**Purpose of the tool:** This tool describes the key perinatal safety elements with examples for the safe administration of magnesium sulfate during labor. The key elements are presented within the framework of the Comprehensive Unit-based Safety Program (CUSP).

**Who should use this tool:** Nurses, physicians, midwives, pharmacists, and other labor and delivery (L&D) unit staff responsible for the preparation and administration of magnesium sulfateduring labor.

**How to use this tool:** Review the key perinatal safety elements with L&D leadership and unit staff to determine how the elements will be implemented on your L&D unit. Consider any existing facility policies or processes related to magnesium sulfate use. Consider using preprinted orders, standing orders, and staff training to support implementation. A sample of how some of these key perinatal safety elements can be incorporated into a unit approach to safe magnesium sulfate administration is provided in the Appendix of this tool.

# Key Perinatal Safety Elements

***Standardize When Possible (CUSP Science of Safety)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Standard criteria established for magnesium sulfate use. | * Criteria for use of magnesium sulfate are established.
* Medical indications for use vary. Several professional organizations, guidelines, and evidence reviews offer examples of maternal and fetal conditions that may be indications for use of magnesium sulfate.1-7
* Absence of contraindications for magnesium sulfate are verified and documented. Contraindications on the manufacturer’s drug label include8—
	+ Patients with heart block
	+ Patients with myocardial damage
 |

***Standardize When Possible (CUSP Science of Safety) (continued)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Standard criteria established, met, and documented for magnesium sulfate use.(continued) | * In addition, the FDA and professional organizations offer warnings against use of magnesium sulfate longer than 5 to 7 days because of risk of fetal and neonatal bone demineralization and fractures.3,9
* Staff with requisite training and supplies available to respond to magnesium-related adverse events, for example respiratory depression.10,11
 |
| Use uniform and standard drug packaging, preparation, and labeling.12 | * Unit-established process for using manufacturer’s premixed bags or pharmacy-prepared bags of magnesium sulfate for both loading dose (bolus) and maintenance infusion. Medication errors are more common in unit-prepared bags, so this practice should be avoided.12
* Pharmacy and nursing staff should use a consistent approach to labeling all magnesium sulfate bags and tubing used to administer the medication.11
 |
| Standardize magnesium sulfate dosing using a calibrated infusion pump with free-flow protection. | * Limit the number of different kinds of infusion pumps to maximize staff familiarity with infusion equipment.10
* Establish the unit’s standard approach for administering a loading dose (bolus). Use of the maintenance infusion to administer a bolus manually is a high-risk practice that should be avoided. Safe dosing options include—
* Administering the bolus from the maintenance infusion using a “smart” infusion pump that has the following safety features:10
	+ Pump includes a bolus dose feature that allows programming to automatically switch to the continuous infusion rate at the end of the bolus AND staff are trained to use this feature.
	+ Separate dose limits can be set for bolus doses and maintenance doses.
	+ Dose limit alerts are operational at all times.
	+ Dose limit alerts are configured as a “hard stop,” requiring pump to be reprogrammed if dose exceeds limits.
 |

***Standardize When Possible (CUSP Science of Safety) (continued)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Standardize magnesium sulfate dosing using a calibrated infusion pump with free-flow protection. (continued) | * If a smart infusion pump with these safety features is not available, then loading dose should be administered via a separate bag. Premixed or pharmacy-prepared bags (e.g., 4 g/100 ml or 8 g/100 ml) should be used unitwide to reduce variability and risk of error.
* The same standard preparation either premixed or pharmacy-prepared bags (e.g., 20 g/500-ml bag) unitwide for maintenance infusion.13
* Use of a 500-ml bag can help distinguish the bag from liter bags containing fluids or other medications.11
* The smaller volume also reduces the amount of magnesium that can be delivered in the event of an accidental rapid infusion (e.g., pump programming error or failure).
* Complete removal of the line from the intravenous (IV) port when magnesium sulfate therapy is discontinued to avoid accidental infusion.10,11
 |
| Use uniform parameters for maternal and fetal monitoring and provider notification prior to initiation of magnesium sulfate and during infusion. | The use of uniform parameters for fetal and maternal monitoring and provider notification before and during magnesium sulfate use minimizes variability across providers and nursing staff in order to reduce the risk of error.  |
| Standardize laboratory reporting of serum magnesium levels. | Hospital policy and process for uniform reporting of serum magnesium levels. Magnesium levels can be reported as milligrams per deciliter (mg/dL), milliequivalents per liter (mEq/L) and millimoles per liter (mmmol/L), and the same magnesium level would be reported using different numbers depending on the unit of measure. Bedside staff, providers, and lab personnel should agree on one unit for reporting and communicating magnesium levels to avoid miscommunication and delays in timely care.10 |

***Create Independent Checks (CUSP Science of Safety)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Assess appropriateness of magnesium use in patient by staff other than the ordering provider. | An independent verification of indications and maternal and fetal status per unit-established standard criteria can minimize medication use in cases where risk may exceed benefit. These criteria may include—* indications for use (e.g., neuroprotection of fetus during preterm labor, seizure prophylaxis for preeclampsia)
* contraindications for use
* maternal status prior to initiation
* fetal status prior to initiation
 |
| Use preprinted orders or electronic order entry for magnesium sulfate order. | Unit process for ordering magnesium using preprinted orders or electronic order entry reduces dosing errors due to incorrect dose or illegible orders. Avoidance of abbreviations for magnesium sulfate.10,12 |
| Use independent verification whenever there is a rate change or a new magnesium sulfate bag is hung. | A second qualified staff member independently checks that the magnesium bag is clearly labeled, contains the correct dose, and that tubing and pump are set up correctly whenever a new bag is hung or a rate change is made.10 This verification is facilitated by tracing the tubing by hand from the IV bag to the pump, and then to the patient.14 |
| Use uniform parameters for maternal and fetal monitoring at regular intervals. | Use uniform parameters for maternal and fetal monitoring at regular time intervals per unit-established processes during loading dose and maintenance infusion to identify changes in status. Various clinical references offer parameters for monitoring:3,10,15* *Assessment prior to initiation*: Vital signs, deep tendon reflexes/clonus, level of consciousness, symptoms such as headache, visual disturbances, nausea/vomiting, epigastric pain, tocography, and fetal heart rate (FHR) (antepartum and intrapartum only).
* *Assessment during infusion*: Vital signs, with specific focus on oxygen saturation and respiratory pattern, deep tendon reflexes, fluid intake/output, tocography, signs and symptoms of labor progression, worsening signs/symptoms of preeclampsia, magnesium toxicity, and fluid overload. Typically, a nurse
 |

***Create Independent Checks (CUSP Science of Safety) (continued)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Use uniform parameters for maternal and fetal monitoring at regular intervals. (continued) | should remain at the bedside during the loading dose to monitor initial response and reassure patient regarding commonly experienced side effects.* *Use of serum magnesium levels:* Regular, routine serum levels do not always correlate with clinical symptoms and are not needed for most patients. However, regular, routine serum levels may be useful for patients with impaired renal function.
 |
| Use maternal and fetal parameters for provider notification. | Use of uniform, unit-established parameters for provider notification ensures that signs of potential adverse effects or clinical deterioration are communicated for situational awareness and response if needed. * Provider-notification criteria can be based on patient vital signs, FHR patterns, and signs and symptoms of labor progression, worsening signs/symptoms of preeclampsia, magnesium toxicity, or labor progression. Various clinical reviews and references offer some suggested parameters for notification.10,15
 |
| Have standing orders for nurses to respond to signs and symptoms of magnesium toxicity, with quick access to antidote. | Use of uniform, unit-established standing orders allows nurses to provide initial management in response to suspected magnesium toxicity. Magnesium toxicity is a clinical diagnosis, and serum levels do not always correlate with clinical signs and symptoms; thus, nurses who monitor patients receiving magnesium sulfate should—* know how to recognize the signs and symptoms of toxicity
* have ready access to the antidote, calcium gluconate, via a kit stored in the patient’s room or easily accessible on the unit
* know how to temporarily support ventilation and activate a rapid response for advanced airway support
 |

***Create Independent Checks (CUSP Science of Safety) (continued)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Have standing orders for nurses to respond to signs and symptoms of magnesium toxicity, with quick access to antidote. (continued) |

| **Symptoms** | **Magnesium Level (mg/dl)** |
| --- | --- |
| Normal adult values | 1.7–2.4 |
| Therapeutic range | 5–9 |
| Loss of patellar reflexes | 8–12 |
| Feelings of warmth, flushing | 9–12 |
| Somnolence | 10–12 |
| Respiratory difficulty/depression | 12–16 |
| Muscular paralysis | 15–17 |
| Altered cardiac conduction | >18 |
| Cardiac arrest | 30–35 |

Adapted from Simpson, 2004.10Standing orders for nurse response for signs and symptoms of magnesium toxicity can include—* activating a rapid response (i.e., call for additional help)
* stopping the infusion
* monitoring vital signs, including oxygen saturation and respiratory rate and pattern
* drawing a STAT magnesium blood level
* If respiration is depressed, administering oxygen by face mask and administering calcium gluconate to antagonize the effects of excessive magnesium levels
* If respiration is arrested, supporting ventilation with bag-valve-mask, administering calcium gluconate, and activating request for advanced airway support
 |

***Learn From Defects (CUSP Module)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Debrief and analyze near misses and adverse events related to magnesium sulfate use. | * Unit can decide its approach to debriefing events based on seriousness of event, expertise available, and data monitoring and tracking capabilities.
	+ Informal debriefings by clinical team immediately following event using an approach that does not shame or blame individuals. This approach allows for understanding of what went well, what could have gone better, and what could be done differently next time.
	+ Regular forum with a multidisciplinary team can help the unit learn from defects and sensemaking using the following tools:
		- Discovery form
		- Root cause analysis
		- Eindhoven model
		- Failure mode and effects analysis
		- Probabilistic risk assessment
		- Causal tree worksheet
		- Interdisciplinary case reviews
 |
| Have a process in place to review use of magnesium sulfate outside of defined indications. | Unit can decide its approach to reviewing cases where magnesium sulfate was used outside of the unit’s established criteria for use. This might include an existing medical peer-review process or review by a perinatal safety or quality committee. |
| Have a process in place to review severe maternal or neonatal morbidity and mortality events.  | Unit can decide its approach to reviewing cases of severe maternal or neonatal morbidity or mortality. This might include an existing medical peer-review process or review by a perinatal safety or quality committee.A sample process and forms for a committee review are available at the Council on Patient Safety in Women’s Health Care, [www.safehealthcareforeverywoman.org](http://www.safehealthcareforeverywoman.org). Select “Get SMM Forms.” |
| Share outcomes or process improvements from the informal (debriefing) and formal analysis with staff to achieve transparency and organizational learning. | Sites can decide how often this information will be shared, how much will be shared, and with whom, and whether this should be specified in a unit policy or handled more informally. |

***Simulation (Safety Program for Perinatal Care Signature Element)***

| **Key Perinatal Safety Elements** | **Examples** |
| --- | --- |
| Sample scenarios:* Magnesium sulfate toxicity
* Preeclampsia/seizure
 | * Two sample scenarios available through the Safety Program for Perinatal Care can be used to train teams on the key perinatal safety elements related to magnesium sulfate use. This scenario reinforces teamwork and communication related to—
	+ situational awareness
	+ ability to get additional help quickly
	+ timely use of standing orders for managing magnesium sulfate toxicity
	+ communicating with rapid responders
	+ communicating with patient/family
	+ using briefings, huddles, and debriefings
 |

***Teamwork Training (TeamSTEPPS®)***

| **Key Perinatal Safety Elements** | **Examples/customizable components** |
| --- | --- |
| Situational awareness during magnesium sulfate use. | Situational awareness refers to all staff caring for the patient—* knowing what the patient’s plan is through briefings and team management,
* being aware of what is going on and what is likely to happen next,
* verification and check back on information, and
* providing ongoing updates.

In the context of magnesium sulfate use, this includes staff alertness for early signs of abnormal fetal or maternal status, and knowing the plan for a timely response to prevent further deterioration. |

***Teamwork Training (TeamSTEPPS®) (continued)***

| **Key Perinatal Safety Elements** | **Examples/customizable components** |
| --- | --- |
| Use SBAR (**S**ituation, **B**ackground, **A**ssessment, and **R**ecommendation), callouts, huddles, and closed-loop communication techniques. | * Use of SBAR, callouts, and closed-loop communication among team members. In the context of magnesium sulfate use, these techniques are particularly useful—
	+ for communicating a sense of urgency when requesting other unit personnel and provider for help responding to sudden changes in maternal or fetal status (e.g., seizure, magnesium toxicity, fetal distress).
	+ for communicating changes in maternal or fetal status,
	+ when giving and receiving new orders to manage sudden changes in maternal or fetal status,
	+ when briefing new care team members who arrive to support a rapid response,
	+ when regrouping to discuss plan of care if patient fails to respond to initial measures.
 |
| Communicate during transitions of care. | Use of transition communication techniques assures a shared mental model of plan of care and perceived risks between shifts or between units. This may include bedside review by nursing team of pump settings, mainline IV fluids, and written orders for magnesium sulfate.10 |
| High-reliability teams:* Anyone can sound an alarm, request help, or challenge the status quo.
* Hierarchy is minimized.
* Communication is continuous, valued, and expected.
 | * Team members protect each other from work overload and place requests or offers for assistance in the context of patient safety. It is expected that assistance will be actively sought and offered.
* Team members will advocate for the patient when one person’s viewpoint does not coincide with another’s.
* Assert a corrective action in a firm and respectful manner.
* Use CUS language: “I am **c**oncerned. I am **u**ncomfortable. This is a **s**afety issue.”
* Use the Two Challenge rule and repeat your concern and inquire if you have been heard.
* Use a predetermined “stop the line” phrase.
 |

***Teamwork Training (TeamSTEPPS®) (continued)***

| **Key Perinatal Safety Elements** | **Examples/customizable components** |
| --- | --- |
| High-reliability teams:(continued) | * Manage conflict using a constructive positive approach to emphasize “what is right, not who is right”:
* **D:** Describe the specific behavior or situation. **E:** Express how the situation makes you feel or concerns you.
* **S:** Suggest other alternatives.
* **C:** Consequences stated in terms of team goals, not punishment.
 |

***Patient and Family Engagement (CUSP)***

| **Key Perinatal Safety Elements** | **Examples/customizable components** |
| --- | --- |
| Discuss risks and benefits of intrapartum or postpartum magnesium sulfate use.  | Use unit-established process for conveying risks and benefits of magnesium sulfate use to patient and family. |
| Educate patient/family regarding magnesium sulfate use. | * Use unit-established approach for nursing-led patient education regarding magnesium sulfate infusion, mobility restrictions, and expected effects.
* Educate patient and family concerning frequency of nursing assessment and monitoring, signs and symptoms to report to nursing staff.
* Provide instructions for reporting signs and symptoms to nursing staff.
 |

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**Appendix**

*Every effort was made to ensure the accuracy and completeness of this resource. However, the U.S. Department of Health and Human Services makes no warranties regarding errors or omissions and assumes no responsibility or liability for loss or damage resulting from the use of information contained within.*

**SAMPLE Safe Medication Administration Process for Magnesium Sulfate**

(References are located in the reference list above.)

| Category | Example Process |
| --- | --- |
| 1. Verifying and documenting indications for use
 | Verify and document indications and absence of contraindications for use of magnesium sulfate when receiving orders for magnesium sulfate. * Indications for use1-7
	+ neuroprotection of fetus before anticipated early preterm delivery (< 32 weeks gestational age)
	+ seizure prophylaxis or treatment in women with preeclampsia or eclampsia
	+ use as a tocolytic for up to 48 hours for short-term prolongation of pregnancy for the administration of antenatal corticosteroids in women between 24 and 34 weeks gestation who are at risk of preterm delivery within 7 days
* Contraindications for use8
	+ Use more than 5 to 7 days
	+ Patients with heart block
	+ Patients with myocardial damage
* Staff with requisite training and supplies available to respond to magnesium-related adverse events including respiratory depression
 |
| 1. Assessment
 | Baseline maternal and fetal assessment and periodic assessment. Assessment documentation on labor and delivery flowsheet.* *Assessment prior to initiation*: Vital signs (temperature, pulse, blood pressure, respiratory rate and pattern), deep tendon reflexes(DTRs)/clonus, breath sounds, level of consciousness, symptoms such as headache, visual disturbances, nausea/vomiting, epigastric pain, tocography, and fetal heart rate (FHR) pattern (antepartum and intrapartum only).
* Verify seizure precautions:
	+ oxygen and suction available at the bedside
	+ bedrails in the upright position
	+ patient is NPO (nothing by mouth)
* *During loading dose:* While the loading dose is being administered, the nurse should remain at the bedside to monitor the patient.
 |
| 1. Assessment (cont'd)
 | * *Periodic nursing assessments:* Every 15 minutes during first hour of infusion, every 30 minutes during second hour, and hourly thereafter. Assessments should include—
	+ vital signs (blood pressure, respirations [rate and pattern], pulse, temperature, oxygen saturation level)
	+ DTRs and presence or absence of clonus
	+ fluid inputs and outputs (if a patient cannot ambulate to the bathroom or use a bedpan, an indwelling urine catheter may be needed)
	+ level of consciousness
	+ breath sounds
	+ presence of headaches or visual disturbances (blurred or double vision)
	+ presence or absence of epigastric pain
	+ presence of extravasation or infiltration at intravenous (IV) site
	+ signs/symptoms of magnesium toxicity, worsening pre-signs or symptoms of eclampsia, or progression of labor
	+ periodic urine assessment for protein (if applicable)
	+ vaginal bleeding
	+ tocography and FHR (with antepartum or intrapartum use)
* Serum magnesium-level monitoring every 6 hours

\_\_\_YES (Patients with impaired renal function)\_\_\_NO (Patients with normal renal function) |
| 3. Administration | * Administer the mainline fluids and magnesium sulfate using a calibrated infusion pump.
* Connect the magnesium sulfate medication bag into the mainline IV tubing by attaching itto the lowest port on an extension set or the lowest connector on the IV tubing set to facilitate immediate disconnection during emergencies.
* Initiate magnesium sulfate with a loading dose (bolus) using a premixed bag of 4 grams per 100 ml. Infuse the bolus dose over a 20- to 30-minute period.
 |
| 3. Administration (cont'd) | * When bolus is complete, initiate a premixed maintenance bag with a concentration of 20 grams of per 500 ml. Administer maintenance infusion at a rate of (check one)—

\_\_\_1 gram/hour (25 ml/hour)\_\_\_1.5 grams/hour (38 ml/hour)\_\_\_2 grams/hour (50 ml/hour)\_\_\_Other (separate provider order required for rates other than the above rates)* Label the magnesium sulfate line with appropriate medication sticker.
* Do not infuse other medication into the magnesium sulfate line.
* Second nurse must verify pump settings and line hookup whenever there is a rate change or a new bag is hung.
* When the order for magnesium is discontinued, the pump should be stopped and the bag and IV tubing promptly disconnected from the patient and discarded.
 |
| 4. Provider notification parameters and standing orders for responding to suspected magnesium toxicity | * Notify the primary maternity care provider if any of the following conditions occur:
	+ changes from baseline more than 20 mmHg SBP or 10 mmHg DBP mmHg
	+ pulse >120 bpm or < 60 bpm
	+ respiration < 14 or > 24
	+ oxygen saturation < 95%
	+ urine output less <30 ml/hour
	+ increasing proteinuria
	+ increasing clonus
	+ DTRs 4+
	+ persistent headache or visual disturbances
	+ increasing swelling of face, hands, or feet
	+ presence/worsening of epigastric (right upper quadrant pain)
	+ increasing nausea/vomiting
	+ bruising
	+ vaginal bleeding
	+ Activate a rapid response AND notify the primary maternity care provider for—
	+ signs and symptoms of magnesium toxicity
	+ seizure
* Signs and symptoms of magnesium toxicity include respiratory depression (less than 12 respirations/minute), prolonged expiration, severe chest heaviness or shortness of breath, a significant decrease in the level of consciousness, the absence of deep tendon reflexes, and a significant decrease in the patient’s pulse or blood pressure.
 |
| 4. Provider notification parameters and standing orders for responding to suspected magnesium toxicity (cont'd) | * Magnesium toxicity is a clinical diagnosis, and serum levels do not always correlate with clinical signs and symptoms.

| **Symptoms** | **Magnesium Level (mg/dl)** |
| --- | --- |
| Normal adult values | 1.7-2.4 |
| Therapeutic range | 5-9 |
| Loss of patellar reflexes | 8-12 |
| Feelings of warmth, flushing | 9-12 |
| Somnolence | 10-12 |
| Respiratory difficulty/depression | 12-16 |
| Muscular paralysis | 15-17 |
| Altered cardiac conduction | >18 |
| Cardiac arrest | 30-35 |

Adapted from Simpson, 200410* Standing orders for suspected magnesium sulfate toxicity
	+ Stop the infusion
	+ Activate a rapid response and notify provider
	+ Monitor respiratory rate, pattern, and monitor oxygen saturation with pulse oximeter
	+ Draw a STAT serum magnesium level
	+ If respiration is depressed, administer oxygen 2L by face mask and administer calcium gluconate 1 gm (10 ml of a 10% solution) over 5 minutes.
	+ If respiration arrests, request advanced airway support and bag-valve-mask to support respiration.
 |
| 6. Patient comfort and education | * Discuss risks and benefits of magnesium sulfate with patient and family.
* Explain the magnesium infusion procedure, mobility, and dietary restrictions.
* Explain expected therapeutic effects, and discuss likely side effects, and symptoms of toxicity that should be reported immediately.
* Discuss how patient and family can request urgent assistance if nurse is not at bedside.
* Place lights in the patient’s room on low.
* Maintain a quiet environment.
* Provide a fan at the bedside for relief from flushing, hot flashes, and sensation of increased body temperature.
 |
| 7. Communication  | * Notify pediatrics when antepartum and intrapartum patients are placed on magnesium sulfate
* Verify medication bag, pump settings, and IV tubing are correct during change of shifts or other transitions of care team
* Use TeamSTEPPS communication techniques to—
	+ request urgent additional help
	+ assert and advocate for safe practices (CUS)
	+ brief new team members, such as during a rapid response (SBAR)
	+ acknowledge receipt of orders (closed-loop communication)
	+ maintain situational awareness by sharing new information with team as it is learned
 |

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