

Magnesium Sulfate in Prehospital Care

By Michael Silverman, EMT-P

Magnesium compounds have been used in the healthcare setting for many years. Over-the-counter (OTC) products like magnesium oxides and magnesium hydroxides (magaldrate, Antiflux, Lowsium, Riopan) are used as antacids; magnesium salicylates (Doan's pills, Magan, Mobidin) are used as non-narcotic analgesics; and magnesium salts (Milk of Magnesia) are used for constipation.¹ This article focuses on the more progressive uses of intravenous magnesium sulfate that are beginning to appear in prehospital care protocols and trial studies, specifically for serious asthma and stroke. The more accepted use of magnesium for eclampsia and cardiac care is briefly reviewed.

Eclampsia

Pre-eclampsia is a hypertensive disorder that occurs during pregnancy and can cause headaches, vision problems, abdominal pain, nausea, vomiting and sudden swelling of the face, hands or feet. Eclampsia, a Greek word for "bolt from the blue," can present with seizures—the hallmark of eclampsia—along with agitation, altered level of consciousness and the above signs and symptoms.²⁻⁶

Paramedic treatment includes airway support, oxygen therapy, large-bore IV with NS TKO, cardiac monitoring and transporting the patient in the left lateral position. Seizure activity is typically treated with intravenous magnesium sulfate, 4 grams over three minutes. In the prehospital setting, diazepam (Valium) or midazolam (Versed) can be used if magnesium does not terminate the seizure.⁷ The only definitive treatment for eclampsia is delivery of the neonate.

Cardiac Care

Magnesium deficiency is associated with a "high frequency of cardiac arrhythmias, symptoms of cardiac insufficiency and sudden cardiac death." As a result, many prehospital protocols include the use of magnesium sulfate for treating refractory VF/VT or the presence of torsade de pointes: Class IIa intervention for refractory VF/VT (acceptable, probably useful and effective) and class I (useful and effective) for torsade.^{8,11} Since this medication is far down the prehospital protocol for treatment of VF/VT, it is not commonly used except in the case of early-recognized torsade.

Magnesium sulfate is also used, generally in the hospital setting, for acute MI with known magnesium deficiency (class I) and class IIb (acceptable, possibly helpful) when given prophylactically, although the literature suggests the latter treatment offers little to no benefit.⁹⁻¹¹ It is unlikely that magnesium would be used in the prehospital setting for acute MI unless paramedics could clearly identify and articulate to on-line medical control that the MI patient uses or misuses diuretics, and has poor dietary intake and habits.

The AHA-recommended dose for refractory VF/VT (cardiac arrest) is 1 or 2 grams IV push.¹¹ Recommended torsade dose is 1 or 2 grams over 5–60 minutes, although higher doses up to 5–10 grams have been used. The dose for acute MI is 1–2 grams over 5–60 minutes. Prehospital dosage for cardiac arrest tends to be IV push or as an infusion over a period up to three minutes.

This medication has a long history of being well tolerated. Side effects at these dosage levels are rare, but can include hypotension, absent or decreased deep tendon reflexes, respiratory depression, circulatory collapse, diaphoresis and drowsiness.

Severe Asthma

The use of magnesium sulfate for treating asthma was first reported in 1938.^{12,13} Although not a primary therapy in the prehospital setting, it may prove useful in the severe asthmatic patient, and paramedics should be aware of this secondary potential lifesaving treatment.

Although the primary role of inflammation in asthma is well known, prehospital care tends to focus on bronchodilation using beta-agonists such as albuterol and epinephrine (in extremis), and anticholinergic agents such as ipratropium bromide. Some systems include corticosteroids like methylprednisolone to treat airway edema, as well as chemical sedation should intubation become necessary.

Magnesium deficit leads to increased acetylcholine release and muscle excitability. It is known that acute temporary elevation of serum magnesium can result in bronchodilation (smooth muscle relaxation), even in patients with normal magnesium levels. Evidence also shows that magnesium acts as a competitive antagonist with calcium and reduces the neutrophilic burst associated with the inflammatory response in asthma.¹⁴ Regardless, the beneficial effect of magnesium is controversial because a large clinical trial has not been done, even though numer-

ous case studies show dramatic reversal of severe bronchospasm, minimizing the need for intubation and reducing in-hospital admissions in that group of patients.

A systematic meta-analysis conducted by searching the Cochrane Airways Review Group concluded that although indiscriminate use was not warranted in the ED setting, there was "sufficient evidence to support its use in a subgroup of patients experiencing severe asthma who appear to respond differently to the administration of magnesium. These patients benefited both in terms of admission rates and improved pulmonary function."¹⁴ The researcher later said, "It (magnesium sulfate) costs virtually nothing and is incredibly safe, especially in the doses we use for acute asthma." In the prehospital setting, any patient who does not respond to the initial beta-agonist dose should be classified as severe and a candidate for intravenous magnesium sulfate.

Another meta-analysis, conducted independently, reached similar conclusions. The only significant difference was that this researcher recommended its use in both moderate and severe asthma cases.¹⁵

Although this treatment will generally not result in dramatic improvement of pulmonary function, given the potential benefit of this medication, low incidence of side effects, cost-effectiveness and its presence in most paramedic drug inventories, it should be routinely used in prehospital care when a patient presents with severe asthma and initial therapies are not effective. If your assessment indicates the patient is not improving after initial beta-agonist treatment and the patient has a history of intubation and/or hospital admission after similar episodes, this would be an excellent candidate for magnesium sulfate. The optimal dose is 25–100 mg/kg for children and 2 g for the adult patient, both delivered over a 20-minute period.¹⁴ Treating acute asthmatic patients with a less dramatic history should not be harmful, and could be beneficial.

Magnesium Sulfate and Stroke

Acute stroke is the third-leading cause of death in the United States, after heart attack and cancer, and the leading cause of long-term disability. Public awareness campaigns emphasizing "brain attack" education, early recognition and prompt transport to the hospital are now common.¹⁶

In many cases, stroke treatment is no longer just supportive. Early recognition opens the door for more effective interventions for both ischemic and hemorrhagic

stroke. For example, early recognition of ischemic stroke allows providers to consider thrombolytic treatment, although the benefit-to-risk ratio due to intracerebral hemorrhage and overall effectiveness is quite controversial.^{17,26} Prehospital providers need not focus on these controversial treatment issues. Rather, we should focus on supportive care and rapid transportation to the most appropriate facility.

Magnesium is well known as a neuroprotective agent. A \$16 million Phase 3 trial titled “FAST-MAG” has just been funded at the University of California, Los Angeles (UCLA) to demonstrate “that paramedic initiation of IV magnesium sulfate within two hours of symptom onset improves the long-term functional outcome of hyperacute stroke patients.”¹⁸ The initial pilot study, conducted between May 2000 and January 2002, showed that “paramedics initiated the drug much more quickly compared to the usual approach of waiting until the patient was in the hospital, and patients tended to make a better recovery.”¹⁹

Patients in the UCLA trial study met the following criteria: age 40–95; identified in the Los Angeles stroke screen criteria; identified within two hours of onset of symptoms; continued to have symptoms after 15 minutes.

Patients excluded from the study met the following criteria: coma; rapidly improving; SBP <90 or >220; severe renal dysfunction (on dialysis); severe respiratory distress (oxygen saturation <90%); second- or third-degree heart block; major head trauma in the last 24 hours; stroke within the last 30 days.

A critical part of the study was reliable identification of stroke patients using the Los Angeles Prehospital Stroke Screen (LAPSS) described in the sidebar.¹⁹ The trial study selected a prehospital magnesium sulfate dosage of 4 grams over 15 minutes, followed by a maintenance infusion of 16 grams over 24 hours in the hospital setting.

Although there are a number of neuroprotective agents, extensive clinical experience with magnesium demonstrates patients’ ability to tolerate it safely. Magnesium increases cerebral blood flow to ischemic brain areas by dilating blood vessels and prevents damaging calcium buildup in injured nerve cells.^{20,21,22} If the outcome of this trial is positive, it has the potential to significantly change our approach to stroke treatment in the prehospital and emergency department settings.

Although potential routine treatment of stroke with intravenous magnesium sulfate is many years away, prehospital care providers should now concentrate on early recognition, supportive care and rapid transport of suspected stroke patients to the most appropriate facility. Many prehospital protocols now support rapid transport of stroke patients to the most appropriate facility with a “stroke team” rather than the closest facility, especially when patients meet specific criteria such as baseline health status and known time of onset.^{20,23,24,26}

Another Potential Application

Although this section has little to do with prehospital emergency care, it was interesting to find that magnesium sulfate is being studied to determine if prenatal use—specifically before preterm birth—can improve pediatric outcomes, such as total mortality, reduction in neurosensory disability, motor dysfunction and cerebral palsy.²⁷ Although these studies are not strong enough to recommend widespread use, additional research may one day offer a treatment that can provide an overall reduction in the prevalence of cerebral palsy.²⁸ ■

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Early Recognition of Stroke

There are two well-known tools to help a prehospital provider rapidly and reliably identify a stroke patient: the Los Angeles Prehospital Stroke Screen²⁰ (LAPSS) and the Cincinnati Prehospital Stroke Scale (CPSS).²⁵

LAPSS

If all of the following criteria are met, the patient is identified as meeting the LAPSS criteria for a “code stroke.” The last known time the patient was at baseline or deficit-free and awake must be documented.

- Age >45
- History of seizures or epilepsy absent
- Symptom duration less than 24 hours
- At baseline, patient not wheelchair-bound or bedridden
- Blood glucose 60–400
- Obvious asymmetry:

Facial smile, grimace—normal or droop

Grip—normal, weak or no grip

Arm strength—normal, drifts down or falls rapidly

Based on above exam for asymmetry, patient has only unilateral weakness. If the above are yes or unknown, the patient meets screening criteria.

CPSS

The CPSS does not include criteria for acute stroke therapy, but is a good screening tool to identify stroke patients.

Facial Droop

Action: Have patient show teeth or smile.

Normal: Both sides of face move equally well.

Abnormal: One side of face does not move as well as the other side.

Arm Drift

Action: Have patient close both eyes and hold both arms out.

Normal: Both arms move the same or both arms do not move at all.

Abnormal: One arm does not move or one arm drifts down compared with the other.

Speech

Action: Have the patient say, “You can’t teach an old dog new tricks.”

Normal: Patient uses correct words with no slurring.

Abnormal: Patient slurs words, uses inappropriate words or is unable to speak.

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