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CARDIAC ARREST WITHIN 24 HOURS OF MAGNESIUM SULPHATE ADMINISTRATION IN A TERTIARY EMERGENCY DEPARTMENT IN KARACHI

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Abstract

Objective: *To determine the frequency of cardiac arrest within 24 hours of magnesium sulphate (MgSO4) administration in patients treated in a tertiary emergency department.*

Study Design: *Descriptive cross-sectional study.*

Settings: *Accident and Emergency Department, Jinnah Postgraduate Medical Centre, Karachi, Pakistan.*

Period: *January to April 2025.*

Material & Methods: *The coded records of 77 patients who received intravenous or intramuscular MgSO4 were analysed. Cardiac arrest was defined as loss of effective cardiac output requiring cardiopulmonary resuscitation within 24 hours of administration. Frequencies, percentages and an exact binomial 95% confidence interval (CI) were calculated. Clinical toxicity was described using the study definition.*

Results: *Mean age was 33.5 ± 8.6 years; 76 patients (98.7%) were female. Indications were severe pre-eclampsia in 42 (54.5%), eclampsia in 28 (36.4%), refractory asthma in five (6.5%) and arrhythmia in two (2.6%). One patient had cardiac arrest (1.3%; exact 95% CI 0.03%–7.02%) 2.8 hours after MgSO4 initiation. Four patients (5.2%) met the recorded clinical toxicity definition, including the patient with arrest. Cardiopulmonary resuscitation and calcium gluconate were documented for that patient; spontaneous circulation returned, and all 77 patients were recorded as surviving to discharge.*

Conclusion: *Cardiac arrest was observed in one of 77 MgSO4-treated emergency patients. The event was temporally associated with treatment; causation cannot be determined from this descriptive study. The wide CI supports continued monitoring and larger studies.*

INTRODUCTION

Magnesium sulphate (MgSO4) is utilised in the emergency management of eclampsia, as well as in select medical emergencies like acute asthmatic attacks and certain cardiac arrhythmias. $MgSO_4$ has an established role in various pathologies of pregnancy, especially in the management of pre-eclampsia and eclampsia. Different health care systems use different methods of dosing $MgSO_4$ in the management of these conditions. Although $MgSO_4$ is often assumed to be a safe drug, recent research has documented adverse effects of the drug at the organ system level.[1,2,3]

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$MgSO_4$ is primarily excreted by the kidneys. Adverse effects of excessive serum levels of the drug include loss of deep tendon reflexes, respiratory depression and hypotension and cardiac conduction abnormalities.[4,5] Adverse effects may be reversible. Several recent studies have evaluated the effectiveness of shortening the duration of the standard treatment with $MgSO_4$ in obstetrics. Other studies assessing obstetric $MgSO_4$ practices have been conducted in Pakistan.[6,7,8,9] Clinical trials have evaluated alternative methods of administration of $MgSO_4$ in obstetrics.[10] Evidence from the Emergency Department has demonstrated the need to administer $MgSO_4$ for the treatment of acute asthma.[11]

This study will examine the frequency of adverse effects associated with the use of $MgSO_4$ in emergency medicine practices at Accident and Emergency Department of Jinnah Postgraduate Medical Centre (JPMC), Karachi. The focus is on the first 24 hours post $MgSO_4$ administration. Of particular interest are the levels of $MgSO_4$ toxicity in various patient populations.

MATERIAL & METHODS

Study Design: Descriptive cross-sectional study.

Settings: Accident and Emergency Department, JPMC, Karachi.

Duration: The enrolment dates ranged from January to April 2025.

Sample Size: The sample was generated using a synopsis based upon a single-proportion formula, assuming 4.7% toxicity, a confidence level of 95% and an absolute precision of 5%. The estimate was increased from 69 to 77 due to incomplete information. The 4.7% assumption is related to $MgSO_4$ toxicity and not to the primary endpoint. Therefore, this sample was not large enough to make inferences about risk factors.

Sampling Technique: Non-probability sampling of eligible patients receiving MgSO4 during the study period.

Inclusion Criteria: The participants were all individuals, of any sex and of any age, who were given $MgSO_4$ (IV or IM) in the ED as per the study protocol.

Exclusion Criteria: Participants were excluded who suffered a cardiac arrest prior to the administration of $MgSO_4$.. Other exclusion criteria included end-stage renal disease and/or dialysis, $MgSO_4$ administration at another facility, synopsis researcher exclusion and participant researcher refusal.

Data Collection Procedure: Participant data included demographics, reason for $MgSO_4$ administration, type and dose of $MgSO_4$, observation period and times, adverse effects, and end-of-study toxicity. The primary study endpoint was “cardiac arrest", which was defined as “loss of effective cardiac output”. If cardiac arrest occurred, measures to restore cardiac output (i.e., CPR) would be undertaken. Other definitions: Clinical toxicity was defined as patellar reflexes (areflexia), respiratory rate <12 and systolic BP <90. Return of spontaneous circulation (ROSC) was defined as the return of pulses and BP. Serum magnesium levels were not provided in the supplied study data.

Data / Statistical Analysis: The SPSS version 27 was used for statistical analysis and 77-record coded dataset were cross-checked. Continuous variables are represented as mean ± standard deviation or as median. For categorical variables, value and percentage are represented. The exact Clopper-Pearson interval was calculated for the main proportion of interest. Descriptively, other proportions are represented. Formal statistical tests of association have not been considered, due to the presence of only a single case of interest.

Ethical Approval: The research project was approved by the Institutional Review Board of Jinnah Postgraduate Medical Center. Thereafter, the researchers obtained informed consent from the participants. In the absence of the patient's ability to provide consent, a legally authorised representative was approached for it.

RESULTS

The analysis included 77 cases. The average age was 33.5 years (range 18 to 64 years) with a median age of 34 years. Of the 77 cases, 70 (90.9%) were women in child-bearing age receiving magnesium sulfate (MgSO4) for obstetric indications. Of all cases, 51 (66.2%) were given IV magnesium sulfate and 26 (33.8%) received both IV and IM magnesium sulfate. Additional information is provided in Table 1.

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Table 1. Baseline and treatment characteristics (n=77)

Characteristic	Value
Age, years, mean ± SD	33.5 ± 8.6
Female sex	76 (98.7%)
Male sex	1 (1.3%)
Severe pre-eclampsia	42 (54.5%)
Eclampsia	28 (36.4%)
Refractory asthma	5 (6.5%)
Arrhythmia	2 (2.6%)
Intravenous route only	51 (66.2%)
Intravenous plus intramuscular route	26 (33.8%)
Loading dose, g, mean ± SD	7.25 ± 4.90
Maintenance rate, g/hour, mean ± SD	0.71 ± 0.67
Renal function documented normal	72 (93.5%)

SD, standard deviation. Five patients had no documentation of normal renal function; this does not establish renal impairment. The g/hour field does not fully describe intramuscular maintenance regimens.

One patient developed cardiac arrest 24 hours after receiving MgSO4 (1/77, 1.3%; exact 95% CI 0.03% - 7.02%). The patient was a 38 year old female who had an intravenous infusion of MgSO4 for treatment of eclampsia. Cardiac arrest occurred 2.8 hours after the infusion. Prior to this, she was documented to have bradycardia and hypotension, as well as absence of patellar reflexes and respiratory depression. CPR was performed and she was given calcium gluconate. Return of cardiac spontaneous activity was documented as well as the patient's survival to hospital discharge. Sequence, but not drug causation, has been demonstrated for this case. A total of 5.2% (4/77) of the patients developed clinical toxicity. All patients, including these 4 patients, survived to hospital discharge (Table 2).

Table 2. Clinical outcomes within 24 hours (n=77)

Outcome	n (%) or estimate
Cardiac arrest	1 (1.3%)
Exact 95% CI for cardiac arrest	0.03%–7.02%
No cardiac arrest	76 (98.7%)
Recorded clinical toxicity	4 (5.2%)
No recorded clinical toxicity	73 (94.8%)
ROSC among patients with arrest	1/1
Survived / discharged	77 (100%)

CI, confidence interval; ROSC, return of spontaneous circulation. Toxicity reflects clinical criteria, not a serum magnesium concentration.

The only arrest occurred in the 35 years and older eclampsia group needing intravenous (IV) treatment and maintenance treatment. Descriptive statistics for the prespecified groups are shown in Table 3. As the number of outcomes was small, a statistical test was not performed to evaluate the presence of an effect. A p-value was not reported.

Table 3. Descriptive distribution of cardiac arrest by prespecified strata

Stratum	Patients, n	Arrests, n
Age <35 years	40	0
Age ≥35 years	37	1
Obstetric indication	70	1
Non-obstetric indication	7	0
Loading dose ≤4 g	38	1

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Stratum	Patients, n	Arrests, n
Loading dose >4 g	39	0
Intravenous only	51	1
Intravenous plus intramuscular	26	0
Maintenance treatment recorded	44	1
No maintenance treatment recorded	33	0

DISCUSSION

During the 24 hours following $MgSO_4$ administration, one of 77 patients experienced a cardiac arrest. As the total study size was small, the true prevalence of this event is unknown but is likely less than 7.02%. The frequency of clinical toxicity of $MgSO_4$ was 5.2%, which is similar to the 4.7% frequency used to calculate the sample size in the synopsis. Direct comparison of the two is not appropriate due to differences in the populations and settings of the studies.[10]

The treatment of eclampsia forms a significant part of this $MgSO_4$ cohort. The evidence suggests there is uncertainty about the optimal duration and dosage of $MgSO_4$ to prevent seizures.[2,6,12,13,14,15] A loading dose of $MgSO_4$ to treat a convulsive event is standard practice in emergencies and has been investigated in both the Karachi and Lahore studies. The focus of both studies was not to assess the frequency of cardiac arrest in the studies.[8,9]

In the absence of other information, it is reasonable to conclude that cardiac arrest was caused by magnesium intoxication. Some of the signs, including bradycardia and hypotension, can be seen as part of the toxic cardiac effect of $MgSO_4$. Other case reports have documented TWA of $MgSO_4$ resulting in cardiac arrest and similar conduction abnormalities.[4,5,16,17] It is also important to consider that eclampsia itself can cause cardiorespiratory collapse. No data was available to support that the arrest was caused by $MgSO_4$.

The data reveals that renal function and respiratory status, as well as other vital signs, should be monitored while treating with $MgSO_4$. Records in the coded file did not capture the serum concentration levels of the study participants, and five records did not mention baseline function of the study participants' renal systems. The length of treatment with $MgSO_4$, as well as the period of time for which the function of study participants was to be non-government, continues to be a subject of research.[18,19] The focus of the research, however, has been to establish a method of predicting the duration of the postpartum period, as well as to determine the window of time within the postpartum period in which $MgSO_4$ may be discontinued.[11,20]

This study has a number of limitations. For example, the small number of participants and the use of non-probability sampling increase the risk of the results being biased. It is likely that the participants in the study would have experienced serious adverse events, including cardiac arrest. As the study focused on cardiac arrest, it is possible that not all participants would have had clinical signs of magnesium toxicity. Clinical magnesium toxicity was documented. Other patients may have been undergoing treatment for conditions that require co-treatment with magnesium, including patients who had severe cardiac arrest and respiratory failure.

CONCLUSION

One patient out of 77 experienced cardiac arrest within 24 hours of receiving MgSO4 in our emergency department. Cardiac arrest was closely related to the administration of MgSO4 and the patients were all reported to have survived to hospital discharge. The information presented does not increase the precision of the estimate and does not prove cause and effect.

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