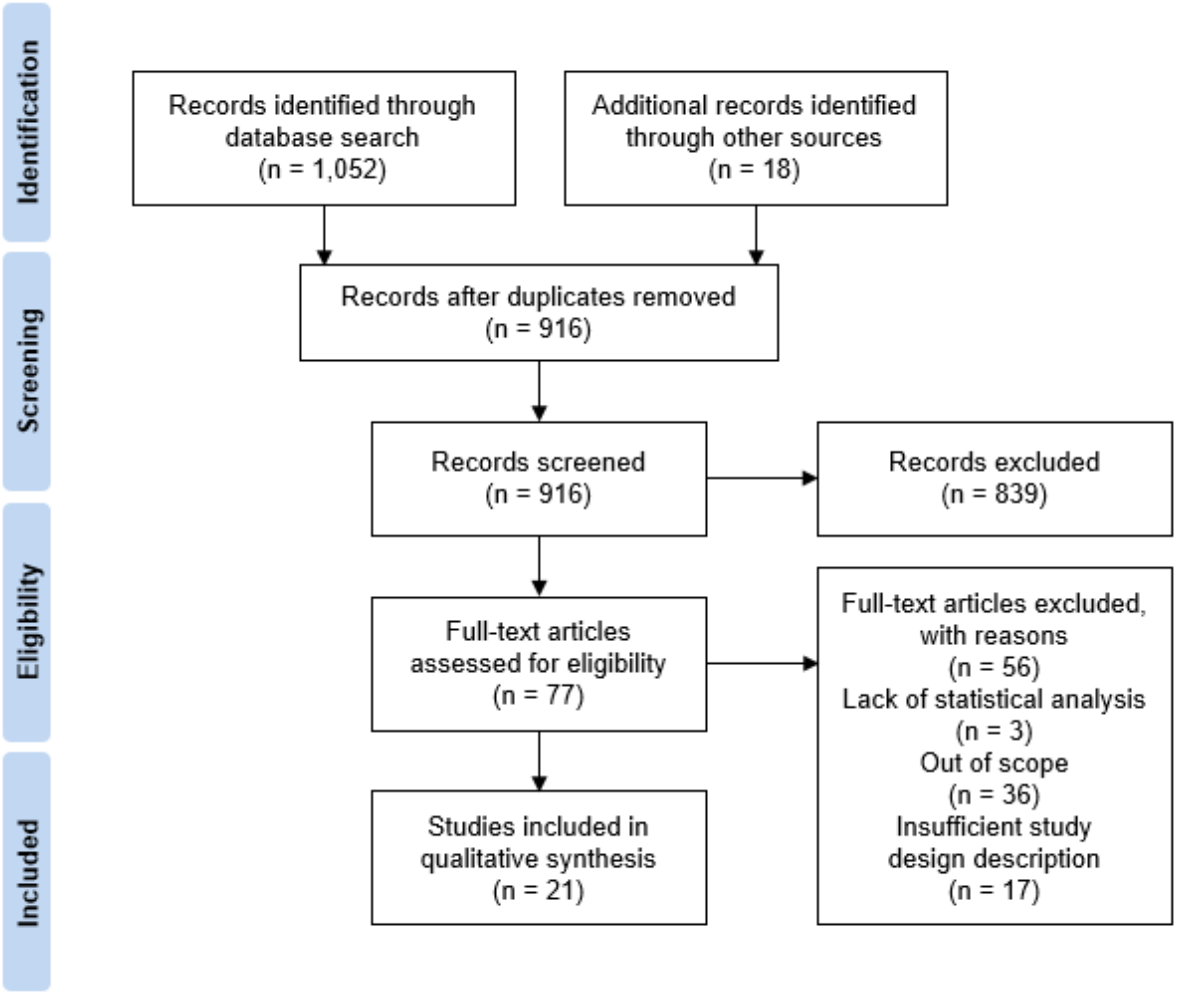
Appendix A. Cross-Cutting Patient Safety Topics/Practices PRISMA Diagrams

Figure A.1: Cross-Cutting Patient Safety Topics/Practices, Patient and Family Engagement—Study Selection for Review



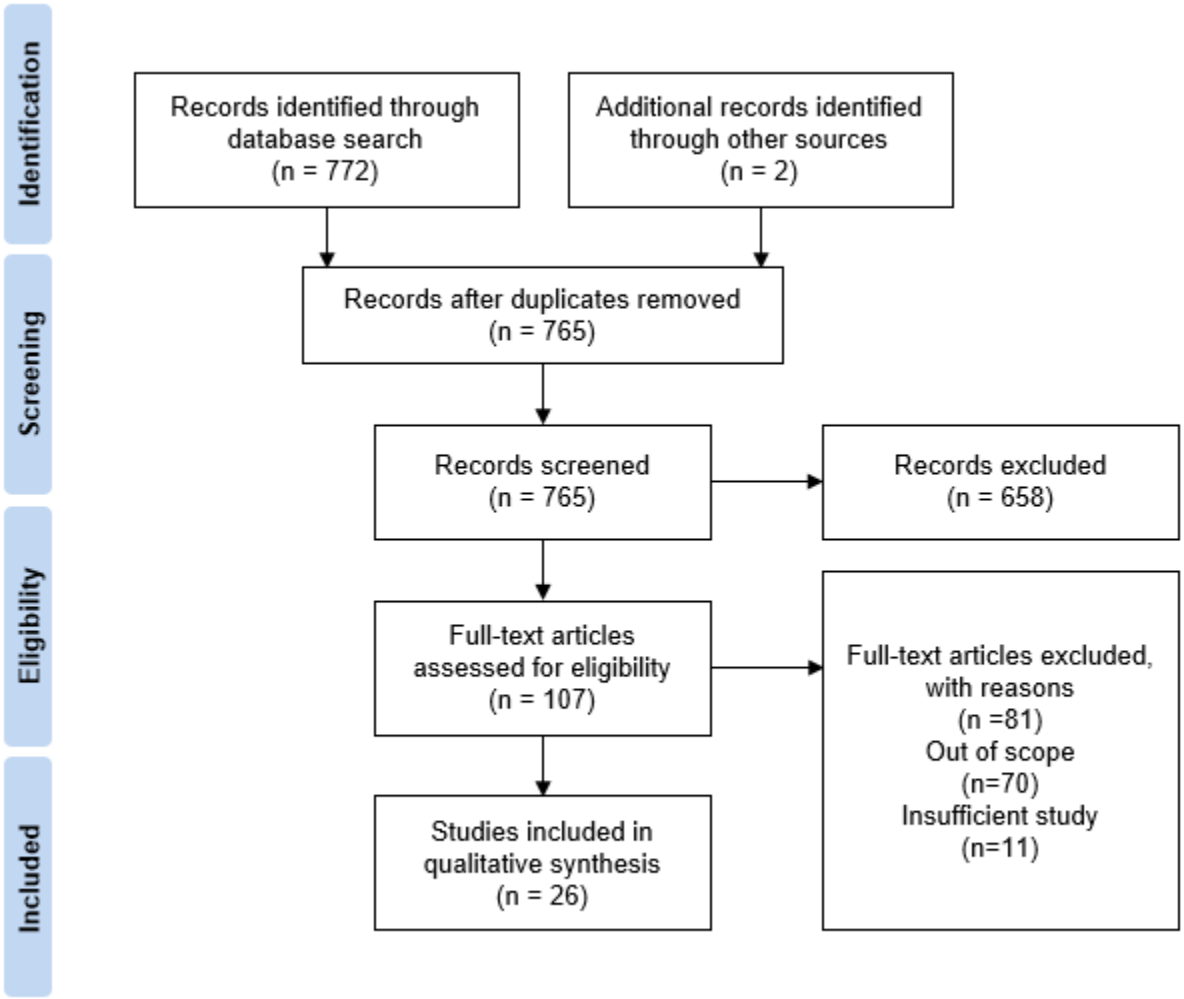
PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Figure A.2: Cross-Cutting Patient Safety Topics/Practices, Safety Culture—Study Selection for Review



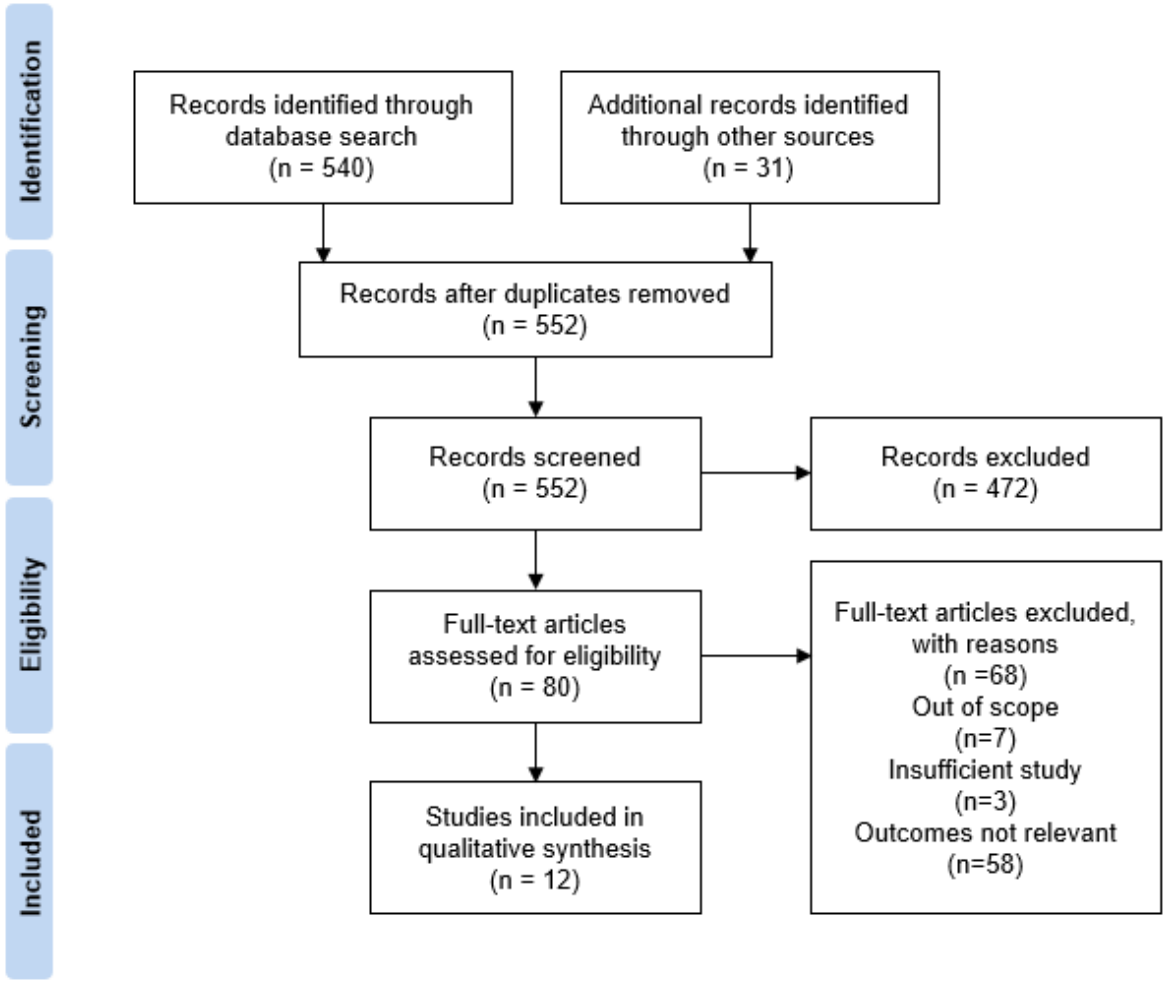
PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Figure A.3: Cross-Cutting Patient Safety Topics/Practices, Clinical Decision Support—Study Selection for Review



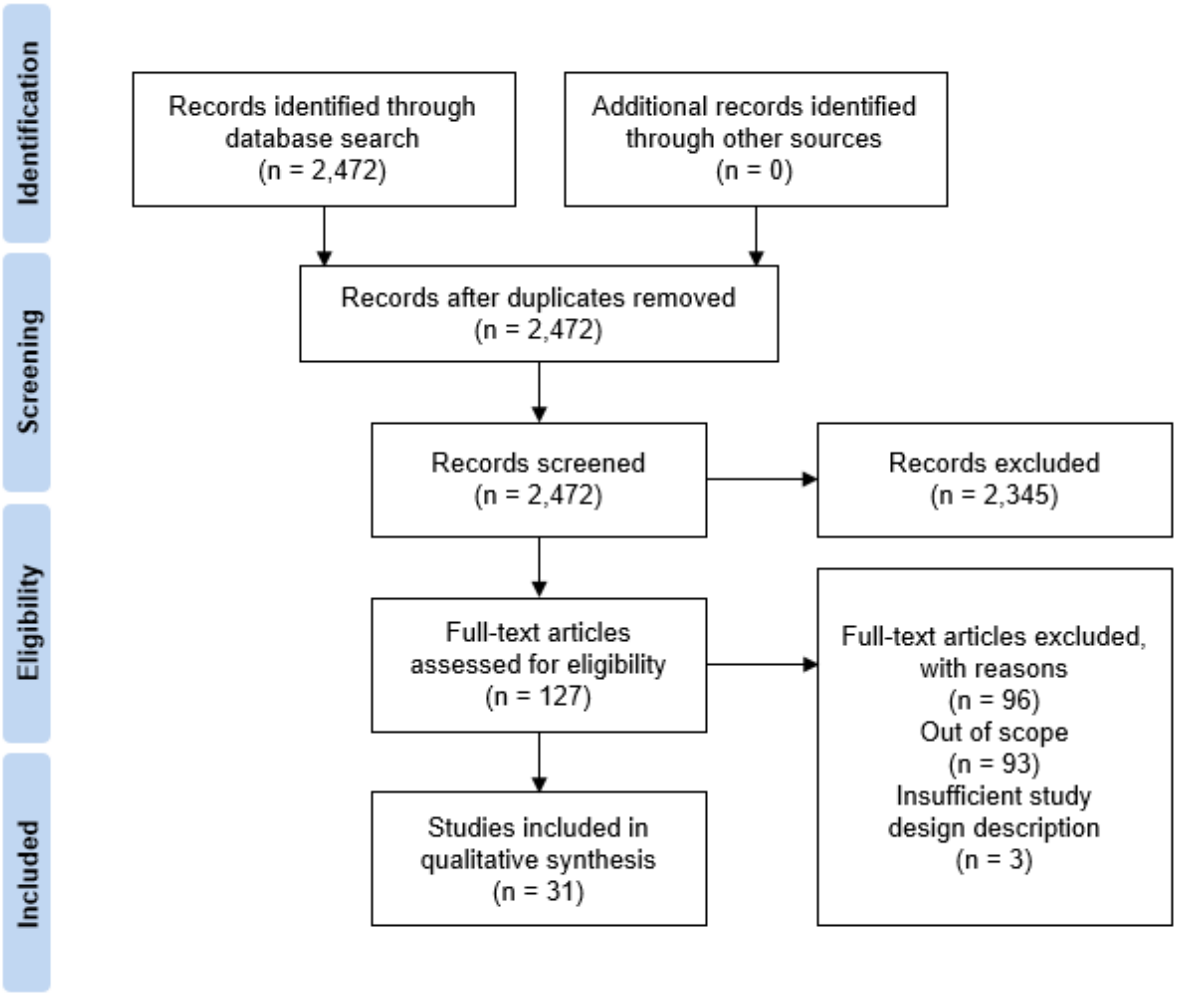
PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Figure A.4: Cross-Cutting Patient Safety Topics/Practices, Cultural Competency—Study Selection for Review



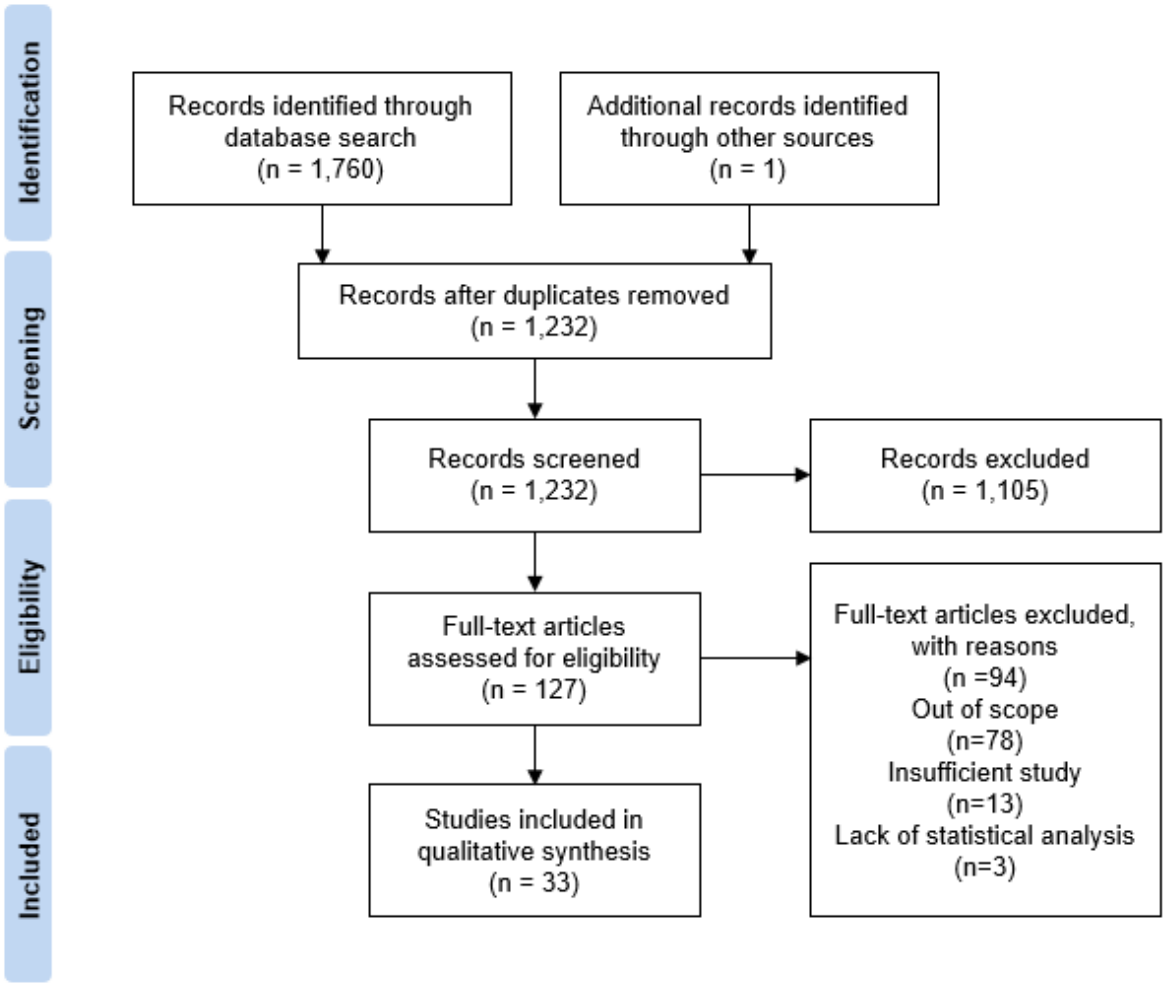
PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Figure A.5: Cross-Cutting Patient Safety Topics/Practices, Monitoring, Audit, and Feedback—Study Selection for Review



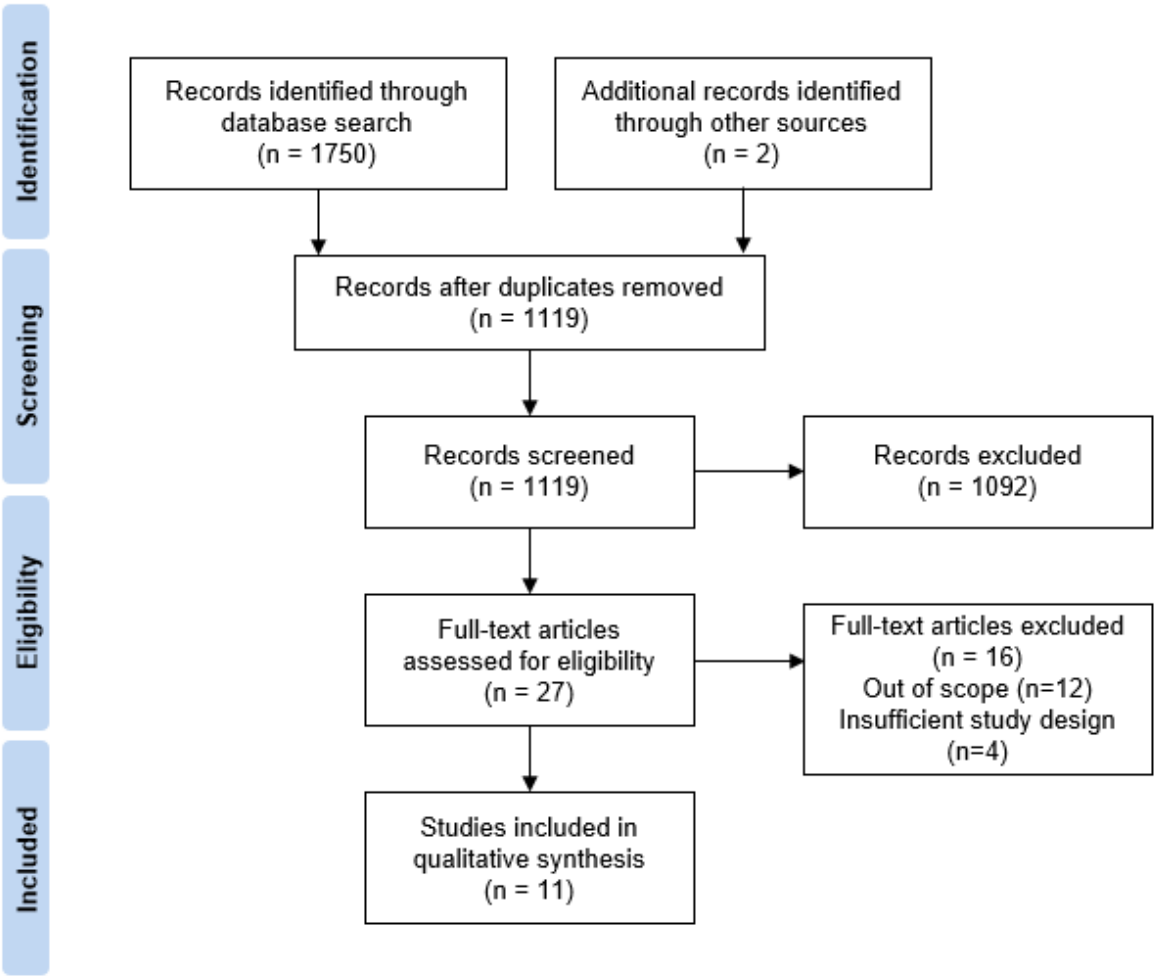
PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Figure A.6: Cross-Cutting Patient Safety Topics/Practices, Teamwork and Team Training—Study Selection for Review



PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Figure A.7: Cross-Cutting Patient Safety Topics/Practices, Education and Training Through Simulation—Study Selection for Review



PRISMA criteria described in Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009 Jul 21;6(7): e1000097. doi:10.1371/journal.pmed1000097.

Appendix B. Cross-Cutting Patient Safety Topics/Practices Evidence Tables

Table B.1: Cross-Cutting Factors Patient Safety Topics/Practices, Patient and Family Engagement—Single Study

Note: Full references are available in the Section 17.1 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits
Eden et al., 2017[5]	Condition Help (CH), a patient and family-initiated rapid response system	Observational study. The number of CH calls was recorded from January 2012 through June 2015. A patient care liaison and the unit charge nurse responded to CH calls. Each call reason was sorted into 1 of 10 categories. After a CH call, the patient's chart was reviewed to examine if it was related to a patient safety issue. Patient outcomes after the CH call were documented.	Two adult tertiary care referral hospitals	During collection period, 367 CH calls were made by 240 patients. Of the 240 patients, 43 (18%) activated the CH team with multiple calls, which comprised 46.3% of all calls (170/367). The majority of calls were made by patients, not family members (76.8%). Most of the CH calls were related to inadequate pain control (48.2%), followed by dissatisfaction with staff (12.5%). The majority of calls involved non-safety issues (83.4%) and safety issues (11.4%). In 152 calls (41.4%) of the 367 total calls, a change in care was made. The other 53 calls (34.9%) involved additional patient counseling or nonmedical changes. The traditional rapid response team (RRT) was activated within 24 hours of the CH for 19 cases (5.2%). Of the 19 cases, 6 were transferred to the intensive care unit. Overall, RRT was seldom activated, level of care was seldom escalated, and mortality was rare.

Table B.2: Cross-Cutting Patient Safety Topics/Practices, Patient and Family Engagement—Systematic Reviews

Note: Full references are available in the Section 17.1 reference list.

Author, Year	Description of Patient Safety Practice	Setting; Population	Summary of Systematic Review Findings
Park et al., 2019[1]	Patient and family engagement	Hospitals, nursing homes, private clinics, and academic medical centers; 42 studies reviewed	Both study participants and healthcare providers expressed positive attitudes toward patient and family engagement. Successful implementation of patient and family engagement is hampered by lack of patient safety knowledge among patients and lack of clear implementation guidelines for healthcare providers. The impact of patient and family engagement is hard to determine because there are few studies that evaluate such interventions.
Berger et al., 2014[3]	Patient and Family Engagement	Hospitals; 12 studies reviewed	Overall, there is a lack of high-quality evidence to inform successful implementation of patient and family engagement. More studies are needed to evaluate the effectiveness of such interventions.

Table B.3: Cross-Cutting Patient Safety Topics/Practices, Safety Culture—Single Studies

Note: Full references are available in the Section 17.2 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Sexton et al., 2018[18]	Leadership WalkRounds with feedback: Conducting Leadership WalkRounds and providing feedback about the risks that were reduced as a result of conducting them.	Cross-sectional survey administered to a convenience sample of 31 hospitals through the Michigan Health and Hospital Association (MHA) Keystone Center; 28,853 surveys were sent out and 16,797 were returned (response rate=70.4%); 53.9% of respondents reported at least 10 years in their specialty, and nurse was the most frequently selected role (27.1%).	Thirty-one Michigan hospitals were invited to participate. Seventeen (55%) had 99 or fewer beds, five (16%) had between 100 and 199 beds, six (19%) had 200 to 299 beds, and two (6%) had more than 400 beds.	Significant differences were found between the first and fourth WalkRounds, with feedback quartiles on all safety culture SCORE subscales measured: teamwork climate, safety climate, improvement readiness, local leadership, personal burnout, and burnout climate. Respondents who reported higher levels of WalkRounds with feedback also had higher scores on the safety culture subscales (including more positive safety climate, lower personal burnout, and lower burnout climate), two out of the three resilience subscales, and four out of the five engagement subscales.	Not provided	The authors note that one of the most cited methods for reducing burnout is Krasner's physician mindfulness training. This training usually spans 27 hours over an 8-week period and has demonstrated an effect size of 0.62 (based on Cohen's *d*) for burnout reduction. The current study calculated an effect size of 0.43 between the first and fourth quartiles of WalkRounds with feedback, suggesting the usefulness of this relatively brief intervention on burnout reduction.	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Sexton et al., 2014[17]	Leadership WalkRounds	Cross-sectional survey administered to a convenience sample of 44 NICUs; 3,294 surveys were sent out and 2,073 were completed (response rate=62.9%); 706 units (adult clinical areas) in 49 hospitals were used as a comparison group.	Forty-four NICUs in California: 10 were from regional hospitals, 28 were from community hospitals, and 6 were from intermediate hospitals.	The first and fourth WalkRounds feedback quartiles differed significantly on the two SAQ dimensions measured ("safety climate" and "teamwork climate") and on two of the four HSOPS dimensions measured ("overall perceptions of safety" and "feedback and communication"). The first WalkRounds feedback quartile reported less burnout than the fourth quartile, but was not statistically significant.	Not provided	Participation in Leadership WalkRounds and WalkRounds feedback was lower in NICUs compared with adult clinical areas. There were no significant differences in safety climate between the NICU and adult clinical areas. The authors note that it may be more difficult for some staff to participate in Leadership WalkRounds (e.g., nightshift, non-nursing providers).	High	None
Schwendimann et al., 2013[16]	Leadership WalkRounds	Retrospective, cross-sectional survey; 19,053 surveys were received for a response rate of 80.2%. (The total number of surveys sent out was not specified.)	Forty-nine hospitals within a nonprofit healthcare system. A total of 706 clinical and nonclinical units participated.	A significantly higher safety climate was found in the units where there was greater exposure to WalkRounds. The units where 60% or more of respondents indicated that they had at least one WalkRound exposure also reported significantly higher patient safety risk reduction and higher feedback about WalkRound actions that had been taken.	Not provided	Anecdotal evidence suggested that the WalkRounds provided the forum for team members to speak up about errors and safety risks, as well as adopt new practices and share lessons learned.	High to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Frankel et al., 2008[15]	Leadership WalkRounds. Senior leaders, quality and safety personnel, and clinical managers/ directors attended a half-day WalkRounds training session. Coaching sessions were conducted via the telephone every 2 months for 2 years.	Pre-post design. The SAQ safety climate subscale (7 items) was administered prior to the WalkRounds project (n=790) and approximately 18 months later (n=702).	Two hospitals in Massachusetts implemented weekly WalkRounds, including an academic teaching institution and a community teaching hospital.	The baseline SAQ data indicated that 10 out of 21 clinical care areas had safety climate scores below 60%, whereas only 3 clinical areas had scores below 60% post-WalkRounds. The academic teaching institution's safety climate score significantly improved, from 62% on the pre-SAQ to 77% on the post-SAQ. The safety climate score for the community hospital significantly improved following the WalkRounds project, from 46% to 56%. Safety climate scores increased from pre to post for all caregiver types except nurse managers/charge nurses, whose scores decreased over time. Paired sample t-tests showed significant improvement on items related to: discussing and learning from errors, feeling encouraged by colleagues to report concerns, and knowing how to report concerns.	Not provided	The types of problems discussed during Leadership WalkRounds varied by caregiver type, with nurses focusing on operational problems and physicians focusing on issues related to clinical decision making. Some issues could be resolved locally, some required collaboration across departments, and some required significant resources/budget allocations. Many of the concerns that were shared during the Leadership WalkRounds were addressed and resolved. The authors note that WalkRounds is an inexpensive intervention relative to other quality improvement efforts, but it does require a strong commitment from leadership, a project champion trained in quality or safety, and time and resources to manage the data and feedback gathered.	High to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Hefner et al., 2017[21]	Crew Resource Management, including facilitated training, day-long retreats to develop/tailor CRM safety tools, and role-playing.	One-group pre-post design; 784 staff completed the pre-HSOPS survey; 667 staff completed the post-HSOPS survey.	The Ohio State University Wexner Medical Center. Eight departments from the main and satellite hospital, the comprehensive cancer hospital, and the heart hospital participated.	Overall, significant improvements were observed on 10 of the 12 HSOPS dimensions. The two dimensions for which no significant improvement was observed were "supervisor promotes patient safety" and "staffing." Staff consistently responded less positively on the pre- and post-assessments than did practitioners. While most departments saw pre to post improvements on a minimum of seven dimensions, the radiation oncology department scores significantly improved on only two dimensions from pre to post and the interventional radiology department's scores significantly improved on five dimensions after training.	Not provided	To examine the decreasing scores for radiation oncology, the open-ended comments provided by survey respondents were reviewed. They suggested that this most likely was a result of staff changes and turnover that occurred in that department during the study period, as the comments were related to understaffing, workflow problems, communication failures, and lack of buy-in. The authors proposed that strong, stable leadership and human resources may mediate the relationship between CRM and patient safety culture. The authors also noted that the project was a significant undertaking and required staff allocation and buy-in at all levels.	High	The article did not provide details regarding the length of the CRM training (e.g., 1 day, 4 hours).

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Schwartz et al., 2018[24]	Clinical Team Training (based on Crew Resource Management Training) and implementing a patient safety project.	Cross-sectional study design. Thirty-three VA facilities participated in the initial training, and 17 facilities participated in the 12-month recurrent training. Participants represented a variety of clinical areas.	VA medical facilities in the United States.	Scores on all 27 TSCQ items improved over time. Significant improvement was found on 8 of 27 items at the 6-month assessment (5 items related to teamwork, 3 items related to safety climate), and significant improvements were found on 11 of the 27 items at the 12-month follow-up (6 items related to teamwork, 4 items related to safety climate, and 1 item related to perceptions of management).	Not provided	The most pronounced improvements identified through the TSCQ data were: (1) briefings at the start of a shift/case had become a standard method of communication in many clinical areas, (2) respondents believed that the organization was doing more for patient safety than it had a year ago, (3) respondents were more likely to know the first and last names of those with whom they had worked on their last shift, (4) personnel felt encouraged to report any safety concerns, (5) respondents were aware of the proper channels in which to direct their patient safety questions, (6) nurses' input was well received, and (7) physicians and nurses worked as a coordinated team.	High	The article did not provide details regarding the length of the training (e.g., 1 day, 4 hours). No specific information was presented on the facilities (e.g., number of beds).
Budin et al., 2014[20]	Four-hour Crew Resource Management Training with a 2-hour refresher class 1 year following implementation. Training was led	One-group pre-post design with external benchmarking comparisons. Seventy nurses and 88 physicians completed the	Perinatal units at a large urban academic medical center in the northeastern United States. The center has three triage	Prior to the intervention, physicians' perceptions on the Teamwork Climate subscale were significantly more positive than nurses'. Both nurses' and	Not provided	The authors stressed the positive results achieved by this low-tech intervention. However, other changes were also implemented, such as creation of a medical safety officer role. Four officers	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
	by five nurse-physician teams who were trained in CRM first and then trained others.	Teamwork and Safety Climate subscales of the SAQ prior to the initial training. Fifty-eight nurses and 46 physicians completed the same subscales after they had completed a refresher course conducted 1 year following implementation.	beds, 10 L&D rooms, three ORs, a three-bed post-anesthesia care unit, and four antepartum beds.	physicians' perceptions of teamwork climate significantly improved at the 1-year follow-up, although physicians remained more positive than nurses. No differences were found between nurses and physicians on the safety climate subscale prior to the CRM intervention, but significant improvements in safety climate were reported for both groups on the follow-up assessment. Post-intervention data were also compared with available benchmark data. Post-intervention means on the Teamwork subscale and the Safety Climate subscale were significantly more positive than the mean for two benchmark groups: nurses and physicians working in various inpatient settings and as U.S. intensive care unit caregivers.		rotated to provide constant coverage. Team meetings were held with all disciplines twice a day to improve communication and outcomes. Huddles were conducted with the primary team, safety officer, charge nurse, and/or leadership throughout the day if there were patient concerns. Four large flat screens were purchased to support huddles, handoffs, situational awareness, and cross-monitoring.		

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Jones et al., 2013[25]	TeamSTEPPS® Team Training program developed by AHRQ.	Quasi-experimental design: Static group (n=1,328) and pre-post comparison for intervention group (n=2,137). Safety culture was measured using the Hospital Survey on Patient Safety Culture (HSOPS).	Thirty-seven critical access hospitals in the central United States with fewer than 25 beds): 24 hospitals participated in the intervention, and 13 served as a static comparison group. Participants represented a variety of work areas, with the majority reporting that they had direct patient contact (control= 77.2%, intervention= 80.1%, p=0.009).	The intervention group had significantly more positive scores on three HSOPS dimensions: Organizational learning/continuous improvement, teamwork within departments, and teamwork across hospital departments. Early adopters of TeamSTEPPS® had significantly higher scores on three HSOPS dimensions when compared with early/late majority and laggard hospitals (frequency of events reported, staffing, and hospital management support for patient safety). No statistically significant differences were found between the intervention and static groups in terms of the adoption of team behaviors (transfer). The proportion of respondents who reported transfer were 26% for early adopters, 18% for early/late majority, and 7% for laggard hospitals.	Not provided	Participating in the TeamSTEPPS® training had a minimal impact on perceptions of safety culture, learning the TeamSTEPPS® tools had a moderate impact, and transfer of team behaviors had the greatest impact. Although laggard hospitals may have been most in need of team training, they were slower to adopt the TeamSTEPPS® training due lack of management support.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Berkowitz et al., 2012[27]	Team Improvement for Patient and Safety (TIPS) conferences. These conferences were 30 minutes long and used to discuss potentially avoidable acute care hospital transfers or adverse events that may have ended in an acute care hospital transfer. The TIPS conferences were held every 2 weeks over the course of the 1-year study period.	Pre-post design. Ten participants completed the baseline Nursing Home Survey on Patient Safety Culture, 41 completed the 6-month post-assessment, and 40 completed the 12-month post-assessment of this measure.	Subacute rehabilitation unit with 50 beds that admits approximately 1,000 patients per year. This unit resides within a 600-unit long-term care, religious-affiliated, not-for-profit organization located in Boston, Massachusetts.	Mean scores on the Nursing Home Survey on Patient Safety Culture significantly improved over time. When looking at overall survey results, the percentage of respondents that agreed or strongly agreed with all survey items increased by almost 20 percentage points.	Not provided	The unit was able to conduct 22 of the 26 intended TIP meetings (84.6%) during the course of the study. The TIP conferences functioned as a structured debrief. Individuals submitted problematic cases for discussion. Effort was made to discuss each submitted case within 1–2 weeks of its occurrence. Actionable steps were recorded and “tips from TIPS” emails were sent to all staff. The times for the TIP conferences were varied to allow staff from all shifts to participate. The small sample size for the baseline administration of safety culture survey was explained as fear of submitting data. The increase in sample size on the post-intervention measures is attributed to the changes in culture that were occurring.	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Carney et al., 2011[23]	VA Medical Team Training Program.	One-group pre-post design; 3,419 OR staff from high- and medium-complexity facilities completed the "Safety Climate" subscale of the Safety Attitudes Questionnaire (SAQ) prior to the training; 1,454 OR staff from high- and medium-complexity facilities completed the "Safety Climate" subscale of the SAQ after training.	One hundred and one Veterans Health Administration hospitals.	Significant pre-post differences were reported for respondents working at both high and medium complexity facilities on all seven items on the SAQ safety climate dimension.	Not provided	The Medical Team Training Program involved 2 months of preparation and planning, development of an action plan to identify problem areas, an agreement to use perioperative briefings and debriefings, and a 1-year implementation commitment. Monthly meetings were also held so that the interdisciplinary team could receive coaching on project implementation.	High	No information about the length of the training program (e.g., 1 day, 4 hours).

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Blegen et al., 2010[26]	Four-hour interdisciplinary team training with follow-on unit-based support team; 454 healthcare staff received the training.	One-group pre-post design (surveys were anonymous and not matched); 434 trainees completed the HSOPSC pre-intervention survey and 368 completed the HSOPSC post-intervention survey 1 year following the training.	Inpatient medical units of three hospitals in California: academic university medical center, non-teaching community hospital, and an integrated healthcare system hospital.	No pre-post improvement was observed for one of the participating hospitals. The remaining two hospitals reported significant improvements on 10 of the 12 HSOPC dimensions.	Not provided	The program had a positive impact on safety culture in two of the participating hospitals. The differential impact of the team training program and the unit-based support team was not examined. It is unclear whether one may have had a stronger effect than the other, although the authors felt that both were necessary to achieving the overall results.	High	This was a pilot test, but reads like a true empirical study.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Gore et al., 2010[22]	An 8-hour seminar based on Crew Resource Management was delivered to all OR personnel. Perioperative briefings were implemented following the seminar to improve communication and teamwork.	One-group pre-post design; 207 pre-intervention surveys were returned (34.5% response rate) and 156 post-intervention surveys were returned (27.6% response rate). The survey contained three subscales related to teamwork, safety climate, and reporting of errors.	OR department within one hospital.	Significant improvements were reported for 2 of 13 items related to error reporting and 2 of 11 items related to safety climate. There were no significant improvements reported related to teamwork. A look at the data by respondent demographics revealed that nurses were most impacted by the training. The scores of nurses significantly improved on 3 of the 4 items related to teamwork, 1 of the 13 items related to error reporting, and 3 of the 11 items related to safety climate.	Not provided	The post-intervention surveys were sent only 8 months following the initial training seminar (and 6 months after the implementation of perioperative briefings), which may not have been a sufficient amount of time to observe pre-post change.	High	The specific name of the survey administered was not included, only that it was made available by AHRQ. The CRM seminar was taught by aviation pilots who presented information, facilitated roleplays, and facilitated OR personnel in conducting perioperative briefing. Perhaps this initiative would have had a greater impact if it had been tailored more to the participants and their environment.
Lin et al., 2018[33]	Statewide Comprehensive Unit-based Safety Program (CUSP) and individualized bundles.	Pre-post cohort design. Pre-post design.	Fifteen hospitals in the State of Hawaii ranging from a 25-bed critical access hospital to a 533-bed	Significant pre-to-post improvement was reported for 10 of the 12 HSOPS subscales, with the most notable improvement on: “organizational	Over the course of the study period, the rate of SSI decreased significantly	The authors noted that they felt that the learning platform used in this project was very beneficial, as it allowed communication and networking among	Moderate	There are no details as to how many respondents completed the pre-and post-

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
	Hospitals were encouraged to implement as many interventions as they liked, but were required to select a minimum of three.		academic medical center.	learning/continuous improvement" (59% vs. 70%), "frequency of events reported" (51% vs. 60%), "feedback and communication about error" (52% vs. 59%), "teamwork within units" (58% vs. 75%), "supervisor/managers expectations and action promoting safety" (53% vs. 60%). No statistically significant improvement was found on the "staffing" or "handoffs and transitions" subscales. Over the course of the study period, the rate of SSI decreased significantly (from 12.08% to 4.63%). The superficial SSI rate decreased significantly, from 8.08% to 2.78%, with little change in deep SSI rate (1.70% to 0%), nor organ/space SSI rate (2.56% to 1.85%). Correlations between safety culture subscales and SSI rates were negligible or weak.	(from 12.08% to 4.63%). The superficial SSI rate decreased significantly from 8.08% to 2.78% with little change in the deep SSI rate (1.70% to 0%), nor organ/space SSI rate (2.56% to 1.85%). Correlations between safety culture subscales and SSI rates were negligible or weak.	participants and created a sense of community. They further highlighted the importance of operating room debriefs. While participating hospitals were urged to incorporate briefings as part of their bundled interventions, analyses regarding the use of debriefs were not reported.		measures of safety culture.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Hsu and Marsteller, 2016[29]	Comprehensive Unit-based Safety Program (CUSP) and five evidence-based practices for reducing CLASBI rates.	Fifty-four ICUs used CUSP and 17 ICUs not using CUSP served as a comparison group.	All hospitals in Michigan that have an adult ICU were invited to participate. The majority of the ICUs that participated in the study were from teaching hospitals.	No statistically significant improvement was found for the non-CUSP group from the pre-to-post SAQ administration (n=19 at baseline and n=14 at time 2). For the CUSP group, pre-SAQ data were available for 47 ICUs and 38 completed post-SAQ. The ICUs in the CUSP group statistically improved their post-SAQ scores on four of the six subscales measured. No statistically significant change was found for either “stress recognition” or “perceptions of management” over the study period.	There were no statistically significant differences found in CLASBI rates between the CUSP and non-CUSP groups.	Not provided	High to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Saladino et al., 2013[19]	Comprehensive Unit-based Safety Program (CUSP), which included: educate staff on the "science of safety," identify safety concerns, implement executive WalkRounds, implement improvements, and document/share results.	Single-group repeated measures design. The sample included 81 unit-based staff members (51% were nurses).	Twenty-two-bed surgical critical care unit within a 369-bed Magnet-designated community hospital.	The 36-item critical care version of the Safety Attitudes Questionnaire (SAQ) was administered to evaluate changes in safety culture. Sixty participants (74%) completed the pre-SAQ and 55 (69%) completed the post-SAQ. No statistically significant pre-to-post changes were reported for any of the SAQ subscales. Safety concerns were gathered during monthly WalkRounds that occurred over a 6-month period. A total of 77 safety issues were identified over this period, with 44 being resolved (57.1%).	Not provided	Some scores on the SAQ actually declined over the study period. The authors believe this may have occurred because they posted the safety issues identified during the monthly WalkRounds, and this heightened awareness of how frequently safety issues were arising and may have made the staff feel that there was a lack of safety within the unit. The authors note that the 6-month study period was likely too short to result in significant changes and that the literature suggests there should be approximately 12 to 18 months between pre- and post-safety culture assessments.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Simpson et al., 2011[30]	Comprehensive Unit-based Safety Program (CUSP).	Pre-post design.	Fifteen Michigan hospitals with perinatal service.	This study reported improvements on several dimensions of the Safety Attitudes Questionnaire. They also reported significant improvement on all six process measures collected. There were no significant differences in the outcomes measured, although the data were trending in the right direction.	Not provided	The implementation of CUSP included: assessing and promoting a culture of safety, interdisciplinary team building, case review, coaching, administrative support of the safety infrastructure, and ongoing evaluation of care processes and outcomes.	Moderate	None
Vigorito et al., 2011[31]	Comprehensive Unit-based Safety Program (CUSP). Based on results from the Safety Attitudes Questionnaire (SAQ), units were encouraged to develop an action plan for how they would improve their scores.	Pre-post design; 841 of 1,024 participants completed the pre-intervention SAQ (82%) and 918 of 1,080 completed the post-intervention SAQ (85%). Pre-to-post change was examined for units that had submitted a SAQ action plan and those that had not. CLASBI and VAP infection data were also collected as outcome measures.	Twenty-three ICUs from 11 hospitals enrolled in the Rhode Island ICU Collaborative.	Nine units completed and submitted action plans following the pre-intervention SAQ. Units that had a SAQ action plan demonstrated greater improvement on five of the six SAQ subscales than the units that did not have a SAQ action plan (although not statistically significant). Perceptions of "teamwork climate" and "stress recognition" decreased from pre to post for units without an action plan (-6.4% and -6.6%, respectively), whereas	CLASBI rates decreased by 10.2% for units that had a SAQ action plan over the course of the study period as compared with a 2.2% decrease for the units without an action plan. VAP rates decreased by 15.2% for units with a SAQ action plan and	The only SAQ subscale for which no improvement was seen was "working conditions." The authors noted a high turnover rate for nurse clinical manager and ICU directors (61% during the study period) which likely accounted for lower scores in this area. This quality improvement effort has continued and the authors report that the ICUs continue to make improvements in their SAQ scores every year.	Moderate	Participation was voluntary and anonymous.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
				they improved for units that had a SAQ action plan (18.4% and 4.5%, respectively). Pronounced improvement in “job satisfaction” was observed for the units with an action plan (25.9%) versus those without an action plan (7.3%). Decreases in perceptions of “working conditions” were found for both groups.	increased by 4.8% for those without an action plan. Differences in CLASBI and VAP rates for the two groups were not statistically significant.			

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Paine et al., 2010[32]	Comprehensive Unit-based Safety Program (CUSP) was introduced to over 30 units.	Pre-post design; 144 units completed all seven subscales of the SAQ in 2006 (pre-assessment) as well as in 2007 and 2008.	Academic teaching hospital (i.e., Johns Hopkins Hospital) in Baltimore, Maryland.	Scores on the SAQ improved over time, with statistically significant improvements observed on all of the SAQ except "stress recognition" from 2006 to 2008. Scores on "stress recognition" remained at 45.36% and 45.84% across the years. Scores increased from 61.01% to 69.37% on the "safety climate" subscale and from 64.74% to 70.64% on the "teamwork climate" subscale.	Not provided	Units were given a goal to either maintain their "safety climate" and "teamwork climate" scores on the pre-SAQ (if it was 60% or higher) or to improve their score on the subscales by 10 points.	High	The article says that units initially volunteered to implement CUSP, and later units were encouraged to adopt CUSP if their safety culture scores were low. The authors further noted that the units varied in the degree that they fully implemented CUSP. Data are presented for 144 units, but the units that actually implemented CUSP are not identified. During the study period, approximately a dozen other quality improvement interventions were happening across the hospital. Not

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
								able to establish the amount of time between pre-SAQ, intervention, and post-SAQ.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Edwards et al., 2008[34]	Multiple interventions, including: safety rounds, self-reporting system enhancements, and the SBAR (Situation, Background, Assessment, and Recommen-dation) communication strategy.	Pre-post design. Clinical staff, including nurses, respiratory therapists, and other staff, were participants. Physicians did not participate. Participants were surveyed (using the 9 subscales from the HSOPS and 2 overall patient safety outcomes) prior to the interventions and again approximately 1 year later. Pre-intervention data were available for 394 staff and post-intervention data were available for 428 staff.	Two inpatient facilities of Children's Healthcare of Atlanta: one academic hospital (235 beds) and one community-based hospital (195 beds).	Statistically significant improvements were found on the following HSOPS subscales: "Non-punitive response to error" (3.09 vs. 3.24), "frequency of event reporting" (3.47 vs. 3.62), "feedback and communication regarding error" (3.42 vs. 3.59), "organizational learning" (3.77 vs. 3.88), "supervisor/manager expectations and actions" (3.60 vs. 3.85), and "teamwork within units" (3.98 vs. 4.14). Scores declined on one HSOPS subscale ("teamwork across units") and significantly declined on the other ("hospital handoffs and transitions") over time, although followup analyses indicated that results were pulled down by stagnant or declining scores from respondents from the academic hospital.	Not provided	The changes observed in HSOPS scores seem to align with the safety initiatives that were chosen. Together, these initiatives relayed the importance of (and commitment to) patient safety. Staff discussions revealed that the decline in "handoffs and transitions" may have been related to workflow changes related to the self-reporting system enhancements (e.g., workarounds that didn't work anymore), which made communication at shift changes and transfers more difficult. This also affected some of the teamwork between units at the academic hospital that participated in the study.	High	None

Table B.4: Cross-Cutting Patient Safety Topics/Practices, Safety Culture—Systematic Reviews and Meta-Analyses

Note: Full references are available in the Section 17.2 reference list.

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings	Notes
Sacks et al., 2015[13]	Briefings/ debriefings, team-building exercises, educational campaigns, checklists, and bundled interventions.	Surgical settings, including labor and delivery and other surgical subspecialties.	Ten studies were evaluated as moderate quality and reported improvement in at least one dimension of safety culture measured, such as communication and job satisfaction. Thirty studies reported no improvement in one or more measures. Longer term positive effects on culture were reported in four studies (median followup was 9 months). Increased efficiency following safety culture interventions was reported by two moderate-quality studies. Finally, two moderate-quality studies measured patient outcomes, with both reporting a reduction in post-operative complications. Ten low-quality studies also provided evidence that safety culture initiatives were associated with better patient outcomes.	Studies varied widely in how interventions were implemented and measured. Multiple interventions were often bundled together (e.g., team building program such as MTT or TeamSTEPPS® combined with briefings or a checklist). The two primary obstacles to safety culture initiatives were participant resistance and regression toward baseline performance.	None

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings	Notes
Weaver et al., 2013[12]	Team training, Executive WalkRounds, CUSP.	Hospital settings.	Sixteen of the 20 team training studies reported significant improvement in safety culture, five reported improvements in care processes, and seven reported improved patient safety outcomes. All eight studies of WalkRounds reported improvement in perceptions of safety culture, while three of the eight provided evidence of improved care processes or patient outcomes. Six of the eight CUSP studies showed improvement in perceptions of safety culture and two found improvement in care processes.	The best strategy for improving safety culture may be to include bundled interventions in which team training is accompanied by other tools that support communication and engagement, such as WalkRounds or briefings.	None

Table B.5: Cross-Cutting Patient Safety Topics/Practices, Clinical Decision Support—Single Studies

Note: Full references are available in the Section 17.3 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Abdel-Kader, et al. 2011[38]	CDSS and education intervention vs. education intervention alone to enhance referrals and quantitative proteinuria assessments in chronic kidney disease (CKD) patients. CDSS intervention consisted of two separate alerts within the ambulatory electronic medical record (EMR), EpicCare.	Small cluster RCT. Study duration: 10 months. Patient population: 58 in the control group, 60 in the intervention group. Fifteen GIM faculty were randomized into the CDSS intervention group. Primary outcome was the presence of an EMR order for a nephrology consultation or presence of nephrology encounter in EMR. Secondary outcomes were measures of quality of CKD care.	Large university-based outpatient general internal medicine practice	CKD was documented in the EMR in 37% of patients in intervention group and 21% in control. For this, ~39% of patients in the intervention arm had a proteinuria assessment vs. 30.1% in the control. Among patients without a proteinuria assessment at baseline, 16.3% in the control group had one at follow-up vs. 27.7% in the intervention group.	Ten percent of patients in the alert group were referred to a nephrologist vs. 17% in the control group.	The intervention did not increase renal referrals, but it may have improved proteinuria assessments in patients who lacked one at baseline.	Low/ moderate—small patient population	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Abramson, et al. 2013[10]	E-prescribing application within the EHR included CDS to aid with prescribing.	Retrospective study of 20 ambulatory care providers. Reviewed prescription data from 3 months and 1 year post EHR implementation.	Eight sites, parts of an FQHC	Rates of prescribing errors were low at 3 months and 1 year. Rates of errors between the two time periods were not significantly different.	Rule violations were high but not statistically different between 3 months and 1 year.	Low rates of errors after intervention suggest that e-prescribing in the ambulatory setting can improve prescribing safety.	Moderate—retrospective, small population	None
Ahuja et al., 2018[11]	Implemented CCDS tools to enhance medication and patient safety related to the direct oral anticoagulants (DOACs). Assessed the effectiveness of the CCDS by measuring adherence to the dosing strategy recommendation for each DOAC.	Retrospective study; 121 patients—30 patients received dabigatran, 61 apixaban, and 30 rivaroxaban.	Tertiary academic center, 725 beds	Achieved 80% adherence to dabigatran CCDS dosing recommendations, 75% for apixaban, and 87% for rivaroxaban.	There was minor bleeding in 11 patients and major bleeding in 4 patients. Bleeding events did not correlate with nonadherence to CDSS. Thirty-five orders were non-adherent—of these 49% were lower doses than recommended in CCDS.	Study demonstrates that implementing CCDS may ensure safe prescribing of high-risk medications. Difficult to ascertain the reason for nonadherence due to retrospective nature. Lower dose may have been selected to potentially mitigate a higher risk of individual bleeding.	Moderate—retrospective, small population	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Awdishu et al., 2016[12]	CDS tool contained in EHR to improve the appropriate prescribing of medications for patients with renal insufficiency. Intervention arm received CDS while control did not.	Prospective cluster RCT.	University health system. Study population: all physicians who cared for patients with impaired kidney function in outpatient or inpatient. Utilized Best Practice Alert functionality within EHR to design custom alerts for medications—prospective drug ordering and look-back alerts. Medication alerts in the control were not displayed to the physician.	Drug discontinuation or dosage adjustment occurred in 17% of the intervention vs. 5.7% in control. Drug dose adjustment alerts were acted on more frequently than alerts for contraindicated drugs. Prospective alerts were associated with higher proportion of appropriate medication adjustment than look-back alerts.	Appropriate medication adjustment occurred in <20% of cases in intervention group.	Found that alerts significantly increased appropriate modifications to prescriptions. Impact of alerts was greater for dose adjustment rather than discontinuation.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Bode et al., 2017[28]	Purpose was to improve the quality of care of at-risk patients through the addition of connected blood glucose (BG) meters and CDSS to improve workflow and thus provide more efficient titration of patient's insulin regimens remotely. Glytec CDSS is an FDA-cleared cloud-based clinical decision support tool utilized by a health care provider to assist with insulin dose titration.	Retrospective paired before and after design without a control group. Intervention was a system involving the addition of a cellular enabled BG meter and insulin dose titration guided by Glytec CDSS. Population: 46 patients with type 1 or type 2 diabetes.	Not provided	During treatment with CDSS, A1C decreased from a baseline average of 10.2% to 7.8% at 3 months, 7.8% at 6 months, 7.8% at 9 months, and 7.2% at 12 months.	Not provided	Use of CDSS was shown to effectively get patients to their glucose targets while also improving the efficiency and workflow of the care team to allow for remote insulin titration between office visits.	Moderate—no control	None
Boustani et al., 2012[34]	Interdisciplinary team used available guidelines and two recently published systematic evidence reviews to develop the content and the format of the electronically delivered CDSS.	RCT evaluating the efficacy of a screening program coupled with a CCDS in enhancing hospital care for elders with cognitive impairment (CI). Primary outcome: orders of Acute Care for Elders (ACE) consultation.	University-affiliated, public hospital, 340 beds; population: 998 patients. >65 years, hospitalized on medical ward, have CI	Physicians receiving CDSS issued more discontinuation orders of definite anticholinergics but was not statistically significant.	CDSS did not increase physicians' orders for ACE consults, physicians' discontinuation of Foley catheterization, or discontinuation of physical restraints. CDSS had no statistically significant impact on health outcomes (hospital stay, mortality, home discharge, etc.)	Findings show the CDSS did not significantly change physician prescribing behavior.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Burgess et al., 2016[27]	Evaluated the impact of using online care process model (CPM) clinical decision support tool vs. not during care of patients hospitalized for management of lower extremity cellulitis (LEC). AskMayoExpert (AME) is an online clinical support tool that contains clinical decision algorithms termed "care process models" (CPMs).	Pre/post-intervention study; 37 patients pre-intervention and 48 post-intervention. Primary aim was to compare the initial antibiotic regimen prescribed for patients in the pre-intervention phase vs. the post-intervention phase, and to perform a sensitivity analysis of all LEC admissions, comparing when the CPM was used vs. not.	Mayo Clinic Hospital, St. Mary's Campus	During pre-intervention phase, CPM was used in 14% of LEC admissions. In post phase CPM utilization increased to 50%. During the 14 months, a total of 85 LEC admissions were analyzed, and the CPM was utilized during 29 of them. The appropriate antibiotic was prescribed by Hospital Day 2 in 62% of admissions when the CPM was utilized as compared to 21% when it was not used.	Significant difference in need for broadening coverage of antibiotics between CPM users and non-users. Antibiotics were broadened in 14% of the CPM group vs. 2% of the non-CPM group.	Results showed that when CPM was utilized it was associated with increased prescribing of the recommended antibiotic regimen.	Low/ moderate—small population	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Chaparro et al., 2017[14]	Pediatric Leapfrog CPOE evaluation tool uses simulated patients with associated test orders to evaluate a CPOE's ability to alert providers to potentially harmful medication errors. Tool evaluates CDS and provides a onetime cross-sectional assessment of whether appropriate decision support is being provided.	Evaluated 41 institutions over 2 years. Longitudinal analysis of test performance was carried out.	Hospitals—majority were free-standing pediatric institutions	CPOE systems that underwent testing performed significantly better in the basic decision support grouping than in the advanced grouping. Linear regression between basic and advanced decision support scores showed a moderate positive relationship. Found that pediatric CPOE systems intercepted ~2/3 of medication errors using the Leapfrog evaluation tool.	Not provided	Found that pediatric CPOE systems showed significant improvement in test scores of 4%/year with repeated testing using the Leapfrog tool, suggesting that repeated evaluations of CPOE/CDS systems may lead to improved ability to intercept potential medication errors.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Felcher et al., 2017[40]	Implemented three CDS tools in the EHR of a large health plan: (1) a new vitamin D screening guideline, (2) an alert that requires clinician acknowledgment of current guidelines to continue ordering the test, and (3) a modification of laboratory ordering preference lists that eliminates shortcuts.	Retrospective, descriptive analysis of an internal QI initiative. Compared the rate of vitamin D screening among adult health plan members in the 6 months prior to implementation of CDS tools to the rate 6 months following this intervention using a repeated cross-sectional design.	Large integrated group model health care delivery system	Vitamin D screening rates decreased from 74.0 tests per 1,000 members in the pre-implementation period to 24.2 tests per 1,000 members in the post-implementation period. Rates of appropriate vitamin D screening increased significantly. Cost of unnecessary testing significantly decreased (estimated annual cost saving for the system of $1.4M).	Not provided	Implementation of CDS tool was associated with significantly reduced overall rates of vitamin D screening and a significant increase in the proportion of ordered vitamin D screening tests that were clinically appropriate.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Field et al., 2009[13]	CDSS providing specific dose recommendations for long-term care residents with renal insufficiency. CDSS built on commercially purchased CPOE system. Developed four types of alerts.	RCT. The 22 long-stay units were randomly assigned for prescribing physicians to either receive or not receive the alerts.	Academically affiliated long-term care facility in Canada; resident care unit	Rates of alerts were nearly equal in intervention and control units. Proportions of final drug orders for which doses were appropriate were similar between the intervention and control units. Across all categories of alerts, drug orders in the intervention units were appropriate significantly more often than in control units.	Not provided	CDS system did not improve rate at which physicians order appropriate doses but did produce a substantial improvement in prescribing.	Low	International—Canada
Fitzgerald et al., 2011[41]	Real-time, computer-prompted, evidence-based decision and action algorithms (computer-assisted decision support).	Randomized controlled interventional study: 1,171 patients (3 groups); severely injured adults.	Level 1 adult trauma center	Error-free resuscitations were increased with the intervention. Morbidity from shock management, blood use, and aspiration pneumonia were decreased. Protocol compliance was improved. and errors and morbidity were reduced.	Not provided	Not provided	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Flanders et al., 2009[29]	CDS tool (CDT) for intravenous insulin dosing: the CDT allows for automated and standardized calculation of IV insulin drip rates.	Comparison of performance of the glucose control initiative as either a paper protocol or a computer based tool. Prospective cohort study. Piloted CDT in 1 ICU and then implemented across all.	ICUs at Methodist Hospital and Indiana University Hospital from 2004-2007	Percentage of blood glucose measures under the GCI upper limit increased from 68.33% at baseline to 79.53% in 2005 and 83.09% in 2007, indicating a reduction in hyperglycemia.	Initially, incidence of hypoglycemia increased slightly. Conducted a QI program root cause analysis to determine causes and made adjustments.	Following the successful pilot of the CDT, little resistance was encountered when it was expanded to other units.	Low	None
Genco et al., 2016[30]	Secondary objective of study was to determine whether CDSS alerts are successful at preventing opioid-related ADEs.	Retrospective chart review; 4,581 eligible ED visits were studied.	Urban academic medical center ED	None of the adverse drug events experienced by patients in this study were considered preventable by clinical decision support.	Providers sorted through 4,692 alerts to avert 38 potential adverse drug events—high sensitivity=low specificity.	None of the ADEs experienced by patients in this study were preventable by the CDSS. However, 46 alerts were accepted for 38 patients that averted a potential ADE.	Moderate—retrospective	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Gill et al., 2011[17]	her-based CDS coupled with clinician education about national guidelines for GI risk reduction for patients on NSAIDs. Two-part form automatically activated when EHR office note was started for these patients: (1) alert indicating patient was on NSAID and was high risk, and (2) tools to prescribe a gastro-protective medication, discontinue NSAID, or change it to one with less GI risk.	RCT. Intervention group received: full intervention packet, including the EHR-based CDS form, training regarding this form, the educational module, and the newsletter. Control did not receive any intervention. Study population: intervention 2,222 patients, control 3,012 patients.	National network of primary care offices (27 offices/ 14 States)	For at-risk patients, 25.4% in the intervention and 22.4% in the control were provided guideline-concordant care during the study year.	After the study, only 42% of intervention clinicians said they would provide care according to American College of Gastroenterology guidelines for patients on low-dose aspirin and 58% for elderly patients with no other risk factors. Only 23% said they were likely to continue using the form after the study. A reported 44% found the form disruptive on office work flow.	Findings showed her-based CDS with clinician education had a small but statistically significant positive impact on guideline-concordant care. Small but statistically significant impact on the individual component of prescribing a new gastro-protective medication, but not the component of discontinuing the traditional NSAID.	Low	None
Harinstein et al., 2012[32]	Goal was to determine performance of active medication monitoring system for drug-induced thrombocytopenia using a commercially available CDSS. Drug-laboratory result alert contained CDSS.	Population: 64 adult patients.	MICU and CICU at a university affiliated medical center	Not provided	CDSS did not interface with electronic medication administration record contained within the her, which caused an increase in the number of false positive alerts.	Found the alert to have more favorable performance characteristics when compared with other prior alerts.	Moderate—no control	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Kharbanda et al., 2016[42]	Developed, implemented. and evaluated the safety and effectiveness of an EHR-linked CDS tool for patients with suspected appendicitis. Goal was to reduce computed tomography (CT) use. CDS tool included a (1) standardized abdominal pain order-set, (2) web-based risk stratification tool, and (3) "time of ordering alert."	Quasi-experimental study. Population: children 3-18 years; intervention cohort=2,803.	Large pediatric hospital system, pediatric EDs	During the implementation period, CT use declined each month by 2.5%, resulting in a 54% relative decrease in CT use from the pre-implementation period to the end of the study. No significant change in ultrasound trend from pre- to post-implementation. Found no significant differences in the rates of negative appendectomies or missed appendicitis.	Not provided	Findings indicate that key elements for successful implementation include: (1) creating a collaborative guideline committee to ensure widespread acceptance; (2) obtaining support of leadership, especially in IT; and (3) integrating the CPG into the clinical workflow.	Low/ moderate—quasi-experimental	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Lavin and Ranta, 2014[43]	Transient ischemic attack (TIA)/Stroke Electronic Decision Support tool designed to improve diagnostic accuracy of GPs, limit ED referrals to high-risk patients, and prompt GPs to initiate secondary prevention immediately if specialist review is anticipated to be delayed by more than 24 hours.	Safety Audit: monitoring for major morbidity and mortality potentially attributable to TIA/Stroke EDS use after its launch.	Not provided	Seventy-nine patients managed with the aid of EDS, resulting in eight appropriate immediate hospital admissions because of patients being at high risk of stroke. Three patients had delayed admission, but care was fully guideline based, and patients had no adverse outcomes.	Two deaths occurred but not as a result from inappropriate EDS advice.	Study aimed to assess the safety of EDS tool in clinical practice and found no evidence to indicate any serious associated risk. No evidence to indicate serious preventable harm due to misdiagnosis, inappropriate triage, or over/under medication prompted by the EDS.	Moderate—safety audit	International—New Zealand

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Lilih et al., 2017[31]	Implemented a CDSS for gastrointestinal prophylaxis based on the Dutch guideline for gastrointestinal prophylaxis.	Pre/post intervention study. Objective was to determine whether CDSS resulted in improved compliance with the Dutch guideline for gastrointestinal prophylaxis.	Dutch hospital, inpatient and outpatient	Before implementation, 84.0% of prescriptions for gastrointestinal prophylaxis were co-prescribed during or within 1 hour after the order. After implementation this increased to 94.5%. Before implementation, 11.2% of drug safety alerts were correct according to guidelines; after implementation, 100% were correct. Before implementation, 4.4% of the correct drug safety alerts resulted in the addition of gastrointestinal prophylaxis within one hour after ordering the medication, while in the post-implementation period, 44.7% of the clinical rule pop-ups resulted in the addition of gastrointestinal prophylaxis.	Not provided	Results show that the CDSS is capable of improving patient safety.	Low	International—Netherlands

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Milani et al., 2011[36]	Evaluate whether CPOE with enabled decision support (CPOE-DS) is feasible in the acute coronary syndrome setting. On admission the admitting physician had the choice of using pre-printed paper orders with check boxes that followed the AHA/ACC guideline recommendations or CPOE-DS software that generated a paper order set.	Recorded clinical characteristics, hospital length of stay, and 30-day, 90-day, and 1-year mortality in 1,321 ACS patients. Used logistic regression analysis.	Ochsner Foundation Hospital cardiac service	Attainment of "perfect" care (every quality measure successfully completed) occurred in 89% of CPOE-DS patients vs. 61% of patients admitted with standard order sets.	Not provided	Findings show that use of CPOE with decision support is feasible in the ACS process of care and increases the likelihood of achieving perfect care.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Mishuris et al., 2014[45]	Categorized practices into three groups: all CDS tools active, without one or more CDS functions, and any disabled CDS.	Retrospective, cross-sectional analysis that used logistic regression to determine whether CDS is associated with improved quality indicators. Used data from the National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) outpatient department records.	Ambulatory clinic visits	Rates of visits for new problems and follow-up of chronic problems were less common at clinics without at least one of the CDS functions vs. clinics with all the CDS functions. Visits for preventive care were more common at clinics without at least one of the CDS functions.	Not provided	Found significant associations between the use of CDS and some (but not all) clinical quality measures before the enactment of meaningful use.	Low/ moderate	None
Olsho et al., 2014[46]	On-Time Quality Improvement for Long-Term Care: CDS intervention for pressure ulcers that uses risk reports embedded in HIT systems to identify recent changes in risks and guided facilitation to support integration of these reports into practices.	Interrupted time series design. Intervention group: 12 nursing homes; analyzed data from 13 nursing homes that did not implement On-Time.	Nursing homes	Found large and statistically significant reductions in pressure ulcer incidence associated with implementation of core On-Time components. Results imply approximately 2.6 pressure ulcers avoided per 100 residents per month.	Use of the optional behavioral report was associated with a large and statistically significant increase in pressure ulcer incidence.	Results imply a cost savings of $250,000 per year.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Prewitt et al., 2013[15]	Examination of whether there is a difference in ADE rates after simultaneous implementation of clinical decision support via CPOE and smart pump patient controlled analgesia (PCA).	Retrospective review of ADEs found by VRS and ADEs pre- and post-implementation.	Large tertiary and quaternary care hospital	Identified decrease in the risk of PCA events but was not statistically significant. Difference in pre- and post-implementation causality of five or greater for ADEs, indicating the event correlates with the drug; however, there was no difference in severity of three or greater, indicating no change in patient harm. VRS data showed obesity and weight were statistically significant with fewer events post.	Not provided	Results support the recommendation of CDS via CPOE and PCA smart pump technology.	Moderate—retrospective	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Ranta et al., 2014[44]	Transient ischemic attack (TIA)/Stroke Electronic Decision Support tool is designed to improve diagnostic accuracy of GPs, limit ED referrals to high-risk patients, and prompt GPs to initiate secondary prevention. Aim of this study was to assess if the implementation of a TIA/Stroke EDS (following safety audit) would be associated with a reduction of avoidable TIA management delays without incurring additional patient risk.	Prospectively identified all patients referred with a diagnosis of TIA. Compared data prior to EDS launch (2009) with 2 years after (2011).	Outpatient TIA clinic or inpatient stroke service	Best medical therapy was achieved by 43% of patients in 2009 and 57% in 2011. Behavioral counseling was provided to 40% of patients in 2009 and 66% in 2011. Time from first point of contact to stroke specialist review was significantly shorter in 2011. No instances of medication-related adverse events or treatment delays due to EDS misdiagnosis or inappropriate triage advice.	Not provided	Results suggest that tool was associated with significant improvement in the rate of initiating the best medical TIA therapy.	Moderate—non-randomized observational	Same intervention tool as Lavin and Ranta article; International—New Zealand
Schnipper et al., 2010[39]	Smart Forms for coronary artery disease (CAD) and diabetes mellitus (DM) enable writing a multi-problem visit note while capturing coded information and providing decision support.	Controlled trial randomized by physician.	Ten adult primary care clinics associated with Partners HealthCare	Patients of PCPs assigned to the intervention arm were more likely to have deficiencies in care addressed in the month following the index visit.	Overall use of Smart Forms was low. PCPs assigned to intervention arm used Smart Form for 5.6% of eligible patients. Use was higher for patients with DM (7.4%) than for patients with CAD (3.5%).	Documentation-based CDS led to a statistically significant, but clinically small, improvement in the care of patients with CAD/DM in primary care. Low use is likely related to usability, since Smart Forms require PCPs to actively change the way they document visits.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Stevens et al., 2017[16]	EQUiPPED: multicomponent QI initiative combining education, electronic CDS, and individual provider feedback to influence prescribing and improve medication safety for older adults. Evaluating the effectiveness of EQUiPPED to reduce use of potentially inappropriate medications (PIMs).	Pre/post-intervention evaluation. Sites employed a PDSA cycle to test change as components were implemented. Based on site-specific findings, EQUiPPED elements were adapted for site-specific needs.	Four VA medical center EDs	Rate of PIMs prescribing at baseline varied from 7.4% to 11.9%. After implementation, sites achieved a monthly PIM of between 4.5% and 6.1%. Adaptation occurred based on results of the PDSA cycle. The most prominent adaptation included site-specific strategies for releasing the EHR-based clinical decision support.	Not provided	EQUiPPED intervention positively influenced provider prescribing behavior and resulted in sustained safer prescribing for older adults discharged from the ED across multiple VA sites.	Low	Bundle not designed to assess impact of individual components.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Umscheid et al., 2012[23]	Examined effect of integrating a CDS intervention that does not involve pop-ups on VTE prophylaxis and event rates.	Retrospective study; population: 223,062 inpatients.	Quaternary care academic health system (3 hospitals)	In the unadjusted analyses, "recommended" prophylaxis significantly increased across the three study periods across all hospitals and services. Adjusted estimates suggest the intervention increased the use of "recommended" and "any" prophylaxis at all three hospitals when comparing the baseline time period 1 with time period 2.	Adjusted estimates suggest that the CDS intervention did not significantly increase the use of "pharmacologic" prophylaxis. VTE event rates increased across the study population; however, sub-analysis using only admissions with appropriate POA documentation suggested no change in VTE rates.	Analysis demonstrated significant increases in VTE prophylaxis that were associated with a CDS intervention.	Low/ moderate	None

Table B.6: Cross-Cutting Patient Safety Topcis/Practices, Cultural Competency—Single Studies

Note: Full references are available in the Section 17.4 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Bailey et al., 2012[19]	Rx bottles with ConcordantRx (language concordant) instructions.	Randomized, experimental evaluation; 202 LEP adults who spoke five non-English languages (Chinese, Korean, Russian, Spanish, Vietnamese), recruited from nine clinics and community organizations.	Nine clinics and community organizations in San Francisco and Chicago.	Subjects receiving the ConcordantRx instructions demonstrated significantly greater Rx understanding, regimen dosing, and regimen consolidation compared with those receiving standard instructions (incidence rate ratio [IRR]: 1.25; 95% confidence interval [CI], 1.06 to 1.48; p=0.007 for Rx understanding, IRR: 1.19; 95% CI, 1.03 to 1.39; p=0.02 for regimen dosing, and IRR: 0.76; 95% CI, 0.64 to 0.90; p=0.001 for regimen consolidation). In most cases, instruction type was the sole independent predictor of outcomes in multivariate models controlling for relevant covariates.	At time of article, California was the first and only State to mandate that pharmacies use a standardized, patient-centered prescription label, through a bill passed in October 2007. The California Patient Medication Safety Act enlisted the California Board of Pharmacy to create a set of requirements for the design and content of Rx labels. The purpose of this bill, implemented in 2011, was to improve comprehension of Rx instructions by ensuring that the information provided is grounded in evidence from health literacy research. Language concordance was not included as a requirement. Regardless, the ConcordantRx instructions comply with the recommendations set forth in this bill in terms of patient-centered labeling and can be used to fulfill California's labeling requirements for the LEP community.	Moderate; convenience sample; qualitative	Process measure

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Cardarelli et al., 2018[53]	Use of lay health workers for post-discharge follow-up calls for high-need patients. Discharge plans were developed from patients' self-identified needs. The care plan and LHW's contact information was provided to the patient upon discharge. The LHW conducted a follow-up call 24–48 h after discharge to review any issues during the interim post-discharge period, assess patient follow-through in engaging with identified community resources and review plans for appropriate follow-up visits.	Pre-post study design. Baseline period of 4 months in which high-need patients did not receive the LHW follow-up calls, compared to 6-month intervention period. Hospitalized patients (males and females over 18 years old of any racial/ethnic group and admitting diagnosis) at high risk of a 30-day readmission to the hospital participated in study. There were 46 patients in the baseline phase and 61 in the intervention phase. Almost all participants were Caucasian, reflecting the predominant population found in Appalachia Kentucky; also, most participants had only a high school education or less (70%) and over 55% had either Medicare or Medicaid as their primary insurance.	A hospital in in Morehead, KY, in Northeast Appalachia Kentucky	Thirty-day readmission rates decreased from 28.3 to 14.8% (*p* = 0.09) between the baseline and intervention phases. When adjusted for education, transportation cost, and a positive anxiety screen, the odds of being readmitted within 30 days further decreased to 77% (OR 0.33; 90% CI 0.14–0.81; p =0.04) among those exposed to the LHW program. In addition, those with transportation cost barriers were over three times more likely to be readmitted within 30-days.	The authors assert that LHWs help transition patients from the hospital to their home by assuring that patients sustain healthy behaviors and access needed services. Because they serve the community in which they live, they often share a similar socioeconomic status and are able to relate to the psychosocial and economic stressors met by their clients. Communicating with the hospitalized patient about social needs and ways to address these needs not only gives patients the tools to improve their situation; it may also instill a sense of empowerment. When considering implementing LHWs in care transition programs, it is important to consider patient population to target (i.e. risk stratification) and the effort level at which a LHW should be employed. The studied model may be an cost-effective alternative for resource-limited rural and community hospitals.	Low to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Flores et al., 2012[56]	Professional interpreters for translation accuracy (compared with ad hoc or no interpreter).	A cross-sectional error analysis of audiotaped emergency department (ED) visits over 30 months; 57 encounters included 20 with professional interpreters, 27 with ad hoc interpreters, and 10 with no interpreters.	Two of the largest pediatric EDs in MA	The analysis found 1,884 interpreter errors, of which 18% had potential clinical consequences. The proportion of errors of potential consequence was significantly lower for professional (12%) versus ad hoc (22%) versus no interpreters (20%) ($p<0.01$). The median errors by professional interpreters with 100 or more hours of training were significantly lower, at 12, versus 33 for those with fewer than 100 hours of training.	Focus on meaning rather than word-for-word translation. Errors of potential clinical consequence were significantly more common with ad hoc interpreters and no interpreters than with professional hospital interpreters. Hours of training, not experience, were associated with greater accuracy for professional interpreters. One hundred or more hours of training might have major impact on reducing errors.	Low to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Karliner et al., 2017[51]	Increasing access to professional interpreters by providing a dual-handset telephone with a direct connection to interpreter services at each hospital bedside that would facilitate use by all clinical providers. These 66 telephones had a programmed button that allowed 24-hour access to a professional (trained and tested) medical interpreter for more than 100 languages.	Observational, natural experiment. Of 8,077 discharges, 1,963 were for limited English proficient (LEP) and 6,114 for English-proficient (EP) patients. Discharges occurred over 3 years. This time-frame begins 18 months prior to the intervention, includes the 8-month intervention period, and continues for 10 months after the intervention.	A medicine floor of an academic medical center consisting of two separate nursing units; one a step-down unit for higher acuity patients and the other for patients with less intensive nursing needs.	There was a significant decrease in observed 30-day readmission rates for the LEP group during the 8-month intervention period compared with 18 months pre-intervention (17.8% vs. 13.4%). At the same time, EP readmission rates increased (16.7% vs. 19.7%). Readmission results remained significant in adjusted analyses (pre-intervention OR=1.07; 95% CI, 0.85 to 1.35; intervention CI, 0.64; 95% CI, 0.43 to 0.95). There was no significant intervention impact on length of stay (LOS) in either unadjusted or adjusted analyses. After accounting for interpreter services costs, the estimated 119 readmissions averted during the intervention period were associated with estimated monthly hospital expenditure savings of $161,404.	Prior to the intervention, usual-care communication included in-person staff interpreters who could be scheduled during usual business hours, and a slowly increasing number of dual-handset interpreter telephones (ranging from 0 to 5 during the pre-intervention period). It took additional time to locate interpreters and bring them to the patient's room, and often they were in use elsewhere. Having a telephone in every patient room, immediately available to clinicians at any time, was a key component to the success of the intervention.	Low	Twenty-five million people in the United States have limited English proficiency (LEP); this growing and aging population experiences worse outcomes when hospitalized. Federal requirements that hospitals provide language access services are very challenging to implement in the fast-paced, 24-hour hospital environment.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Lee et al., 2017[55]	Bedside interpreter phone system at every bedside, enabling 24-hour immediate access to professional interpreters.	Prospective, pre-post intervention implementation study using propensity analysis. Hospitalized patients undergoing invasive procedures on three hospital floors. Chinese- and Spanish-speaking patients with LEP (84 pre and 68 post implementation) and 86 English speakers.	Cardio-vascular, general surgery or orthopedic surgery floors of a hospital.	Post-implementation (vs. pre-implementation) patients with LEP were more likely to meet criteria for adequate informed consent (54% vs. 29%, p=0.001) and, after propensity score adjustment, had significantly higher odds of adequate informed consent (AOR 2.56; 95% CI, 1.15 to 5.72) as well as of each consent element individually. However, compared with post-implementation English speakers, post-implementation patients with LEP had significantly lower adjusted odds of adequately informed consent (AOR, 0.38; 95% CI, 0.16 to 0.91).	Prior to implementation, Interpreter Services staff met with all hospital nurse managers to plan the implementation and communication with nursing staff. Nurse managers educated nurses. Additionally, the physician champion contacted all clinical Chiefs of Service about the phones, who in turn communicated by email with their attending and resident physicians. An article describing the phones was posted in the internal Graduate Medical Education online newsletter. No other system interventions occurred. Despite the observed improvements after interpreter phone implementation, post-implementation patients with LEP still had lower odds of informed consent than English-speakers, even when adjusting for health literacy.	Low to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Lindholm, et al., 2012[50]	Professional interpretation at patient admission or discharge.	This study is a retrospective analysis of length of stay and 30-day readmission rates among patients who were admitted to a tertiary care, university hospital. The study population includes 3,071 admissions with an LOS between 1 and 85 days. Multivariable regression models explored differences among patients who had received interpretation at admission, discharge, or both, controlling for patient characteristics, including age, illness severity, language, and gender.	A tertiary care, university hospital; size not provided.	Of the 3,071 patients included in the study, 39% received language interpretation on both admission and discharge date. Patients who did not receive professional interpretation at admission or both admission and discharge had an increase in their LOS of between 0.75 and 1.47 days, compared with patients who had had an interpreter on both day of admission and discharge ($p<0.02$). Patients receiving interpretation at admission and/or discharge were less likely than patients receiving no interpretation to be readmitted within 30 days.	In this study, the length of a hospital stay for LEP patients was significantly longer when professional interpreters were not used at admission or both admission and discharge. As a measure of severity of illness, the researchers used the hospital's diagnoses cost weight that accounts for differences in patients' illness burden. The researchers felt that interpretation at admission was especially important, as it has the greatest impact on LOS. This intuitively makes sense, since a patient's history accounts for approximately 70% of the necessary information to formulate a correct diagnosis.	Moderate—no comparison group, some patient characteristics not included, single site	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Sudore et al., 2018[54]	To mitigate literacy, cultural, and language barriers to advance care planning, easy-to-read advance directives and a patient-directed, online advance care planning program called PREPARE For Your Care (PREPARE) were created in English and Spanish.	A comparative efficacy randomized clinical trial was conducted from February 1, 2014, to November 30, 2017, among 986 English-speaking or Spanish-speaking primary care patients 55 years or older with two or more chronic or serious illnesses.	Four San Francisco, safety-net, primary-care clinics.	No participant characteristics differed between the two comparison groups, and retention was 85.9% (832 of 969) among survivors. Compared with the advance directive alone, PREPARE resulted in a higher rate of advance care planning documentation (unadjusted, 43.0% [207 of 481] vs. 33.1% [167 of 505]; p<0.001; adjusted, 43.0% vs. 32.0%; p<0.001) and higher self-reported advance care planning engagement scores (98.1% vs. 89.5%; p<0.001). Results remained significant among English speakers and Spanish speakers.	The patient-facing PREPARE program was easy-to-read and did not require clinician/system-level interventions to assist the patient. Materials were written at a fifth-grade reading level. Advance care planning (ACP) improves value-aligned care, yet, it remains suboptimal among diverse patient populations. Was successful among both English- and Spanish-speaking older adults.	Low to moderate	Among the 986 participants (603 women and 383 men), the mean (SD) age was 63.3 (6.4) years; 387 of 975 (39.7%) had limited health literacy, and 445 (45.1%) were Spanish speaking.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Woerner et al., 2009[52]	Delivery of home nursing care using a culturally congruent approach. Hired Hispanic nurses and teachers, added a Spanish language phone line. Allowed nurses to give personal phone numbers to patients; surveyed the patient population about their educational needs and the most appropriate methods for providing healthcare information. Creation of a patient education series in telenovela format. Education on healthy food using culturally appropriate food. Identified non-Hispanic learner needs.	A retrospective analysis of pre-intervention (March 2006 to March 2007)/post-intervention (April 2007 to April 2008) data was done to determine whether or not care delivery outcomes improved for Hispanic patients following introduction of the ¡EXITO! model. Outcome and Assessment Information Set (OASIS) data from 125 unduplicated home care patients were tracked. Nursing care delivery was analyzed using ethnographic research techniques.	Home nursing care for 125 patients.	Acute hospitalization for Hispanic patients/all patients pre-intervention was 43%/30%; post-intervention, it was 24%/17%. Emergency department rate pre-intervention was 23%/24%; post-intervention, it was 21%/26%. Oral medication adherence pre-intervention was 22%/42%; post-intervention, it was 28%/42%. Response rates for satisfaction surveys were low, ranging from 2% to 32% per quarter. For all but one quarter, satisfaction rates were above the targeted 96% rate. Followup analysis found numerous discrepancies between which meds the patient was taking and what the physician and pharmacy thought the patient was taking.	Theory-based intervention for culturally congruent care: theory of transcultural nursing, as explicated in Leininger's Sunrise Enabler model. Prior to implementation, a survey was conducted to identify the learning needs of non-Hispanic nurses. Language is critical but not sufficient to reduce Hispanic population healthcare disparities to the levels of the general population. For project ¡EXITO!, language and access concerns were not the key barriers to the achievement of targeted home care delivery outcomes. Both translators and Spanish-speaking providers were used during the delivery of services, and all patients had some form of third-party payment, most commonly Medicare and Medicaid. Attention to cultural concerns and designing programs that incorporate strategies responsive to culturally based preferences and beliefs can have a positive impact on home care patients.	Low to moderate; p-values not provided.	None

Table B.7: Cross-Cutting Patient Safety Topics/Practices, Cultural Competency—Systematic Reviews

Note: Full references are available in the Section 17.4 reference list.

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings	Notes
Forsetlund et al., 2011[48]	Interventions to improve healthcare services for ethnic minorities.	Healthcare for ethnic minority populations.	Eight studies examined the effect of educational interventions in improving outcomes within cross-cultural communication, smoking cessation, asthma care, cancer screening, and mental healthcare. Most patients were African-Americans and Latin Americans, and all ages were represented. The review concluded that different forms of education, either alone or as part of a more complex intervention, may have a small to moderate but context-dependent effect on improvement of health personnel practices, as well as a smaller effect on patient outcomes across patient populations. Five of the six studies that examined computerized reminders, either alone or as part of a complex intervention, showed statistically significant positive effects for the selected outcomes. Unable to decide whether follow-up and support in terms of personnel resources may affect patient outcomes. Two randomized controlled trials examined the effect of using simultaneous translation via remote consecutive medical interpreting. Two randomized controlled trials examined the effect of matching clients and therapist.	Educational interventions and electronic reminders to physicians may in some contexts improve healthcare and health outcomes for minority patients. The quality of the evidence varied from low to very low. The quality of available evidence for the other interventions was too low to draw reliable conclusions. Researchers found no studies that included only young patients, suggesting that interventions targeting health personnel or health organizations may be applicable regardless of the age of the patient population. This review reveals that the evidence for interventions to improve healthcare for minorities is sparse and generally of low quality.	None

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings	Notes
Horvat et al., 2014[49]	Cultural competency education for health professionals.	Patients from minority culturally and linguistically diverse (CALD) backgrounds.	Searched multiple databases up to 2014. To assess efficacy, the researchers developed a four-dimensional conceptual framework comprising educational content, pedagogical approach, structure of the intervention, and participant characteristics to provide consistency in describing and assessing interventions. Included five RCTs involving 337 healthcare professionals and 8,400 patients; at least 3,463 (41%) were from CALD backgrounds. Health behavior (client concordance with attendance) improved significantly among intervention participants compared with controls (relative risk [RR] 1.53, 95% CI, 1.03 to 2.27, 1 study, United States, ESS 28 women, low quality). Involvement in care by “non-Western” patients (described as “mainly Turkish, Moroccan, Cape Verdean and Surinamese patients”) with largely “Western” doctors improved in terms of mutual understanding (SMD 0.21, 95% CI, 0.00 to 0.42, 1 study, the Netherlands, 109 patients, low quality). Evaluations of care were mixed (3 studies). Further research is required to establish greater methodological rigor and uniformity on core components of education interventions, including how they are described and evaluated.	There was positive, low-quality evidence showing improvements in the involvement of CALD patients. Findings either showed support for the educational interventions or no evidence of effect. No studies assessed adverse outcomes. The quality of evidence is insufficient to draw generalizable conclusions, largely due to heterogeneity of the interventions in content, scope, design, duration, implementation, and outcomes selected.	None

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings	Notes
Lie et al., 2011[16]	Cultural competency training for healthcare professionals.	Healthcare, general.	Search of databases for articles in English published between January 1990 and March 2010. Seven studies met inclusion criteria. Three involved physicians, two involved mental health professionals, and two involved multiple health professionals and students. Two were quasi-randomized, two were cluster randomized, and three were pre/post field studies. Study quality was low to moderate, with none of high quality; most studies did not adequately control for potentially confounding variables. Effect size ranged from no effect to moderately beneficial (unable to assess in 2 studies). Clinical endpoints were at least one of the outcomes of interest in three studies. Three studies reported positive (beneficial) effects; none demonstrated a negative (harmful) effect. The studies, albeit of limited quality, reveal a trend in the direction of a positive impact on patient outcomes. However, overall, the current evidence appears to be neither robust nor consistent enough to derive clear guidelines for CC training to generate the greatest patient impact.	Some research shows a positive relationship between cultural competency training and improved patient outcomes, but there remains a paucity of high-quality research. Future work should address challenges limiting quality. The authors propose an algorithm to guide educators in designing and evaluating curriculums to rigorously demonstrate the impact on patient outcomes and health disparities. It is possible that cultural competency training as a standalone strategy is inadequate to improve patient outcomes, and that concurrent systemic and systems changes, such as those directed at reducing errors or improving practice efficiency, and the inclusion of interpreters and community health promoters as part of the healthcare team, are needed to optimize its impact.	None

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings	Notes
Truong et al., 2014[2]	Cultural competency in healthcare.	Healthcare settings, general.	As cultural competency did not achieve popularity until the late 1990s, and government policies mandating cultural competency did not appear until the early 2000s, a search timeframe of 2000 to 2012 was chosen. Nineteen published reviews were identified. Reviews addressed between 5 and 38 studies, and included a variety of healthcare settings/contexts and a range of study types. There were three main categories of study outcomes: patient-related outcomes, provider-related outcomes, and health service access and utilization outcomes. The majority of reviews found moderate evidence of improvement in provider outcomes and healthcare access and utilization outcomes, but weaker evidence for improvements in patient/client outcomes. Overall, positive effects were reported by most reviews, particularly in relation to provider outcomes. Reviews that compared different types of interventions found that the use of culturally trained health workers was the most effective. However, rather than being comparable, many of the primary studies in these reviews were a mixture of study designs focused on various interventions. Four of five reviews that included studies related to health service outcomes found some evidence of improvement. Seven of the nine reviews that examined patient/client-related outcomes generally found evidence of some improvement in health outcomes. A variety of patient/client outcomes were reported, including physiological outcomes such as blood glucose, weight, and blood pressure, as well as outcomes such as patient satisfaction and trust, knowledge of cancer screening, and knowledge of health conditions. Behavioral outcomes such as dietary and exercise behaviors were examined in three reviews.	There is some evidence that interventions to improve cultural competency can improve patient/client health outcomes. However, a lack of methodological rigor is common among the studies included in reviews, and many of the studies rely on self-report, which is subject to a range of biases, while objective evidence of intervention effectiveness was rare. Future research should measure both healthcare provider and patient/client health outcomes, consider organizational factors, and use more rigorous study designs. Cross-cultural interactions are likely structured and shaped by the worldviews and past experiences of not only the staff and clients but also the culture of the organization, which is embedded in and produced by policy frameworks, organizational arrangements, and physical settings of the organization. Interventions to improve cultural competency need to consider the individual and organizational contexts and the interplay between them.	This article is a review of systematic reviews.

Table B.8: Cross-Cutting Patient Safety Topics/Practices, Monitoring, Audit, and Feedback—Single Studies

Note: Full references are located in the Section 17.5 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Boet et al., 2018[4]	Audit and feedback	Prospective, randomized controlled trial (RCT). Baseline: control: n=1,384; benchmarked n=1,466; ranked n=1,222. Intervention: control n=1,225; benchmarked n=1,428; ranked n=1,121. Patients undergoing surgery >60 minutes and not on cardiac bypass.	Large health science center serving 26,000 patients annually in Ottawa, Canada	Using benchmarked or ranked feedback was no more effective than no feedback in influencing anesthesiologists' performance related to patient temperature outcome in the clinical setting.	Not provided	Not provided	Low	None
Byrnes et al., 2010[21]	Monitoring and feedback	Quality improvement pre-post intervention design; average annual number of patients n=1,206; patients referred to American College of Surgeons (ACS)-verified level I trauma center	Nine hospitals; average licensed bed count was 45, average number of staffed beds was 39	Among patients with an Injury Severity Score (ISS) of <15, the incidence of a good outcome or mild disability was 93% after the intervention compared with 84% before the intervention (p=0.07). Among patients with an ISS ≥15, the incidence of outcomes was nearly identical between the groups.	Not provided	Not provided	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Coleman et al., 2013[8]	Multicomponent intervention including clinical dashboard	Retrospective time series analysis; n=1,200; prescription data extracted from PICS	NHS Foundation Trust	Omission rates were reduced from 10.3 to 4.4% for antibiotics (57% reduction) and from 16.4 to 8.2% for non-antibiotics (50%). The reporting of overdue doses on clinical dashboards resulted in a step-change reduction in missed antibiotic doses of 0.60 (95% CI, 0.26 to 0.95) percentage points (p=0.001).	Not provided	Not provided	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Colquhoun et al., 2017[1]	Audit and feedback	Systematic review; n=140 studies; RCTs	Various	Feedback identified the specific behavior to be changed 86% of the time.	Not provided	Feedback was given on patient outcomes in 14% of the studies, and process of care in 79% of studies. Feedback content included other content 32% of the time, including patient-level data and cost data. Feedback presented aggregated patient data 81% of the time and feedback about individual patients' care 25% of the time. Comparison data were to peers' performance or "others'" previous performance 49% of the time and to a standardized guideline as a comparator 15% of the time.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Dawson, 2015[16]	Auditing and feedback	Qualitative study; n=30; nurses, healthcare support staff, Infection Prevention and Control Team, and people with managerial/ administrative roles	2 NHS hospitals in the UK	Not provided	Not provided	The perception of participants across all Audit Process Involvement (API) groups was that data generated by the current measurement process were "meaningless." Participants had concerns about how data generated by the audit process were used to engender change and found it hard to perceive any change stemming from the audit process.	High	None
Diamantourous et al., 2017[9]	Audit and feedback	Cluster randomized trial; n=720; patients with various risks for VTE	Seven community hospitals and one academic medical center in Toronto, Canada	The rates of appropriate thromboprophylaxis increased in both control and intervention groups. Greater improvement in the intervention group was statistically significant for the major general surgery patient subgroup (p=0.048).	Not provided	Not provided	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Dinescu et al., 2011[13]	Audit and feedback	Pre-post intervention study; n=5; geriatric fellows	Department of Geriatrics and Palliative Medicine at Mount Sinai Medical Center	After intervention, fellows were more likely to complete all required discharge summary data compared with pre-intervention (91% vs. 71%, p<0.001). Discharge summary completeness improved for all composite outcomes examining the four domains of care: admission (93% vs. 70%, p<0.001), hospital course (93% vs. 78%, p<0.001), discharge planning (93% vs. 77%, p<0.02), and post-discharge care (83% vs. 57%, p<0.001).	Not provided	Not provided	High	None
Doers et al., 2015[22]	Audit and feedback	Prospective Quality Improvement Project	4 general internal wards at Milwaukee Veterans Affairs (VA) Medical Center	The total scores significantly improved from 7.0 to 8.2 out of a possible 11 (p<0.0001). Documentation of many essential elements improved significantly during this intervention, such as mental status (p<0.0001), decisionality (p<0.0001), lab or test results (p<0.0001), degree of acuity (p<0.0001), anticipatory guidance (p<0.0001), and future plans (p<0.0005). The use of vague language declined (p<0.0001).	Not provided	Not provided	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Fraser et al., 2017[23]	Audit and feedback	Interrupted time series design; n=548; home health clients	Seven offices within Alberta, Canada	There were no significant trends from baseline to the post-intervention period in number of clients reporting pain, falls, delirium, hospital visits, or pressure ulcers.	Not provided	Not provided	High	None
Gilkes et al., 2017[12]	Audit and feedback	Non-randomized, before-after interventional study; 3,076 patients; ages 15–69 years	Primary care in Australia	Statistically and clinically significant increase in recording patients' alcohol consumption (24% to 36%; OR 1.19; 95% CI, 1.10 to 1.29). There was a significant increase in proportion of patients who had detailed family history of type 2 diabetes (23% to 32%), early ischemic heart disease (24% to 33%), breast cancer (21% to 32%), and colorectal cancer (20% to 30%).	There was a significant reduction in the recording of mammograms from 46% to 36%.	Not provided	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Hubner et al., 2017[3]	Audit and feedback	Prospective; n=2,209; patients who had an out-of-hospital cardiac arrest	Emergency medical technicians (EMTs) and emergency physicians before hospital in Vienna, Austria	No differences in the rates of sustained return of spontaneous circulation (sROSC) (p=0.95) or the fraction of patients pronounced dead in the field (p=0.47). No impact on 30-day survival (p=0.95). Found a strong linear increase of good neurological outcome among survivors during the observation period (p=0.02), showing an increase of 16.2% comparing the first with the last observation interval.	Not provided	Not provided	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Ivers et al., 2014[24]	Audit and feedback	Qualitative study; n=54; family physicians	Not provided	Not provided	Not provided	None of the participants reported that they found the feedback particularly useful. Participants commonly reported that they intended to improve performance by being more mindful of the relevant targets during patient encounters. However, no participants reported using the feedback to set specific goals for improvement or action plans for reaching these goals.	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Ivers et al., 2012[6]	Audit and feedback	Systematic review and meta-analysis of RCTs	80 trials based in North America, 21 in the UK or Ireland, 10 in Australia or New Zealand, and 29 elsewhere	Eighty-two comparisons from 49 studies measured improved compliance with desired practice. Median 4.3% absolute increase in desired practice (IQR 0.5% to 16%). Twenty-six studies measured compliance with desired practice (continuous outcomes): median 1.3% improvement in desired practice (IQR 1.3% to 28.9%).	Not provided	Not provided	Low	None
Ivers et al., 2013[17]	Audit and feedback	RCT; n=4,617 at baseline; 2,157 in feedback plus worksheet arm, and 2,460 in usual feedback arm; adult patients 18 and over with diabetes and/or ischemic heart disease	Primary care clinic in Ontario	No clinically or statistically significant differences were observed across groups in the primary outcomes in either the adjusted or unadjusted models.	Not provided	Not provided	Not provided	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Jeffs et al., 2014[19]	Audit and feedback	Qualitative; n=56; nurses	Five hundred-bed teaching hospital in Toronto, Ontario, Canada	Not provided	Not provided	Participants saw value of seeing the data, as the data provided a visualization of how they were doing. Participants reported the Care Utilising Evidence (CUE) dashboard acknowledged and highlighted the work that nurses do to provide high-quality care and maintain standards of practice. Twenty-seven participants said the data displayed on the dashboard were useful to guide improvement efforts.	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Johri et al., 2017[14]	Audit and feedback	RCT; n=105,351; women giving birth	Thirty-two public hospitals in Quebec Canada	Analyses including all patients showed a small non-significant reduction in caesareans in the intervention group compared with controls and an important reduction in costs, yielding adjusted estimates per-patient of a reduction of 0.005 caesarean sections (95% CI, -0.015 to 0.004, p=0.09) and $180 saved (95% CI, −$277 to −$83, p<0.001).	Not provided	Not provided	Low	None
Kreitmeyer et al., 2017[26]	Audit and feedback	Prospective: n=273 pre-intervention; n=263 post-intervention; pediatric patients	Academic tertiary care hospital with 61 beds in Munich, Germany	Percentage of hospitalized children receiving at least one antibiotic did not change significantly. Antibiotic treatment days decreased by 10.5% (p<0.001), from 483.6 (pre-intervention) to 432.9 (post-intervention) days of therapy per 1,000 patient-days, with a significant effect regarding cephalosporin consumption (-35.5%, p<0.001).	Not provided	Not provided	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Laskshminarayan et al., 2010[25]	Audit and feedback	Cluster-RCT; pre-intervention control n=622, experimental n=589; post-intervention control n=648, experimental n=446; patients age 30–84 with acute ischemic stroke and admitted through the emergency room	Twenty-four acute care hospitals in Minnesota	There was no significant intervention effect for acute, in-hospital, or discharge cases.	Not provided	Not provided	Moderate	None
Langston, 2011[10]	Audit and feedback	Pre/post-intervention study=263 pre-intervention and 253 post-intervention; registered nurses (RNs), nursing assistants (NAs), medical doctors (MDs), and ancillary staff	SICU, neurosurgery ICU, and surgical intermediate care unit at University of North Carolina Hospitals	There was a significant increase overall for hand hygiene compliance after no patient contact (p=0.006). There was a significant increase (16.9%) in hand hygiene compliance for RNs after nonpatient contact (p=0.03). There were no significant differences in hand hygiene compliance after patient contact overall or for any particular type of provider.	Not provided	Not provided	High	Small sample sizes; same people analyzed

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Le Grand Rogers et al., 2015[15]	Audit and feedback	Systematic review; n=24 studies	Various EDs	Of the 24 studies, 23 resulted in improvement in the measured outcomes. There was substantial heterogeneity in the included studies, with an I2 index of 83%. The included studies had an average Downs and Black score of 15.6 of 30 (range, 6–22).	Not provided	In the 24 studies, feedback was given as one-on-one, as a group, or in both manners. Only 2 studies used one-on-one feedback alone. Seven of the 24 studies used the group method to provide feedback. Fifteen of the 24 studies used both the one-on-one and group methods to provide feedback. In seven studies, feedback was provided by a supervisor, whereas in five studies, feedback was provided by a peer or colleague.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Mahant et al., 2008[2]	Audit and feedback	Prospective observational study; n=1,705 pre-intervention, n=1,489 in intervention; 60 beds; pediatric patients	Pediatric inpatient unit at a tertiary care pediatric academic medical center in Toronto, Canada	The intervention was associated with a significant reduction in the proportion of nonqualified hospital days, from 47% to 33% of hospital days (RR: 0.71 [95% CI 0.74 to 0.68] p<0.0001). There was no significant difference in the hospital readmission rate.	Not provided	Not provided	High	None
Redwood et al., 2013[18]	Feedback	Mixed methods; n=88; junior doctors	Teaching hospital with 1,200 inpatient beds	No evidence that the introduction of the dashboard had a significant effect on either the prescribing behavior or the response to laboratory alarms of the junior doctors in the trial.	Not provided	Junior doctors found the dashboard helpful in stimulating reflection on their clinical behaviors and responsibilities. However, they expressed reservations about the sort of performance data that were collected and given as feedback via the clinical dashboard.	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Roberts et al., 2015[27]	Audit and feedback	Before and after design; n=2,609 prescriptions; patients on acute medical unit receiving antimicrobial prescriptions	Acute medical unit in UK	The change from baseline was statistically significant (p<0.01) in all follow-up periods for two indicators: "antimicrobials should have a documented indication in the medical notes" (6.0% at the 5th follow-up) and "antimicrobials should adhere to guideline choice or have a justification for deviation" (8.7% at the 5th follow-up).	Not provided	Not provided	Moderate	None
Sales et al., 2014[28]	Monitoring and feedback	Interrupted time series; n=500; long-term care residents	Nine long-term care units in four facilities in Alberta, Canada	Not provided	Study found no immediate change in the level or number of falls at the outset of the intervention and a modest but significant increase in the rate of falls over the intervention period.	Not provided	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Scales et al., 2011[20]	Multicomponent intervention including audit and feedback, and educational outreach	RCT; n= 9.29 ICU admissions; patients admitted to ICU	Fifteen community hospital ICUs in Ontario, Canada	Improvements to adherence rates in intervention ICUs were similar to control ICUs (ratio of ORs, 3.12; 95% CI, 0.79 to 12.41; p=0.11). There was no change in the proportion of eligible patients receiving deep vein thrombosis prophylaxis among intervention ICUs (OR, 1.28; 95% CI, 0.67 to 2.45; p=0.46) or among control ICUs (OR, 0.52; 95% CI, 0.20 to 1.30; p=0.16).	Not provided	Not provided	Moderate	None
Tuti et al., 2017[7]	Audit and feedback	Systematic review of RCTs; n=81,700 patients	Various settings	Meta-analysis was highly heterogeneous. Three studies found a positive effect of the e-audit and feedback intervention on quality of care. None of the other studies found an effect of the intervention on all the outcome measures evaluated. Dichotomous process measures, clinical process measures, dichotomous clinical outcomes, continuous clinical outcomes	Not provided	Not provided	Low	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Van der Veer et al., 2013[5]	Audit and feedback	RCT; 15 ICUs in intervention, 13,539 total admissions; 15 ICUs in control arm, 12,013 total admissions. All patients admitted except patients following coronary artery bypass graft surgery and organ donation.	Thirty ICUs in the Netherlands	Study did not find significant difference in ICU length of stay or time to ICU death between intervention and control arms.	Not provided	Not provided	Low	None
Weston et al., 2017[29]	Audit and feedback	Retrospective; n=175 patient encounters; adult patients with cardiac arrest who received cardiopulmonary resuscitation (CPR) in the out-of-hospital setting from basic life support and/or advanced life support (ALS) providers present from the Milwaukee Fire Department	EMS system covering 600,000 individuals in Milwaukee, WI	There was a significant improvement in compression depth >5cm ($p<0.001$) in benchmark achievement. The difference between groups for pre-shock pause times was not significant and the means in both groups were above the benchmark goal.	Not provided	Not provided	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Zoutman et al., 2012[11]	Feedback	Randomized study; n=5,032 patient encounters; patients' age newborn–102	Primary care practices in southeastern Ontario	Feedback did not influence the rate of prescribing of physicians in the monthly feedback condition when compared with baseline prescribing and the delayed feedback group (f=0.01, p=0.9); however, monthly feedback increased first-line antibiotic choices when compared with baseline prescribing and the delayed feedback group (F=8.1, p=0.005).	Not provided	Not provided	Moderate	None

Table B.9: Cross-Cutting Patient Safety Topics/Practices, Teamwork and Team Training—Single Studies

Note: Full references are available in the Section 17.6 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Bliss et al., 2012[43]	Surgical Checklist (implemented after team training)	Prospective cohort design with historical controls. One cohort represented where team training had been introduced and one cohort represented where the checklist had been implemented. The historical control group was based on all ACS NSQIP cases that had occurred before the team training intervention had been introduced and that met the study inclusion criteria.	Surgical unit of 600-bed tertiary care facility and teaching hospital located in the Northeast	Overall compliance using the checklist was reported as 97.26%, although individual checklists were not always fully completed, especially the items that appeared redundant/ unnecessary (e.g., introducing team members when individuals were already familiar with one another).	A significant decrease in adverse event rates was noted from the historical control (23.6%) and from the team training-only cases (15.9%) to the cases where the checklist was used (8.2%). Completion of three checklist items was shown to significantly decrease morbidity rates. The occurrence of deep surgical site infections significantly increased when "confirmation of identity, procedure, procedure site, and consent(s) filled out" and "procedure and procedure site filled out" were not completed on the checklist (p=0.014 and p=0.041, respectively). Major morbidity	Team training followed up with an accountability measure such as a checklist is relatively inexpensive and leads to improvements. The length of the checklist may reduce compliance over time, so revising the checklist to include only the most essential items is desirable.	Moderate	The surgical services staff had participated in a team training program prior to the introduction of the perioperative briefing and postoperative debriefing checklist. Training participants were oriented to the Association of Perioperative Registered Nurses Comprehensive Surgical Checklist on the last day of the training.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
					and infectious events were significantly higher when the checklist item related to team introductions was left incomplete (p=0.004 and 0=0.015, respectively).			
Fargen et al., 2013[41]	Pre/peri-procedural checklist	Seventy-one procedures were included in the baseline period and 60 procedures were included after the implement-tation of the checklist. One hundred twenty-one post-procedural surveys were collected in the baseline period and 132 post-procedural surveys were collected in the post-intervention period.	Neuro-interventional suite	Communications significantly improved from the baseline to the post-intervention period (baseline=38.8% were rated as excellent, 43% were rated as good; post=68.2% were rated as excellent, 28.8% were rated as good, p<0.001). Twenty-one individuals provided opinions about the effectiveness of the checklist. Ninety-five percent believed that the use of the checklist should continue.	The overall number of adverse events decreased after the implementation of the checklist as compared with at the baseline (6 with the checklist vs. 25 in the baseline, p=0.001). Eight of the nine specific adverse events/near misses decreased after the checklist was implemented (non-significant), and one adverse event/near miss remained the same.	The checklist had a positive impact on team communication, and adverse events/near misses decreased.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Halverson et al., 2009[19]	Team Training curriculum based on Crew Resource Management	1,150 trainees participated in the training, including attending physicians, house staff, and nurses working in the operating room. Additional preoperative and postoperative personnel were also included in the mandatory training.	University-affiliated hospital	Post-intervention perceptions of teamwork significantly improved on 14 of the 19 items (p <.05). Briefings were not observed in the pre-training period, whereas preoperative briefings were observed 66% of the time at the 6-month follow-up (p<.001). Survey data indicated that respondents held positive perceptions regarding the utility of the briefings, with nurses and anesthesia providers providing higher utility ratings than surgeons. Pre- to post-compliance related to time-outs increased (47% to 86%).	The percentage of on-time first case starts increased over the study period from 69% (pre-intervention) to 76% (post-intervention). No significant changes were reported in the timely administration of prophylactic antibiotic or in turnover times.	Thirty-seven percent of respondents reported that they had communicated information during the preoperative debrief that could have increased the risk to the patient or delayed the case if they had not shared the information ahead of time.	Moderate	The 4-hour team training program was mandatory. Two weeks after the training, instructors coached teams in conducting preoperative briefings and debriefings.
Halverson et al., 2011[14]	Team Training curriculum based on Crew Resource Management	Pre-post observational study; 76 hours of operating room observations were made in the pre-Team Training condition, and 74 hours of observations were made in the post-Team	Operating rooms of Northwestern Memorial Hospital	Prior to the team training intervention, communication errors occurred at a rate of 0.737 per hour; they significantly decreased to 0.270 per hour following the intervention (p<.001). In the pre-intervention period, communication errors were most frequently related to progress reports (32%)	Not provided	Not provided	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
		Training condition. Post-training observations were made approximately 6 to 9 months after the training.		and equipment (23%), whereas the majority of communication errors in the post-intervention period (70%) were related to equipment. Communication errors in the pre-intervention period were classified as resulting in inefficiencies (24%), delays (20%), and tension (12%). The highest proportion of communication errors in the post-intervention period resulted in delays (33%), tension (17%), and inefficiencies (13%). Some communication errors were categorized as having no effect these occurred more frequently following the training (pre=12%, post=25%).				

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Kleiner et al., 2014[36]	Coaching on conducting effective pre-briefs/debriefs	Pre-intervention/ post-intervention evaluation design	Surgical department with 17 inpatient and 8 outpatient ORs in an academic hospital	There was a significant increase in the briefing score from the pre-intervention to post-intervention (mean= 3.478 to 3.644, p=.044). For the debriefings, quality items included using a standardized checklist, discussing what went well, discussing what did not go well, and thanking the team. A significant increase was also reported for the debriefing score from the pre- to post-intervention (mean=2.377 to 2.991, p <.0001).	Not provided	Sustaining change following team training can be a challenge. This study used a coach who was familiar to and respected by faculty and staff members at this hospital to aid surgical teams in making continual improvement.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Krimminger et al., 2018[39]	Handovers	Pre-post observational study	Twenty-one-bed cardiothoracic intensive care unit (CTICU) in a large university-affiliated medical center that performs over 19,400 surgical procedures a year	There was a significant decrease in the mean number of handover process errors from the pre- to post-intervention periods (pre=6.1, post=2.8, p<.001). An average of 5.2 information-sharing errors occurred per handoff in the pre-intervention period; this decreased significantly to 2.3 following the intervention (p<.001). All items on a survey that measured satisfaction with the handover showed improvement from pre to post, and 8 out of 12 improvements were statistically significant. The item that measured overall satisfaction with the OR to ICU handover failed to reach statistical significance (mean rank=147 at T1 to 165 at T2, p=0.065).	Not provided	The new handover process was associated with improvements in the post-intervention period, including fewer process and information sharing errors per handover. The time per handover slightly increased in the post-intervention period, but this increase was not significant. Based on survey data collected, reaction to the new handover process was generally positive.	Moderate to high	Participation in the observed handovers was voluntary. Ten of the 143 staff members declined to participate (7%); they were all nurses. Trained observers were used who did not work at the facility. Satisfaction surveys were anonymous.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Levy et al., 2014[15]	Crew Resource Management Training (5 hours)	Retrospective study with some pre-post measures. A total of 352 participants attended the training.	Three hospitals: (1) Moses Cone Hospital in Greensboro, NC, is a community-based, urban Level 2 trauma center. (2) Detroit Receiving Hospital in Detroit, MI, is an academic teaching hospital and Level I trauma center. (3) Harper University Hospital is an academic teaching hospital and tertiary care facility.	Pre and post-data across the three hospitals demonstrated significant improvement on all three confidence items (p<.001), which was maintained at the 30-day follow-up assessment. Participants significantly improved their knowledge from the pre- to post-assessments (61% of items correct on pre-test, 73% of items correct on post-test, p<.001). At the 30-day post intervention assessment, knowledge had decreased some since the training but was still significantly higher than at the baseline (61% at baseline vs. 66 at 30-day post-assessment, p=.026).	There was an increase in the proportion of patients at Moses Cone Hospital who received reperfusion in less than 90 minutes after the training (80% vs. 92%, ns). A significant increase was observed for guideline-compliant anticoagulant use at Harper University Hospital (29% vs. 63%, p<.001). There was a significant increase in documented risk score at Detroit Receiving Hospital (0% vs. 7%, p=.007).	One of the aims of the study was to improve patient care, although the outcome measures collected showed mixed results across the three hospitals. The authors note that the CRM training was not mandatory and the effort lacked a strong champion. As a result, the use of CRM principles was not reinforced and not consistently implemented. Staffing changes and lack of resources were also cited as barriers in this study.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Lisbon et al., 2016[23]	TeamSTEPPS® Training (4-hour didactic session)	Pre-post design; 113 participants attended the TeamSTEPPS® training; 113 respondents completed the measures before the training, 60 completed the measures again on day 45, and 59 completed the measures at day 90.	Emergency department in an academic medical center	Scores on the TeamSTEPPS® Knowledge Test had significantly improved at a 45-day check-in on 15 of the 21 questions (as compared with the baseline). Sustained improvement was reported on 13 out of 21 on a 90-day assessment. Responses on all items of the Communication dimension of AHRQ's Hospital Survey on Patient Safety significantly improved from the baseline to the 45-day assessment and remained at that level at the 90-day assessment. Following the training, huddles (implemented as a strategy during the TeamSTEPPS® training) were observed 64% of the time. CUS, which was another strategy that was implemented as a result of the TeamSTEPPS® training, had been used by almost half (47%) of the respondents at least once.	Not provided	The authors felt that the use of the huddle and CUS strategies were critical to sustaining teamwork-related improvements over the 90-day period following the TeamSTEPPS® training.	High	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Lutgendorf et al., 2017[28]	Multi-disciplinary simulation/ structured debriefs following TeamSTEPPS® principles	Pre-post design; 113 participants completed 16 simulations/ debriefings over a 2-day period.	Military tertiary care medical center	Participants felt significantly more comfortable managing hypertensive emergencies, responding to shoulder dystocia, and handling postpartum hemorrhage following the simulation exercises than they had prior to the exercises.	Time to prepare emergency release blood products decreased from 6 minutes on the first day to 4 minutes on the second day of the simulation intervention. Decreases in the number of postpartum hemorrhage cases were observed following the 2-day simulation exercises as compared with the rates 6 months leading up to the intervention.	Hands-on experience gained through the simulation exercises helped build participants' confidence in managing obstetric emergencies. Observations also indicated that teams were more efficient when dealing with emergency cases after the second day of exercises than on the first. Further, this intervention allowed a new massive transfusion system to be tested and for improvements to be made regarding supplies that were not available within the L&D unit, processes for requesting/ obtaining blood products during emergencies, and the location of the blood bank.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Mahoney et al., 2012[24]	TeamSTEPPS® Training	Pre-post design; 284 participants were trained in TeamSTEPPS; 108 respondents completed the pre-training Team Assessment Questionnaire (invited=296, response rate=36%), and 108 respondents completed the post-assessment of this measure (303 invited, response rate=47%).	The Menniger Clinic, which is a private, not-for-profit, 120-bed psychiatric hospital located in Houston, Texas	A comparison of means indicated significant differences on the pre-and-post scores on team foundation (pre=3.76, post=4.10, p=.001), team functioning (pre=3.88, post=4.16, p=.003), team performance (pre=3.78, post=4.10, p=.001), team skills (pre=3.76, post=4.08, p=.001), and climate and atmosphere (pre=3.68, post=3.97, p=.004).	Not provided	The teamwork skills covered in the TeamSTEPPS® training were integrated into daily practice. New hires are trained in TeamSTEPPS® as part of their onboarding and orientation process.	High	None
Mancuso et al., 2016[18]	Crew Resource Management (CRM) Training	Prospective study, pre-post design	Obstetrics unit at the University of Colorado Hospital	Observations of the quantity and quality of communication were made during six phases of cesarean births. There was a significant increase in quantity of communication (i.e., count of communication checklist items covered during procedure) for the obstetrics team at three of the four key points and for the	Not provided	The quantity of pre-briefs and debriefs that participants engaged in was sustained for 3 months following the CRM intervention. The authors suspect that the obstetrics team, who felt more resistant to pre-briefing following the intervention may	Moderate to high	The CRM training was tailored to focus on the communication and teamwork required of obstetrics teams and neonatal resuscitation teams.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
				neonatal team at two of the four key points following the CRM training intervention. Significant changes in the quality of communication (i.e., number of team members that communicated with each other) were reported for the obstetrics team and for the neonatal teams. A greater number of team members gave their full attention during the pre-brief following the training, but this was significant in the obstetrics team only (obstetrics team baseline=2.13, post=4.46, p<.001; neonatal team baseline=2.78, post=3.18, p=.178). The obstetrics team was significantly more resistant to pre-briefing following the training (baseline=1.00, post=1.25, p <.01), although the neonatal team showed a significant decrease in resistance to pre-briefing after the training intervention		have been more focused on the case than on pre-briefing.		

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
				(baseline=1.18, post=0.92, p <.01).				
Mayer et al., 2011[25]	TeamSTEPPS® Training—Customized 2.5 hour version.	Pre-post design. A comparison group was used for some of the process measures.	Twenty-bed pediatric intensive care unit and a 16-bed surgical intensive care unit	Scores on all six teamwork dimensions measured had significantly improved (as compared with at the baseline) 1 month after the training. Scores on five of the six teamwork dimensions were significant at 12-month assessment (except situation monitoring). Pre to post scores on the Hospital Survey on Patient Safety Culture indicated significant increases in "overall perceptions of safety" and "communication openness" for participants in both units. Significant increases in perceptions were also reported for SICU participants on "teamwork within unit." Participants in the PICU significantly improved their ratings of how well their unit worked together following the training.	The average time to place patients on ECMO was significantly lower after training. No significant difference was reported for the length of RRT events. Decreases in the frequency of nosocomial infections were observed in both units following the training; this frequency was below the upper control limit for seven out of eight months in both units.	The shortened TeamSTEPPS® training still had positive effects on the training participants.	Moderate	Regarding the finding of no significant difference in the length of RRT events after the TeamSTEPPS® training, follow-up interviews indicated that it was difficult to use the TeamSTEPPS® skills they had learned with primary staff at the bedside who had not been trained in TeamSTEPPS®

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Mukhopadhyay et al., 2018[40]	Handoff	Pre-post observation design	Twenty-two-bed surgical and trauma intensive care unit of a 635-bed non-profit tertiary academic medical center	The presence of a surgical team member at handoff had increased from 32% of the time in the baseline period to 84% post-intervention (p <0.001).The presence of a physician team member had also increased significantly, from 52% of the time to 94% (p <0.001). All elements of the surgical report were communicated significantly more frequently in the post-intervention period (84%) as compared with the pre-intervention period (29%, p <.05). The completeness of the anesthesia report also significantly improved, from 15% to 40% following the intervention (p <.05). There was some increased efficiency observed in the average time for patients to be placed on the ventilator and time to complete transfer to ICU monitors, but these decreases were not statistically significant.	Not provided	The implementation of the handoff protocol resulted in greater improvement from all members of the care team. It also reduced the amount of missing information during handoffs.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Murphy et al., 2015[37]	Roundtable debriefs	Retrospective analysis pre-post design; 28 pre-intervention cases were compared with 36 post-intervention cases.	Emergency department in an urban academic hospital with 751 beds	Not provided	No statistical differences were found between the pre- and post-intervention data on the frequency of assisted falls (p=0.17), unassisted falls (p=0.28), and the rate of falls per 1,000 patient encounters (p=0.28).	Falls had been on an increase prior to the roundtable debriefing intervention, and this trend was somewhat disrupted following the intervention.	High to moderate	None
Paull et al., 2013[29]	Simulation-Based Crew Resource Management Training	Pre-post design. Participants received CRM training with 2-hour simulation session. Sample size of 334 participants.	Surgical care floors at 12 facilities within the Veterans Health Administration	Confidence in using CRM techniques significantly improved on all eight communication and teamwork items over baseline scores following the intervention. Significant improvements were reported on 14 of 15 of the teamwork behaviors observed. Scores increased by 15 to 23%. No difference was found on the teams' skills related to "resource allocation."	Not provided	The authors felt that including simulated exercises was an important part of their team training effort, as it gave participants the chance to put their teamwork skills to work. The didactic training, simulated scenario, and feedback gained during the debriefings helped participants build confidence and improve their skills.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Peckler et al., 2012[30]	Team training with high-fidelity simulation	Pre-post design; 41 first-year interns who work in the trauma room. Two groups participated in the training on two separate days.	Southeastern American Level I Trauma Center and university-affiliated teaching hospital	Scores on a situational judgment test increased following the training for Group 1 (pre mean=15.63, post mean=17.29, p<0.10) but did not reach statistical significance. A statistically significant increase was observed in Group 2's scores for the pre to post assessment (pre mean=13.77, post mean=16.55, p<0.01).	Not provided	This study emphasizes the importance of practicing teamwork concepts and receiving feedback, especially for less experienced providers such as residents.	High	None
Petrovic et al., 2015[38]	Handoff protocol	Prospective, unblinded cross-sectional study; 53 handoffs observed in pre-intervention and 50 handoffs observed in the post-intervention period.	Peri-anesthesia care unit in a tertiary care facility serving 55,000 patients annually	The duration of the handoff increased from the pre- to post-intervention period (from an average of 9 minutes to 11 minutes, p=.01). The handoff also started more quickly when the patient arrived in the post-intervention cases (pre-mean=4.4, post-mean=2.9 minutes, p<.01). The total number of defects per handoff significantly decreased, from 9.92 prior to the intervention to a post-intervention average of 3.68 (p<.01). The number of missed items on the anesthesia report and on the surgery report both significantly	Not provided	A 77% reduction in communication errors between the OR to PACU was achieved using the new handoff protocol. Nurses were the most satisfied with the new handoff protocol. Some resistance to participating was seen among the surgical team, but a combination of leadership support, education, and peer pressure successfully got them on board.	No control group	Participation in this study was voluntary and anonymous.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
				decreased (from 2.02 to 0.94, p<.01 and from 7.57 to 2.64, p<.01, respectively). Significantly fewer technical defects (i.e., equipment problems) occurred per handoff in the post-intervention period (0.34 vs. 0.1, p=.04). There was a pre to post increase on all items for PACU nurses, five of which increases were significant (p<.05). Anesthesia providers completed only four items on the satisfaction assessment that were relevant to their role. Satisfaction scores declined for anesthesia providers following the intervention, but not significantly. Finally, surgery providers did not complete the pre-satisfaction survey, since there was low participation for this group at bedside handoffs prior to the intervention. Post-intervention data indicated high levels of satisfaction from surgery providers (percentage favorable				

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
				across 4 of 7 items=94%)				
Porter et al., 2014[42]	Pre-procedural pause with checklist	Pre-post design. Data were gathered on 31 cases in the baseline period, 36 cases in the immediate post-intervention, and 34 cases in the 18-month post-intervention.	Virginia Mason Hospital, a 335-bed community teaching hospital with 24 ORs and three surgical groups located in Seattle, Washington	Compliance with the pre-procedural pause increased significantly from the baseline to the post-intervention period (from 78% to 96% cases, p<.0001). At an 18-month audit, compliance remained at 96%. Team members introduced themselves significantly more in the post-intervention period (94% from an average of 44%, p<.0001), and this practice had continued to increase at the 18-month audit (97%, p<.0001). All checklist items were completed for 54% of cases in the baseline, whereas all items were completed in 97% of cases in the immediate post-intervention period. There was no change in the frequency of the surgeon's soliciting input from the rest of the team from the baseline to immediately after the intervention (56%), but this had increased to 94% at the 18-month audit.	Not provided	Providing each team member a specific role in the PPP checklist increased participation and the exchange of information, and resulted in more thoroughly completed checklists. Early involvement of all team members in the development of the PPP checklist protocol was critical to its success. Since this study was conducted, the PPP checklist has been extended to use in other areas of the hospital, including interventional radiology, gastroenterology, and electrophysiology.	Moderate to high	Audits were performed by a trained anesthesia technician or junior member of the surgical teams, as introducing an external observer had caused enhanced performance in previous audits.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Riggall and Smith, 2015[33]	Inter-professional simulation training	Convenience sample with pre-post measures; 84 staff participated in 17 simulations; 53 participants completed both the pre- and post-TeamSTEPPS® Teamwork Perceptions Questionnaire (T-TPQ).	40-bed medical unit in a northeastern tertiary-care teaching hospital	Pre-post T-TPQ data indicated that only perceptions of "leadership" significantly improved following the simulation training (pre-test mean=2.167 vs. post-test mean=2.566, p=.003). Scores on "team structure" and "communication" remained stable, and scores on "mutual support" slightly decreased on the post-simulation survey.	None of the resuscitation events requiring defibrillation met the guidelines provided by the AHA in the pre-intervention period. However, resuscitation events that required defibrillation in the post-intervention period all received it within the AHA guidelines of 2 minutes.	The authors point out that the participants who took part in the simulations had not received TeamSTEPPS® training. Thus, they may have been unfamiliar with the terms used in the measure as well as when specific components of teamwork were needed/ demonstrated in the simulations.	Moderate to high	None
Riley et al., 2011[31]	TeamSTEPPS® training workshop with in situ training exercises	Pre-post design with three groups: control, condensed TeamSTEPPS® workshop delivered, and condensed TeamSTEPPS® training with in situ training exercises (i.e., full intervention).	Perinatal units in three small community hospitals (50 to 66 beds) in the Midwest	There were no changes in safety culture reported either for groups that received interventions (condensed TeamSTEPPS® workshop or condensed TeamSTEPPS® training with in situ training exercises) or for the control group.	Only the hospital that received the full intervention (i.e., TeamSTEPPS® with in situ simulation) significantly decreased their Weighted Adverse Outcome Score, from 1.15 to 0.72 ($p < .05$).	This study provides evidence that an interdisciplinary team training program coupled with ongoing simulation practice sessions and debriefings can contribute to a decrease in neonatal outcomes.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Sawyer et al., 2013[22]	TeamSTEPPS® Training	Prospective pre-post design. Forty-two physicians, nurses, and respiratory therapists.	Twenty-bed, Level IIIB NICU at Tripler Army Medical Center in Honolulu, Hawaii	Significant improvement in attitudes toward teamwork (using the T-TAQ) from a pre-test average of 4.4 to a post-test average of 4.7 (p <.001). Teamwork knowledge on the TeamSTEPPS® Learning Benchmarks also improved from a pre-test average of 86.8% to an average of 92.6% on the post-test (p<.001). Significant improvements on all five teamwork skills were observed during simulated neonatal resuscitations (p<.001).	Not provided	Not provided	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Sax et al., 2009[17]	Crew Resource Management	Prospective pre-post design. A total of 857 participants were trained at the two hospitals.	A 722-bed university hospital and a 247-bed affiliated community hospital	Immediately after the training, significant improvement was reported on all 10 items measuring empowerment ($p<.05$). At a minimum of 2 months, these improvements were maintained, with further improvement related to leadership (pre-training mean rating=3.0; immediate post-training mean=3.4; and 2 months post-training mean=3.6; $p<.05$). Consistent use of a checklist increased from 75% of the time to 100% during the study period. There was an increase in willingness to report unsafe conditions or near misses over the course of the study period (15.9% in 2002 and 2003 vs. 20.3% in 2004 through 2008; $p<.01$).	Not provided	The authors believe that the CRM training helped participants use a checklist, feel more empowered to speak up, and report unsafe conditions.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Sonesh et al., 2015[20]	Adapted TeamSTEPPS® Training	Pre-post design with a control group. Forty-three clinical obstetric staff members.	2,338-bed southeastern U.S. teaching hospital	Training participants shared positive reactions to the training. Some improvements were found in knowledge of situation awareness and teamwork following the training. Self-reported perceptions of teamwork improved following training, but were not significant. Observational data on decisions indicated that decision accuracy significantly improved following the training ($p < 0.05$).	Length of stay for infants decreased, from 3.85 days to 2.83 days ($p <= .07$). There were no differences in pre-post comparisons of mother length of stay, transfer to NICU, morbidity of infant.	Not provided	High	This study trained only three teams.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Tapson et al., 2011[16]	Crew Resource (5 hours). The intervention combined traditional clinical education regarding VTE prophylaxis (1 hour) in the surgical setting with a comprehensive program on CRM principles and techniques (3.5 hours).	Pre-post design	The study was conducted at Citrus Memorial Health System, a 198-bed community hospital located in Florida.	A statistically significant increase was reported for all three confidence questions (i.e., ability to identify process-related factors that may lead to medical errors in a surgical setting, use of CRM techniques to enhance patient care, ability to identify which of their surgical patients would be appropriate candidates for VTE prophylaxis). A much smaller sample of 29 participants who completed the 30-day survey showed a significant longer term gain in confidence for two of the three confidence questions. Reviews of patient charts demonstrated performance improvement in the post-training period in meeting guideline recommendations for timing, inpatient duration, and use of VTE prophylaxis beyond discharge.	Not provided	The CRM intervention resulted in some improvements related to teamwork processes as well as clinical processes.	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Thomas et al., 2010[32]	Simulation-Based Team Training	Randomized trial with two experimental groups (high-fidelity and low-fidelity skills stations) with control group. Interns for pediatrics, pediatrics and internal medicine combined, family medicine, emergency medicine, and obstetrics and gynecology received the simulation-based team training. Post-intervention data were collected on 43 participants.	Surgical and Clinical Skills Center at the University of Texas Medical School	Teams that completed high-fidelity and low-fidelity skills stations exhibited a greater number of teamwork behaviors, managed workload more effectively, and completed the resuscitation more quickly than the control participants. At the 6-month follow-up assessment, teams in both training groups (high fidelity and low fidelity) exhibited a greater number of teamwork skills than control teams.	Not provided	The simulation-based training curriculum had been introduced to reduce errors. However, this objective was not met. The only long-term effect of the intervention was an increase in teamwork behaviors.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Weaver et al., 2010[21]	TeamSTEPPS® Training	Mixed-model design with one between-groups factor (Team-STEPPS® training vs. no training) and two within-groups factors (time period, team). The trained and control groups were located at separate campuses to minimize treatment diffusion.	The trained campus, which included 112 beds, 11 surgical suites, and more than 52,400 emergency department (ED) visits	Eighty-one participants felt more confident about their ability to work as an effective team member after training. No significant improvements in knowledge were found following the training. Trained teams engaged in significantly more pre-briefings after attending training (p <.001), and a greater number of team members spoke up during the briefings (p<.001). Trained teams significantly improved over control teams on two teamwork behaviors: communication (p<.05) and mutual support (p<.01). Scores on all four safety culture dimensions of the HSOPS improved following the TeamSTEPPS® training.	Not provided	There were positive results on all levels of evaluation. Pre-briefings significantly increased for the trained teams, and significantly more team members shared information during the briefings. Trained teams engaged in significantly more behaviors related to communication and mutual support. Improvements were reported on all dimensions of patient safety culture for those who participated in the TeamSTEPPS® training.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Wolf et al., 2010[26]	Veterans Health Administration Medical Team Training (MTT)	The OR teams consist of an attending surgeon, one to two residents, an attending anesthesiaol-ogist, an anesthesia resident or CRNA, scrub nurse/ tech, and a circulating nurse.	San Francisco VA Medical Center, an academic-affiliated hospital and regional referral center with eight ORs. More than 3,500 surgeries are performed per year.	Safety attitudes had improved 1 year after MTT on all dimensions, with significant improvement noted on "perceptions of management" and "working conditions." Case delays significantly decreased (23% to 10%, p<0.0001), mean case score increased (4.07–4.87, p<0.0005), and both changes were sustained at 24 months. One-year and 24-month follow-up data demonstrated decreased frequency of preoperative delays (16%–7%, p<0.004), handoff issues (5.4%–0.3%, p<0.0001), equipment issues/delays (24%–7%, p<0.0001), cases with low (<3) case scores (23%–3%, p<0.0005). Adherence to timing guidelines for prophylactic antibiotic administration improved (85%– 97%, p<0.0001).	Not provided	MTT training was delivered and debriefs were implemented. Sustained improvements were observed in teamwork, clinical processes, and patient safety culture.	Low to moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Wolfe et al., 2014[35]	Briefing/ debriefing	Prospective study with historical controls	ICU within an academic, tertiary pediatric facility with 516 inpatient beds	The quality of chest compression was better during the debriefing intervention period. The percentage of epochs that met designated quality targets significantly improved for all comparisons. Rate improved from 71 to 90, depth from 81 to 91, CPR fraction from 64 to 82, and excellent CPR from 20 to 61 (p <0.01).	Two survival outcomes were measured. First, survival to hospital discharge improved in the cases that were debriefed, but was not statistically significant (33% in pre-intervention cases, 52% in the debrief intervention cases, p=0,054). Second, survival with favorable neurological outcomes significantly increased in the debriefing intervention cases (29% in pre-intervention cases, 50% in the debriefing intervention cases).	The cardiac arrest debriefing program significantly improved CPR quality.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/ Findings	Risk of Bias (High, Moderate, Low)	Comments
Young-Xu et al., 2011[27]	Veterans Health Administration Medical Team Training (MTT). Checklists and briefing/ debriefing tools were implemented at the participating facilities and adapted to their needs.	Retrospective cohort study with a contemp-oraneous control group	Seventy-four VA facilities that had participated in MTT training and had 3 years of annual surgical morbidity rate data	Not provided	Facilities in the MTT program (n=42) had a significant decrease of 17% in observed annual surgical morbidity rate (rate ratio, 0.83; 95% CI, 0.79 to 0.88; p=.01). After adjusting for surgical risk, a decrease of 15% in morbidity rate was reported for facilities in the MTT program and a decrease of 10% for those who had not yet participated in the program. The risk-adjusted annual surgical morbidity rate declined in both groups, and the decline was 20% steeper in the MTT program group (p=.001) after propensity-score matching.	A 2-month preparation and planning period was required leading up to the MTT training. This period allows each facility to gain an understanding of their underlying problems. The use of a checklist can improve communication prior to surgery, but the use of briefings was believed to facilitate continued communication throughout surgeries, when unforeseen complications can occur.	Low to moderate	None

Table B.10: Cross-Cutting Patient Safety Topics/Practices, Teamwork and Team Training—Systematic Reviews and Meta-Analyses

Note: Full references are located in the Section 17.6 reference list.

Author, Year	Description of PSP	Setting/s, Population/s	Summary of SR Findings	Implementation Themes/Findings	Notes
Boet et al., 2014[11]	Simulation-based team training	Hospital settings	Four studies in the review assessed transfer of KSAs back to the job setting. Three studies demonstrated that the simulation intervention was significantly more effective than didactic training. Five studies measured the impact of simulation on patient outcomes, with one study reporting a significant reduction in patient mortality.	The small number of studies and lack of significant evidence make it difficult to conclude that simulation training improves patient outcomes.	None
Dietz et al., 2014[12]	Standardized protocols, daily rounds, and training	Intensive care unit	One study investigated the use of a standardized protocol (i.e., daily goal sheet), and reported that it significantly increased the care team's understanding of patient care objectives and reduced length of stay among ICU patients. Studies that incorporated/improved the rounding process reported shorter hospitals stays, reduced postoperative complications, and improved clinical outcomes (e.g., infections, ventilator-associated pneumonia). Five studies incorporated simulation team training; they reported that the training resulted in an increase of teamwork skills and that participants were more confident in their abilities following the training.	Across studies, communication was considered the most important teamwork skill to measure and improve.	None

Author, Year	Description of PSP	Setting/s, Population/s	Summary of SR Findings	Implementation Themes/Findings	Notes
Hughes et al., 2016[13]	Team training	Not specified	Team training significantly improved participant reactions. Team training had a significant positive impact on participant learning. A significantly increased number of team KSAs were applied on the job following team training delivery. Team training improved results such as length of stay and patient mortality. Participant learning positively impacted transfer of training to the job environment. Transfer of training positively impacted results/outcomes achieved. No differences in effectiveness were reported between trainings that included high physical fidelity versus those that used low physical fidelity. Team training was equally beneficial for healthcare students and clinicians.	Team training was beneficial regardless of stage of career, as students and experienced clinicians benefited from the intervention. The results of team training for patient and clinical outcomes were based on a limited number of studies, so those results should be interpreted with caution.	None
Weaver et al., 2014[2]	Team training	Hospital settings	Reactions to team training programs have generally been positive. Studies have demonstrated that team training has a positive impact on participant learning (i.e., knowledge, confidence, attitudes). Team training has also been associated with an increased use of teamwork skills. Half of the studies in this review attempted to measure clinical processes or patient outcomes, with 10 studies reporting some significant improvements.	The authors note that studies of team training have increased, but that many of the studies have been of low to medium quality. Additionally, identifying how long effects can be maintained and identifying appropriate intervals for refresher training require more attention.	None

Table B.11: Cross-Cutting Patient Safety Topcis/Practices, Education and Training Through Simulation—Single Studies

Note: Full references are available in the Section 17.7 reference list.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Bae et al., 2017[10]	2.5-hour simulation-based curriculum where third-year residents were asked to perform a simulated reduction of a distal radial fracture, apply a well-molded short arm cast application, and later remove the cast using a standard cast oscillating saw.	Retrospective, comparison cohort design. A total of 627 patients were included in the study; 188 patients were treated in the pre-simulation group and 439 were treated in the post-simulation group.	Tertiary-care pediatric teaching hospital.	There were eight cast saw injuries in the pre-simulation period and three in the post-simulation period. The rate of cast saw burns was significantly lower following the simulation curriculum ($p = 0.002$).	Not provided	The authors also estimated the return on investment associated with the simulation curriculum introduced in this study. The total cost calculated for the simulation curriculum was $2,465.31 for seven residents. The authors estimated that the cast saw burns in the pre-simulation period were associated with $32,320 in costs, whereas the cast saw burns in the post-simulation period were associated with $5,188 in costs. All rotating orthopedic residents at this facility now receive the simulation curriculum tested in this study.	Moderate	None

Barsuk et al., 2009[12]	High-fidelity simulation.	Observational cohort study with historical controls. A total of 103 internal medicine and emergency medicine second- and third-year residents served as participants; 76 received the simulation intervention, 27 residents received traditional training.	Tertiary-care urban teaching hospital.	Residents who received the simulation intervention significantly improved their performance on clinical skills pre- to post-intervention for internal jugular central venous catheter (CVC) insertion (pre = 50.6%, post = 93.9%, $p < 0.005$) and subclavian CVC (pre= 48.4%, post = 91.5%, $p < 0.005$). Residents in the simulation group also significantly improved their scores on a written exam (pre = 70.1%, post = 85.3%, $p < 0.005$). A number of quality indicators were collected to assess the effect of simulation on quality indicators related to CVC insertion. Residents who received the simulation intervention reported significantly fewer needle passes (total, $p < 0.005$; internal jugular, $p <.0.005$); arterial punctures (total, $p < 0.005$; internal jugular, $p <.0.005$); and CVC adjustments (total, p	Not provided	As a result of the study, the hospital began to require that all residents demonstrate mastery of CVC skills in a simulated environment before performing them independently in the ICU.	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
				= 0.002; internal jugular, p = 0.001); and higher successful CVC insertion rates (total, p = 0.005; internal jugular, p = 0.018). No differences were found between the group that received the simulation intervention and the traditional training when examining pneumothorax rates or assessing the quality of subclavian CVCs.				

Gerolemou et al., 2014[13]	Simulation-based training of critical care nurses in sterile techniques during central vein catheterization. Training took place in a simulation laboratory.	Prospective controlled study with a simulation-based educational intervention. Forty-six critical care nurses received the simulation intervention.	University-affiliated, 450-bed urban teaching hospital with 23 medical, surgical and neurological CCU beds.	Performance of sterilization techniques was scored before and after the simulation intervention. The median score in the pre-simulation period was 7 out of 24. The median score in the post-simulation period was 23 out of 24. These data reflect a significant improvement following the intervention ($p < 0.01$). The rate of catheter-related bloodstream infection was examined as an outcome in this study. Prior to the simulation intervention, there were 2.61 infections per 1,000 catheter-days (6 catheter infections in 2,297 catheter-days) in the CCU. The average rate of CRBSIs in the CCU was 0.4 per 1000 catheter-days (1 catheter infection in 2,514 catheter-days). Over the course of the next 12 months, an 85% reduction in the average rate of CRBSI was observed.	Not provided	Studies have emphasized training physicians in central venous catheterization. The current study demonstrates that nurses had a low level of knowledge of proper sterilization techniques and benefited from the simulation intervention.	Moderate	None
Harting et al., 2008	Computer-based	Quasi-experimental,	Academic medical center.	Residents in the post-intervention	Pain control improved for	The authors note that they had not	Moderate to high	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
	simulation involving 2–3 cancer-related pain management cases.	pre-post design. 20 patients admitted with cancer-related pain were in the pre-intervention group and 20 patients admitted with cancer-related pain were in the post-intervention group.		period administered a higher proportion of long-acting oral medications as compared to residents in the pre-intervention period (pre-intervention = 35%, post-intervention = 90%, P < 0.001).	patients in the post-simulation period. The slope of pain scores was found to have been increasing in the pre-intervention period and decreased significantly in the post-intervention period (P < .01)	seen any pain management improvements when they had only provided didactic training with grand rounds.		

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Hebbar et al., 2018[14]	Two-hour simulation workshop where two to three simulations targeting medication administration were conducted in a simulation laboratory. Each simulated scenario was debriefed.	Pre-post design. A total of 1,434 nurses participated in the simulation training over a 7-month period. These included general care nurses, critical care nurses, and emergency department nurses.	Egleston Children's Hospital: 278 beds, 36-bed pediatric ICU, a 25-bed cardiac PICU, with 1,234 nurses. Scottish Rite Children's Hospital: 273 beds, a 34-bed PICU, and 1,206 nurses. Hughes Spalding Children's Hospital: 130 non-critical care beds and 89 nurses.	Following the simulation intervention, average compliance to the medication bundle significantly increased from 51% (month 1) to 84% (month 18, P < 0.001). The rate of medication administration events significantly decreased over the course of the simulation study. During the 12-month pre-intervention period, the rate of medication administration events was recorded at 2.5 per month. The rate significantly decreased to 1.4 events per month during the simulation intervention (P = 0.029), and further decreased to 0.86 events per month in the 7-month post-intervention period (P = 0.014).	Not provided	Overall, there was a 63% reduction in medication administration events from the pre-intervention period to the 18-month post-intervention period. The authors pointed out that although they had trained only 56% of the inpatient and emergency department staff at two of the participating hospitals, rates of medication administration errors have been sustained for 3 years. They suggest this is due to cross-pollination (i.e., those who were trained went on to train others).	Moderate to high	The authors estimated the financial savings of the simulation intervention to be approximately $165,000 to $225,000 (charge savings) with a cost impact of $90,000 to $130,000 per year.

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Mosier et al., 2015[8]	Simulation lab with some didactic training.	Pre- and post-intervention analysis of the airway management program.	Academic referral center with a 201 bed medical ICU staffed by two teaching teams.	The success rate of first-attempt intubations significantly improved in the post-simulation period. Successful first attempts increased from 73.5% in the pre-intervention period to 81.6% in the post-intervention period (P = 0.006). The incidence of desaturation decreased following the simulation-based training curriculum from 25.9% to 16.8%.	Not provided	Not provided	Moderate	None

Author, Year	Description of Patient Safety Practice	Study Design; Sample Size; Patient Population	Setting	Outcomes: Benefits	Outcomes: Harms	Implementation Themes/Findings	Risk of Bias (High, Moderate, Low)	Comments
Wayne et al., 2008[9]	Simulation laboratory.	Retrospective case-control study. Thirty-eight second-year internal medicine residents received simulation-based education curriculum and were compared to 40 third-year residents who received the traditional training curriculum.	Northwestern Memorial Hospital, a tertiary health-care facility.	Second-year residents who received simulation training demonstrated significantly higher compliance with the American Heart Association standards when leading with real advanced cardiac life support events as compared to third-year residents who had received traditional training (simulation group = 68%, traditional group = 44%, $p \leq 0.001$).	No differences were found in patient survival of the ACLS event between the simulation-trained and traditionally trained residents (simulation group = 45%, traditional group = 46.4%). However, there was an increase in the average survival time to death or hospital discharge for patients treated by residents in the simulation-trained group compared to the patients who received care from traditionally trained residents (simulation trained residents = 194.7, traditionally trained residents = 107.1, $p = 0.11$).	The short simulation intervention (1-hour baseline assessment, four 2-hour teaching sessions, 1-hour post-assessment) improved procedural skills and quality of patient care.	Moderate	None

Table B.12: Cross-Cutting Patient Safety Topics/Practices, Education and Training Through Simulation—Systematic Reviews and Meta-Analyses

Note: Full references are available in the Section 17.7 reference list.

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings
Griswold-Thoeodorson et al., 2015[4]	Simulation-based mastery learning.	Twelve out of 14 studies were conducted with postgraduate trainees, one study was conducted with medical students, and one introduced simulation to staff physicians.	Eight studies demonstrated a positive impact on procedural performance. Three studies provided evidence of improved success rate, while four studies reported that simulation training resulted in decreased time to complete the procedures. Two studies demonstrated a reduction in patient discomfort. Four studies reported a decrease in complication rates and four provided evidence of cost savings.	Taking a simulation-based mastery approach may take more time than traditional classroom learning. However, the amount of time can be justified if trainees gain greater competence without risk to patients.
Madenci et al., 2014[7]	Simulation training to improve central venous catheter manipulation.	Medical trainees.	Based on the analyses of five studies, the proportion of overall successful CVC insertion was significantly higher for those who received simulation training ($P < 0.01$). Participants who received simulation also required significantly fewer attempts ($P < 0.01$). There were no differences in adverse events between the participants who received simulation training (3.8%) compared to those who received traditional instruction (4.9%, $P = 0.15$).	This meta-analysis assessed the impact of simulation on real patient outcomes. Although there were fewer adverse events for the simulation group, it did not reach statistical significance.
McGaghie et al., 2011[6]	Simulation-based medical education.	Medical residents	Studies of central venous catheter insertion reported positive benefits of simulation-based medical education programs, including: significantly fewer needle passes, catheter adjustments, arterial punctures; higher success rates; and fewer catheter-related bloodstream infections as compared to traditionally trained residents. Research conducted in ophthalmology demonstrated that residents enrolled in the simulation-based curriculum developed better surgical skills and a significant reduction in sentinel complication rates.	Not discussed.

Author, Year	Description of Patient Safety Practice	Setting/s, Population/s	Summary of Systematic Review Findings	Implementation Themes/Findings
Schmidt et al., 2013[5]	Simulation to improve diagnostic procedures, surgical procedures, central venous catheterization.	Hospital setting, tertiary care facilities, trauma centers, and multispecialty medical groups. Participants were largely residents and fellows.	The studies that provided simulation to improve diagnostic procedures reported mixed results on patient discomfort, and some evidence that procedure time decreased and success rates were higher following simulation training. Studies of surgical procedures demonstrated improvements following simulation training, including: increased accuracy, fewer errors, lower rate of sentinel complications, and faster procedures. Studies of central venous catheterization reported that participants who received simulation required fewer needle passes and reduced pneumothoraxes, and fewer catheter-related bloodstream infections, but mixed results were reported on other major complications and patient safety events.	The development of realistic exercises (high in cognitive fidelity) and debriefing are believed to be critical to simulation training. The costs associated with simulation training vary widely depending on the type of exercise, as well as the equipment and personnel needed.

Appendix C. Cross-Cutting Patient Safety Topics/Practices Search Terms

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum	Patient and Family Engagement	(((MH “Patient Participation” OR "Professional-Patient Relations" OR "Physician-Patient Relations" OR "Professional-Family Relations") OR (AB "Patient Participation" OR "Patient Engagement" OR "Patient Involvement" OR "Family Engagement" OR "Family Involvement" OR "Patient and Family Engagement" OR "Patient and Family Involvement" OR "Patient Empowerment" OR "Patient/Family Engagement")) AND ((MH "Patient Safety") OR (AB "Patient Safety" OR "Safety Management")))	MH “Patient Participation” OR "Professional-Patient Relations" OR "Physician-Patient Relations" OR "Professional-Family Relations") OR (AB "Patient Participation" OR "Patient Engagement" OR "Patient Involvement" OR "Family Engagement" OR "Family Involvement" OR "Patient and Family Engagement" OR "Patient and Family Involvement" OR "Patient Empowerment" OR "Patient/Family Engagement")) AND ((MH "Patient Safety" OR "Safety Management") OR (AB "Patient Safety" OR "Safety Management")))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research • Review • Systematic Review			
MedLine Publication Types: • Clinical Trial	Safety Culture	(((MH "Patient Safety" OR "Risk Management" OR "Treatment Errors" OR "Quality of Health Care" OR "Outcome Assessment" OR "Program Evaluation") OR (AB “Medical Error*”	(((MH “Patient Harm” OR “Patient Safety” OR “Safety Management” OR “Risk Management” OR “Medical Errors” OR “Quality of Health Care” OR “Outcome Assessment (Health

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report		OR “Safety, Patient” OR “Patient Safety” or “Health Care Quality” OR “Healthcare Quality” OR “Quality of Health Care” OR “Quality of Healthcare” OR “Quality of Care” OR "Risk Management" OR "Safety Management" OR "Patient Harm" OR "Program Evaluation" OR ("Outcome Assessment*" AND "Healthcare") OR ("Outcome Assessment*" AND "Health Care")) AND ((MH "Organizational Culture") OR (AB "Organizational Culture" OR “Patient Safety Culture” OR "Patient Safety Climate")) AND ((MH "Quality Improvement") OR (AB “Leadership Walk Rounds” OR “Comprehensive Unit-Based Safety Program” OR “Performance Improvement” OR "Quality Improvement" OR “Team Training” OR “Training Workshop”)))	Care)" OR “Program Evaluation”) OR (AB “Medical Error*” OR “Safety, Patient” OR “Patient Safety” or “Health Care Quality” OR “Healthcare Quality” OR “Quality of Health Care” OR “Quality of Healthcare” OR “Quality of Care” OR "Risk Management" OR "Safety Management" OR "Patient Harm" OR "Program Evaluation" OR ("Outcome Assessment*" AND "Healthcare") OR ("Outcome Assessment*" AND "Health Care")) AND ((MH “Organizational Culture”) OR (AB "Organizational Culture" OR “Patient Safety Culture” OR "Patient Safety Climate")) AND ((MH "Quality Improvement") OR (AB “Leadership Walk Rounds” OR “Comprehensive unit-Based Safety Program” OR “Performance Improvement” OR "Quality Improvement" OR “Team Training” OR “Training Workshop”)))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research • Review • Systematic Review			
MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III	Clinical Decision Support	(((MH "Decision Support Systems, Clinical" OR "Decision Making, Computer-Assisted" OR ("Medical Informatics" AND "Reminder Systems") OR ("Medical Informatics" AND "Decision Support Techniques") OR ("Medical Informatics" AND "Clinical Decision-Making")) OR (AB "Clinical Decision Support")) AND ((MH "Patient Safety" OR "Treatment Errors" OR "Quality of Health Care"	(((MH "Decision Support Systems, Clinical" OR "Decision Making, Computer-Assisted" OR ("Medical Informatics Applications" AND "Reminder Systems") OR ("Medical Informatics Applications" AND "Decision Support Techniques") OR ("Medical Informatics Applications" AND "Clinical Decision-Making")) OR (AB "Clinical Decision Support")) AND ((MH "Patient Harm" OR "Patient Safety" OR "Medical Errors"

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial		OR "Quality Assurance") OR (AB "Medical Error*" OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care" OR "Quality of Care")))	OR "Quality of Health Care" OR "Quality Assurance, Health Care") OR (AB "Medical Error*" OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care" OR "Quality of Care")))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research • Review • Systematic Review			
MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial	Cultural Competency	(((MH "Cultural Competency" OR "Culturally Competent Care" OR "Transcultural Nursing" OR "Cultural Diversity") OR (AB "Cultural Intelligence" OR "Cultural Competency OR "Cultural Competence" OR "Culturally Competent Care" OR "Cultural Competencies" OR "Transcultural Nursing" OR "Transcultural Care" OR "Cultural Proficiency" OR "Cultural Diversity" OR "Cultural Intelligence" OR "Cultural Sensitivity" OR "Cultural Humility" OR "Limited English Proficiency" OR "Multicultural Mental Health" OR "Multicultural Health" OR "Multicultural Care" OR "Linguistically Appropriate Approach" OR "Cultural Safety"))	(((MH "Cultural Competency" OR "Culturally Competent Care" OR "Transcultural Nursing" OR "Cultural Diversity") OR (AB "Cultural Intelligence" OR "Cultural Competency OR "Cultural Competence" OR "Culturally Competent Care" OR "Cultural Competencies" OR "Transcultural Nursing" OR "Transcultural Care" OR "Cultural Proficiency" OR "Cultural Diversity" OR "Cultural Intelligence" OR "Cultural Sensitivity" OR "Cultural Humility" OR "Limited English Proficiency" OR "Multicultural Mental Health" OR "Multicultural Health" OR "Multicultural Care" OR "Linguistically Appropriate Approach"

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis		AND ((MH Hospitals OR Inpatients OR "Ambulatory Care Facilities" OR "Physicians' Offices" OR "Long-Term Care" OR "Palliative Care" OR "Subacute Care" OR "Rehabilitation Centers" OR "Residential Facilities" OR "Transitional Care" OR "Home Care Services" OR Pharmacy OR "Primary Health Care") OR (AB Hospital OR Inpatient OR "Physicians' Office" OR "Long Term Care" OR "Rehabilitation Center*" OR "Home Care Service*" OR "Residential Facilit*" OR "Ambulatory Surgery Center" OR "Specialty Care" OR "Primary Care" OR "Home Health" OR Pharmacy)) AND ((MH "Patient Harm" OR "Patient Safety" OR "Medical Errors" OR "Quality of Health Care" OR "Quality Assurance, Health Care") OR (AB "Medical Error*" OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care" OR "Quality of Care")))	OR "Cultural Safety")) AND ((MH Hospitals OR Inpatients OR "Ambulatory Care Facilities" OR "Physicians' Offices" OR "Long-Term Care" OR "Palliative Care" OR "Subacute Care" OR "Rehabilitation Centers" OR "Residential Facilities" OR "Transitional Care" OR "Home Care Services" OR Pharmacy OR "Primary Health Care") OR (AB Hospital OR Inpatient OR "Physicians' Office" OR "Long Term Care" OR "Rehabilitation Center*" OR "Home Care Service*" OR "Residential Facilit*" OR "Ambulatory Surgery Center" OR "Specialty Care" OR "Primary Care" OR "Home Health" OR Pharmacy)) AND ((MH "Patient Harm" OR "Patient Safety" OR "Medical Errors" OR "Quality of Health Care" OR "Quality Assurance, Health Care")) OR (AB "Medical Error*" OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care" OR "Quality of Care")))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research • Review • Systematic Review			
MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline	Monitoring Auditing and Feedback	((MH “Patient Safety” OR "Risk Management” OR “Treatment Errors” OR “Quality of Health Care” OR “Outcome Assessment" OR “Program Evaluation”) OR (AB "Patient Harm" OR "Patient Safety" OR "Safety Management" OR "Risk Management" OR "Medical Error*" OR "Quality of Health Care" OR "Quality of Healthcare" OR ("Outcome Assessment*" AND Healthcare) OR ("Outcome Assessment*" AND "Health Care") OR "Program Evaluation")) AND ((MH Hospitals OR Inpatients OR "Ambulatory Care Facilities” OR “Office Visits” OR “Long Term Care” OR "Palliative Care” OR “Subacute Care” OR “Rehabilitation Centers” OR “Residential Facilities” OR “Transitional Care” OR “Primary Health Care” OR “Home Health Care”) OR (AB	((MH “Patient Harm” OR “Patient Safety” OR “Safety Management” OR “Risk Management” OR “Medical Errors” OR “Quality of Health Care" OR “Outcome Assessment (Health Care)” OR “Program Evaluation” OR “Quality Assurance, Health Care”) OR (AB "Patient Harm" OR "Patient Safety" OR "Safety Management" OR "Risk Management" OR "Medical Error*" OR "Quality of Health Care" OR "Quality of Healthcare" OR ("Outcome Assessment*" AND Healthcare) OR ("Outcome Assessment*" AND "Health Care") OR "Program Evaluation" OR ("Quality Assurance" AND "Health Care") OR ("Quality Assurance" AND "Healthcare") OR “Performance Management” OR “Performance Improvement”)) AND

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research		“Ambulatory Care” OR “Specialty Care” OR “Hospital*” OR “Long Term Care” OR "Long-Term Care" OR "Palliative Care" OR "Physicians' Office*" OR "Subacute Care" OR "Residential Facilit*" OR “Primary Care” OR "Transitional Care" OR "Rehabilitation center*" OR "Primary Health Care")) AND ((MH Feedback OR “Quality Assurance” OR Benchmarking) OR (AB "Clinical Audit" OR "Medical Audit" OR ("Quality Assurance" AND "Health Care") OR ("Quality Assurance" AND "Healthcare") OR "Benchmarking" OR “Performance Improvement” OR “Audit and Feedback” OR “Performance Feedback” OR “Feedback Intervention” OR “Performance Monitoring” OR “Dashboard” OR “Clinical Dashboard” OR “Decision Support Systems” OR “Computerized Feedback” OR “Performance Management” OR “Electronic Feedback” OR “Error Reporting” OR “Performance Measurement” OR "Audit" OR "Computer-Interface Feedback")) NOT ((MH "Education, Medical, Continuing") OR (AB "Alcohol" OR "Continuing Medical Education" OR "CME")))	((MH Hospitals OR Inpatients OR "Ambulatory Care Facilities” OR “Physicians' Offices” OR “Long-Term Care” OR "Palliative Care” OR “Subacute Care” OR “Rehabilitation Centers” OR “Residential Facilities” OR “Transitional Care” OR “Primary Health Care” OR “Home Care Services”) OR (AB "Ambulatory Care” OR “Specialty Care” OR “Hospital*” OR “Long Term Care” OR "Long-Term Care" OR "Palliative Care" OR "Physicians' Office*" OR "Subacute Care" OR "Residential Facilit*" OR “Primary Care” OR "Transitional Care" OR "Rehabilitation Center*" OR "Primary Health Care")) AND ((MH Feedback OR “Clinical Audit” OR “Medical Audit” OR Benchmarking) OR (AB "Clinical Audit" OR "Medical Audit" OR "Benchmarking" OR “Audit and Feedback” OR “Performance Feedback” OR “Feedback Intervention” OR “Performance Monitoring” OR "Monitoring" OR “Dashboard” OR “Clinical Dashboard” OR Computerized Feedback” OR “Electronic Feedback” OR “Error Reporting” OR “Performance Measurement” OR "Computer-Interface Feedback")) NOT

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Review • Systematic Review			((MH "Education, Medical, Continuing") OR (AB "Alcohol" OR "Continuing Medical Education" OR "CME")))
MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline	Teamwork and Team Training	(((MH "Patient safety" OR "Risk Management" OR "Treatment Errors" OR "Quality of Health Care" OR "Outcome Assessment" OR "Program Evaluation" OR "Health Care Delivery") OR (AB "Medical Error*" OR "Safety, Patient" OR "Patient Safety" or "Health Care Quality" OR "Healthcare Quality" OR "Delivery of Healthcare" OR "Healthcare Delivery" OR "Delivery of Health Care" OR "Health Care Delivery" OR "Quality of Health Care" OR "Quality of Healthcare" OR "Quality of Care" OR "Risk Management" OR "Safety Management" OR "Patient Harm" OR "Program Evaluation" OR ("Outcome Assessment*" AND "Healthcare") OR ("Outcome Assessment*" AND "Health Care")) AND ((MH "Multidisciplinary Care Team" OR "Cooperative Behavior" OR "Interprofessional Relations") OR (AB "Communication*, Interdisciplinary" OR "Interdisciplinary Communication*" OR "Multidisciplinary Communication*" OR "Communication*, Multidisciplinary" OR "Care Team*, Patient" OR "Patient Care Team*" OR "Behavior*, Cooperative" OR	(((MH "Patient Harm" OR "Patient Safety" OR "Safety Management" OR "Risk Management" OR "Medical Errors" OR "Quality of Health Care" OR "Outcome Assessment (Health Care)" OR "Program Evaluation") OR (AB "Medical Error*" OR "Delivery of Health Care" OR "Safety, Patient" OR "Patient Safety" or "Health Care Quality" OR "Healthcare Quality" OR "Quality of Health Care" OR "Quality of Healthcare" OR "Quality of Care" OR "Risk Management" OR "Safety Management" OR "Patient Harm" OR "Program Evaluation" OR ("Outcome Assessment*" AND "Healthcare") OR ("Outcome Assessment*" AND "Health Care"))) AND ((MH "Interdisciplinary Communication" OR "Patient Care Team" OR "Cooperative Behavior" OR "Interprofessional Relations") OR (AB "Communication*, Interdisciplinary" OR "Interdisciplinary Communication*" OR "Multidisciplinary Communication*" OR "Communication*, Multidisciplinary"

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
• Published Erratum • Randomized Controlled Trial • Review • Scientific Integrity Review • Technical Report • Twin Study • Validation Studies CINAHL Publication Types: • Clinical Trial • Corrected Article • Journal Article • Meta-Analysis • Meta Synthesis • Practice Guidelines • Randomized Controlled Trial • Research • Review • Systematic Review		"Cooperative Behavior*" OR Teamwork OR "Team Processes" OR Collaboration OR Leadership OR Coordination OR "Team Performance")) AND AB ("Team Effectiveness" OR "Team Training" OR "TeamSTEPPS" OR "VA Medical Team Training" OR "Crew Resource Management" OR "MedTeams" OR "Training Strategy" OR "Training Intervention")	OR "Care Team*, Patient" OR "Patient Care Team*" OR "Behavior*, Cooperative" OR "Cooperative Behavior*" OR Teamwork OR "Team Processes" OR Collaboration OR Leadership OR Coordination OR "Team Performance")) AND ((MH "Quality Improvement") OR AB ("Team Effectiveness" OR "Team Training" OR "TeamSTEPPS" OR "VA Medical Team Training" OR "Crew Resource Management" OR "MedTeams" OR "Training Strategy" OR "Training Intervention")))

Method	Search	Search String for: CINAHL	Search String for: MEDLINE
MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I • Clinical Trial, Phase II • Clinical Trial, Phase III • Clinical Trial, Phase IV • Comparative Study • Controlled Clinical Trial • Corrected and Republished Article • Evaluation Studies • Guideline • Journal Article • Meta-Analysis • Multicenter Study • Practice Guideline • Published Erratum • Randomized Controlled Trial	Staff Education and Training (Simulation)-Without Settings	((MH “Treatment Errors” OR “Quality of Health Care” OR "Quality Assurance") OR (AB “Medical Error*” OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care")) AND ((MH “Patient Simulation” OR “Computer Simulation” OR “Virtual Reality”) OR (AB "Simulation Training" OR "Patient Simulation" OR "Computer Simulation" OR "Virtual Reality" OR "Serious Games" OR "Serious Gaming")))	((MH “Patient Harm” OR “Patient Safety” OR “Medical Errors” OR "Quality of Health Care” OR "Quality Assurance, Health Care") OR (AB “Medical Error*” OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care")) AND ((MH “Simulation Training” OR “Patient Simulation” OR “Computer Simulation” OR “Virtual Reality”) OR (AB "Simulation Training" OR "Patient Simulation" OR "Computer Simulation" OR "Virtual Reality" OR "Serious Games" OR "Serious Gaming")))

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MedLine Publication Types: • Clinical Trial • Clinical Trial, Phase I	Staff Education and Training (Simulation)-With Settings	(((MH “Treatment Errors” OR “Quality of Health Care” OR "Quality Assurance") OR (AB "Medical Error*” OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care")) AND	(((MH “Patient Harm” OR “Patient Safety” OR “Medical Errors” OR “Quality of Health Care” OR "Quality Assurance, Health Care") OR (AB "Medical Error*” OR "Patient Harm" OR "Patient Safety" OR "Quality of Health Care"))

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