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Case Report

What happens when a large dose of magnesium sulfate is infused intravenously?

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Abstract

Introduction: During hospital admission, various drugs are prescribed. Most of these medications are high-alert medications, which can cause significant damage to the patient's body due to its unintentional usage. Unfamiliarity with safe dosage ranges, confusion between similar looking drugs, mislabeling of drugs, equipment misuse, or malfunction and communication problems could induce this kind of errors. We want to report a case of accidental injection of a high dose of magnesium sulfate ($MgSO_4$) in a girl with diabetes mellitus (DM).

Case Report: A 17-year-old girl was admitted to the internal ward for close observation of poorly control DM with complication of hypoglycemia. The patient had muscle weakness and loss of deep tendon reflexes (DTRs) and severe constipation hypoventilation following the accidental infusion of 20 mg of magnesium sulfate (MgSO4). But, the patient was lucky to survive with medical treatment.

Conclusion: MgSO4 is among one of the most frequently used drugs in medical practice. However, despite years of use and provider familiarity, the prescription of MgSO4 occasionally results in accidental overdose and patient damage.

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Introduction

Drug prescription mistakes appear to be a major source of iatrogenic damage to the in-patients. A study has estimated that errors that related to drugs are seen in one-fifth of doses given to patients in-patients.[1] Drug prescription mistakes were found to account for approximately one-fourth of drug-related errors.[2,3] A lot of drug errors have been reported in the similar articles with some resulting in morbidity and mortality.

Case Report

A 17-year-old girl was admitted to the internal ward for close observation of poorly control diabetes mellitus (DM) with the complication of hypoglycemia. Physical examination showed that she was mildly irritable and uncooperative state with easy fatigue and muscle weakness, deep tendon reflexes (DTRs) was weak (1+) but unremarkable cardiovascular and respiratory exam. Her initial magnesium sulfate ($MgSO_4$) levels were 0.4 on the 1st day evening. Laboratory results are shown in table 1.

The blood sugar level was 30 mg/dl at the emergency department admission, and one vial of hypertonic dextrose (50%) was administered quickly and the patient was admitted at the internal ward, endocrinology department. After checking, blood sugar level, which was 50 mg/dl nurse, was ordered to infuse hypertonic dextrose for the treatment of hypoglycemia. After infusion, the patient was

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found to be having difficulty in responding verbally, with dyspnea, but did continue to breathe spontaneously. Her blood pressure (BP) was 80/50 mmHg and heart rate was 110/min. Blood samples were taken for arterial blood gas (ABG) analysis, serum electrolytes including calcium and magnesium levels, coagulation profile, and hemoglobin level. Laboratory results are shown in table 2.

Table 1. Laboratory results at admission

Variable	Value	Range
Urea (mg/dl)	2.0	(F: 15-40)
Creatinine (mg/dl)	0.14	(0.7-1.4)
Serum Na (mEq/L)	108	(136-145)
Potasium (mEq/L)	0.6	(3.6-5)
Serum Mg (mg/dl)	0.4	(adult: 1.8-2.6)

F: Female

The working diagnosis at the time was anaphylaxis due to drug allergy or idiosyncrasia. The resuscitative team was consulted for support and investigate. A trial of 1 g of calcium gluconate was given because the last magnesium level had been below the normal therapeutic range. During the physical examination, her pupils were mildly dilated, but they were symmetrical and reacting to light. She was promptly taken for a head computed tomography (CT) scan, which was negative.

Table 2. Laboratory results after drug error

Variable	Value	Range
Blood sugar (mg/dl)	145	up to 200
Urea (mg/dl)	15	(M: 19-44, F: 15-40)
Creatinine (mg/dl)	0.71	(0.7-1.4)
Ca total (mg/dl)	9.9	(8.6-10.3)
Serum Na (mEq/L)	140	(136-145)
Potasium (mEq/L)	4.1	(3.6-5.0)
Ca ion (mmol/L)	1.23	(1.13-1.30)
Serum Mg (mg/dl)	2.4	(adult: 1.8-2.6)
Phosphorus (mg/dl)	5.2	(adult: 2.6-4.5)

M: Male; D: Female

Abdomen CT ordered to rule out acute pancreatitis, which did not have specific finding at the same magnesium levels had returned to be within the toxic range at 3.3 mmol/L. She was treated supportive and conservatively for respiratory support and correction of magnesium levels. An additional 2 g of calcium was given and planned for forced diuresis with frusmide. A cardiologic consultation was requested to rule out any cardiac problem. There was no cardiac problem. Electrocardiogram (ECG) was normal. A minimal pericardial effusion was noted at bedside echocardiogram. Because the magnesium level of patient was below normal before infusion and rapidly resolution of the abnormality in the short period of time without any intervention. Magnesium toxicity was suspected to be the cause of her dyspnea and difficulty in responding verbally. The team visited the patient room, as the increase in magnesium level had occurred within a short period of time, a drug error was suspected. The trash can from the patient room was checked for discarded bags and an empty bag labeled with magnesium sulfate was found in the trash can. Presumably, this had been erronosly by the nurse considering it to be hypertonic dextrose. Hypertonic dextrose-labeled intravenous (IV) bag was not found in the trash can. The working diagnosis was accidental magnesium sulfate toxicity secondary to displacement of magnesium sulfate vial for hypertonic dextrose ones. That is why the patient had received 20 g of magnesium sulfate as a vial shot.

By early evening of the next day of admission, her magnesium levels had returned to within therapeutic range. After improvement, she was alert, oriented, and asymptomatic and required no supplemental oxygen. She was observed in the ward overnight and the patient was complicated with severe abdominal pain and refractory constipation and gastroenterlogic consultation was requested to rule out any organic problems a total colonoscopy was performed without any significant lesion and patient returned to ward in a stable condition. The last results were shown in table 3.

Table 3. Laboratory results after resolution

Variable	Value	Range
Urea (mg/dl)	15	(M: 19-44; F: 15-40)
Creatinine (mg/dl)	0.84	(0.7-1.4)
Serum Na (mEq/L)	138	(136-145)
Potasium (mEq/L)	4.1	(3.6-5.0)
Serum Mg (mg/dl)	2.0	(adult: 1.8-2.6)

M: Male; D: Female

Discussion

Magnesium is an essential element in biological systems. Magnesium occurs typically as the Mg^{2+} ion. It is an essential mineral nutrient (i.e., element) for life and is present in every cell type in every organism. The intracellular fluid differs significantly from the extracellular fluid; specifically, it contains large amounts of potassium, magnesium, and phosphate ions instead of the sodium and chloride ions found in the extracellular fluid. Special mechanisms for transporting ions through the cell membranes maintain the ion concentration differences between the extracellular and intracellular fluids. Magnesium has some intracellular functions, but magnesium is also required as a catalyst for many enzymatic functions. When the concentration of Mg is increased, activity in the nervous system and skeletal contraction are depressed this latter effect can be blocked by prescription of calcium sometimes, the prescription of magnesium sulfate results in an unintentional overdose and damage to the patient.

A report in the American Journal of Maternal Child Nursing in 2004 reported 52 cases of accidental magnesium sulfate overdosing in labor and delivery settings.[4] Some of these errors were with mortality and morbidity to the mothers. Many of these errors resulted from the unintentional rapid infusion of vial of magnesium sulfate.[5-7] Hypermagnesemia, though rare, is often iatrogenic due to unintentional overdose of IV magnesium, and even with normal renal function the associated hypermagnesemia is clinically significant.[8] Elevated serum magnesium levels can result in a variety of clinical signs and symptoms that are dose-dependent and predominantly affect the cardiovascular and neuromuscular systems causing loss of DTRs and progressive muscle weakness including the diaphragm and other respiratory muscles, leading to acute respiratory failure. In addition, an overdose of the same can lead to hypotension, arrhymia, and even cardiac arrest. It is important to remember that an untreated respiratory arrest leads to cardiac arrest as the cardiac muscle becomes hypoxic and ischemic.[4]

In this case, the patient had muscle weakness and loss of DTRs and severe constipation hypoventilation following the accidental infusion of 20 mg of magnesium sulfate. However, the patient was lucky to have hypomagnesimia at admission which aborted or slowed the unintentional hypermagnesimia. The patient was managed with IV calcium, fluids, without need to forced diuresis with frusmid to assist excretion of magnesium sulfate.[8] The patient was on conservative support until the magnesium levels returned to normal and there was an improvement in the conscious levels.

This critical scenario demonstrates an iatrogenic event where a wrong medication was prescribed; could induce catastrophic result, this was primarily due to the similar appearance of magnesium sulfate and hypertonic dextrose vial made by pharmacy companies. It is available as 20 g magnesium sulfate in vial, while the hypertonic dextrose infusions are 50 g per vial. The labels were almost similar in appearance, and there was no color coding for easy detection. Review of literature in fields no-medical reveals that an error is often not the result of a single act, but induced by the co-operation of a number of factors that include physical, social, and peripheral environments.[9,10] During critical positions, a person wants to see what they expect to see, and words are not usually diagnosed by what is written but by their shapes (the Poggendorff illusion). The Poggendorff illusion is a geometrical-optical illusion that involves the misperception of the position of one segment of a transverse line that has been interrupted by the contour of an intervening structure.[9,10]

The missed drug prescription may be due to a chance occurrence or simple human mistake. Therefore, we would like to suggest the development of hospital policies for the proper storage of high-risk drugs and avoiding packaging and labeling. Similar appearance drugs pharmacy companies must

work in collaborative with medical teams to improve patient safety. The lines of administration and areas of responsibility should be clearly defined between the health-care personnel, and there should be adequate communication among the personnel involved in the medication prescription and administration. High-risk drugs should always be administered via an infusion pump and should be double checked before injecting to the patient by the responsible and supervising nurse.

Conclusion

Magnesium sulfate is among one of the most frequently used drugs in medical practice. However, despite years of use and provider familiarity, the prescription of magnesium sulfate occasionally results in accidental overdose and patient damage. Color coding of packaged vials, use of color-coded tags on lines, and vigilance in its use is required for safe care of patients.

Conflict of Interests

Authors have no conflict of interest.

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