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Magnesium sulfate for eclampsia prevention: Quality of care evaluation in a tertiary centre in Québec, Canada

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Abstract

Background: The current Canadian guidelines endorse the use of $MgSO_4$ for treatment of eclampsia and for prophylaxis in severe preeclampsia. Our study aimed to audit our institution's compliance regarding these guidelines.

Methods: We conducted a retrospective study to evaluate $MgSO_4$ use in: all our cases of eclampsia since 2002, 50 cases of severe preeclampsia, and 50 cases of non-severe preeclampsia.

Results: Sixty-five cases of preeclampsia were analyzed after initial chart review. A high rate of preeclampsia severity misdiagnosis was observed (35%, 23/65). Only 69% (25/36) of the patients correctly diagnosed with severe preeclampsia received $MgSO_4$; after diagnosis correction, 42% (25/59) of the patients with severe preeclampsia received the medication. Of our eight cases of eclampsia, none of the patients received $MgSO_4$ before the seizure (although three had clear indications).

Conclusion: Given the importance of prophylactic $MgSO_4$ use in preventing eclampsia, we have implemented informative measures aimed at rapidly achieving complete compliance with the national guidelines.

Keywords

Severe preeclampsia, non-severe preeclampsia, eclampsia, magnesium sulfate

Background

With preeclampsia complicating 2–8% of pregnancies and eclampsia occurring in 4–6 per 10,000 live births,[1] these hypertensive disorders of pregnancy remain among the principal causes of maternal and perinatal morbidity and mortality. In an attempt to provide a clear approach to the diagnosis, evaluation, and management of the different hypertensive disorders of pregnancy, the Society of Obstetricians and Gynaecologists of Canada (SOGC) endorsed a series of clinical practice guidelines (hereafter ''the guidelines'') based on the best available scientific evidence.[2]

The guidelines describe preeclampsia as a hypertensive disorder of pregnancy characterized by the presence of proteinuria or the presence of one or more ''adverse conditions'' (full list of adverse conditions in Magee et al. 2008). Severe preeclampsia is further defined as preeclampsia with: onset before 34 weeks' gestation, heavy proteinuria, or the presence of one or more adverse conditions.[2] A small proportion of patients with preeclampsia go on to develop eclampsia (0.5%–3%),[3,4] which has been associated with persistent visual and neurological sequelae that may carry long-term consequences for the mother.[5–8] Forty percent of deaths from eclampsia are thought to be preventable.[9]

The guidelines recommend the use of magnesium sulfate ($MgSO_4$) for prophylaxis in patients with severe preeclampsia (I-A[10,11]) and for the treatment of eclampsia (I-A).[2] In developed countries, $MgSO_4$ administration for non-severe preeclampsia may also be considered (I-B).[2]

Given the demonstrated importance of $MgSO_4$ use in preventing and treating eclampsia[3,12] and a perceived lack of uniformity in our institution's use of $MgSO_4$, we felt it was important to undertake an audit of our practices. The primary objective of this study was to evaluate if the use of $MgSO_4$ for treating severe preeclampsia and eclampsia at the Centre Hospitalier Universitaire de Sherbrooke (CHUS) conforms to the current Canadian guidelines. In the event of imperfect compliance, we aimed to identify the criteria influencing a clinician's decision to administer or withhold $MgSO_4$ for the treatment of severe preeclampsia.

Methods

This is a descriptive, retrospective study based on the information provided in patient charts obtained from the CIRESSS (Centre informatisé de recherche évaluative en services et soins de santé) database, where hospital summary sheets are maintained. The study protocol was approved by our institution's Research Ethics Board.

Sample

The following charts were requested from the CIRESSS database: 50 most recent consecutive cases of non-severe preeclampsia between 1 January 2009 and 22 May 2010; 50 most recent consecutive cases of severe preeclampsia between 1 January 2009 and 22 May 2010. We also requested all cases of eclampsia from 1 January 2002 (publication of the MAGPIE trial[3]) to 31 January 2012 to specifically evaluate the current practices of clinicians who are faced with this rare occurrence at our institution. This sample size was used based on the resources available for the extensive chart review needed to attain the primary objective. We excluded ''preeclampsia superimposed on pre-existing hypertension'' to reduce the impact of confounding factors in the management of these patients whose diagnosis and evaluation of severity are especially difficult. Patient characteristics, presence of adverse conditions (10 of the 18 defined by the guidelines[2]), and management modalities were recorded using chart review. Preeclampsia severity diagnoses were verified carefully by the research team to identify

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cases of severe preeclampsia initially misdiagnosed as non-severe, e.g. cases in which the presence of one or more adverse conditions was recorded in the chart, yet the patient was diagnosed with non-severe preeclampsia. Current practice was then compared to the guidelines for $MgSO_4$ use in eclampsia and preeclampsia management.

Statistical analysis

Chi-square and Fisher's exact tests were used to identify the factors influencing a clinician's decision to administer or withhold prophylactic $MgSO_4$ by comparing patients with severe preeclampsia, initially accurately diagnosed, that did and did not receive $MgSO_4$. To determine what factors most influenced clinicians' preeclampsia severity diagnoses, we used Chi-square and Fisher's exact tests to compare the characteristics of patients with severe preeclampsia with correct and incorrect initial diagnoses. A binary logistic regression analysis with backward stepwise model selection was then used to further identify factors associated with preeclampsia severity diagnoses.

Results

Preeclampsia

Of the 100 cases available for review, 34 were rejected for presenting hypertensive disorders without preeclampsia, and one file was rejected due to a classification error. Figure 1 depicts the classification of the remaining 65 files according to preeclampsia severity and highlights the high rate of preeclampsia severity misdiagnosis; 23 severe cases were incorrectly diagnosed as non-severe (misdiagnosis rate of 35%). After correcting these diagnoses, 59/65 (91%) of the preeclampsia cases met the guidelines' criteria for diagnosis as "severe." Table 1 provides additional information about the patients including symptoms and management.

Among the 59 patients meeting the criteria for severe preeclampsia and in whom prophylactic $MgSO_4$ would have been indicated, 25 (42%) received $MgSO_4$. All the patients who received the medication were among the 36 cases initially correctly diagnosed as "severe" (25/36 (69%); Figure 1). No other patients received $MgSO_4$ prophylactically and none had contraindications related to $MgSO_4$.

Table 2 compares the characteristics of women diagnosed with severe preeclampsia, exclusively those initially correctly diagnosed as such ($n = 36$), who received $MgSO_4$ to those that did not. None of the comparisons yielded statistically significant differences.

Univariate comparison of the characteristics of patients correctly and incorrectly diagnosed with severe preeclampsia revealed that severe hypertension (and use of antihypertensive medication), elevated creatinine levels, and hyperreflexia were significantly associated with an accurate diagnosis (Table 3). Furthermore, as the number of concurrent signs included in the guidelines as "adverse conditions" increased, the proportion of patients correctly diagnosed as severely preeclamptic also increased ($p = 0.011$). A similar pattern was tested for in concurrent symptoms identified as adverse conditions, but did not reach statistical significance ($p = 0.676$).

Among the patient characteristics presented in Table 3, the final logistic regression model retained severe hypertension and

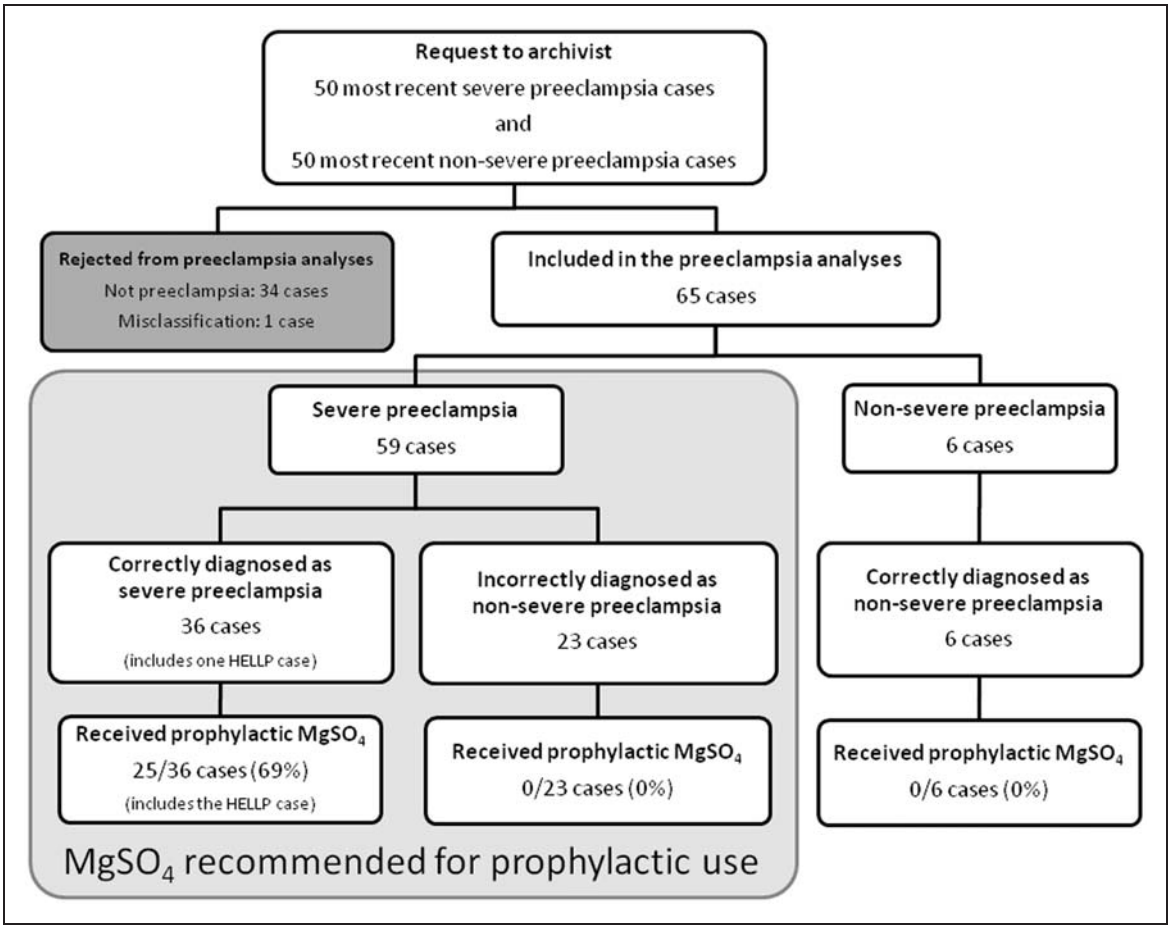

Figure 1. Patient selection and classification related to the audit of preeclampsia management.

Table 1. Patient characteristics for the cases of preeclampsia (non-severe and severe; after diagnosis correction) and eclampsia used in the audit.

Patient characteristics	Non-severe preeclampsia (%)	Severe preeclampsia (%)	Eclampsia (%)
Number of cases (*n*)	6(100)	59(100)	8(100)
Postpartum eclampsia	–	–	5(63)
Primiparous	2(33)	53(90)	2(25)
Age group (years)			
16–24	1(17)	14(24)	2(25)
25–34	4(67)	37(63)	6(75)
35–45	1(17)	8(14)	–
Adverse conditions[a]			
Persistent new/unusual headaches	–	29(49)	6(75)
Visual disturbances	–	16(27)	3(38)
Persistent abdominal/right upper quadrant pain	–	15(25)	3(38)
Severe hypertension	–	40(68)	7(88)
Elevated serum creatinine	–	17(29)	5(63)
Elevated liver enzymes	–	31(53)	3(38)
Thrombocytopenia	–	12(20)	3(38)
Intrauterine growth restriction	–	5(9)	–
Absent/reversed end-diastolic flow in umbilical artery	–	4(7)	–
Other conditions			
Proteinuria	5(83)	48(81)	5(63)
Hyperreflexia	–	30(51)	6(75)
Hyponatremia	–	2(3)	4(50)
Evaluation			
Cerebral imaging (CT scan)	–	1(2)	6(75)
Magnesium blood monitoring	–	6(10)	6(75)
Management			
Prophylactic $MgSO_4$ administration	–	25(42)	–
Posteclampsia $MgSO_4$ administration	NA	NA	7(88)
Use of calcium gluconate	–	–	–
Antihypertensive medication	–	32(54)	7(88)
Concurrent SOGC symptoms[b]			
0	6(100)	18(31)	1(13)
1	–	25(42)	2(25)
2	–	13(22)	5(63)
3	–	3(5)	–
Concurrent SOGC signs[c]			
0	6(100)	7(12)	–
1	–	17(29)	1(13)
2	–	19(32)	2(25)
3	–	10(17)	1(13)
4	–	6(10)	2(25)
5	–	–	2(25)

[a]As defined by the Clinical Practice Guidelines endorsed by the Society of Obstetricians and Gynaecologists of Canada.[2]
[b]Includes: persistent new/unusual headaches, visual disturbances, and persistent abdominal/right upper quadrant pain.
[c]Includes: eclampsia, severe hypertension, elevated creatinine, elevated liver enzymes, thrombocytopenia, intrauterine growth restriction, and absent/reversed end-diastolic flow in umbilical artery.
Data are presented as: number of patients (%).
NA: not applicable; SOGC: Society of Obstetricians and Gynaecologists of Canada.

Table 2. Identification of patient characteristics involved in the decision to administer $MgSO_4$ prophylactically in patients correctly diagnosed with severe preeclampsia.

Patient characteristics	Received prophylactic $MgSO_4$ (%)	Did not receive prophylactic $MgSO_4$ (%)	*p* value
Subset of patients: patients correctly diagnosed with severe preeclampsia ($n = 36$)			
Number of cases	25(100)	11(100)	–
Primiparous	24(96)	9(82)	0.216
Age group (years)			
16–24	3(12)	4(36)	0.190
25–34	18(72)	7(64)	
35–45	4(16)	–	
Adverse conditions[a]			
Persistent new/unusual headaches	14(56)	5(45)	0.559
Visual disturbances	9(36)	2(18)	0.439
Persistent abdominal/right upper quadrant pain	7(28)	3(27)	1.000
Severe hypertension	20(80)	10(91)	0.643
Elevated serum creatinine	9(36)	5(45)	0.716
Elevated liver enzymes	15(60)	6(55)	1.000
Thrombocytopenia	8(32)	2(18)	0.688
Intrauterine growth restriction	3(12)	–	0.538
Absent/reversed end-diastolic flow in umbilical artery	1(4)	–	1.000
Other conditions			
Proteinuria	19(76)	10(91)	0.400
Hyperreflexia	17(68)	6(55)	0.475
Hyponatremia	2(8)	–	1.000
Management			
Antihypertensive medication	19(76)	7(64)	0.454
Concurrent SOGC symptoms[b]			
0	5(20)	5(45)	0.461
1	12(48)	3(27)	
2	6(24)	2(18)	
3	2(8)	1(9)	
Concurrent SOGC signs[c]			
0	2(8)	–	0.210
1	5(20)	4(36)	
2	8(32)	2(18)	
3	5(20)	5(45)	
4	5(20)	–	

[a]As defined by the Clinical Practice Guidelines endorsed by the Society of Obstetricians and Gynaecologists of Canada.[2]
[b]Includes: persistent new/unusual headaches, visual disturbances, and persistent abdominal/right upper quadrant pain.
[c]Includes: eclampsia, severe hypertension, elevated creatinine, elevated liver enzymes, thrombocytopenia, intrauterine growth restriction, and absent/reversed end-diastolic flow in umbilical artery.
Data are presented as: number of patients (%). p values correspond to Chi-square or Fisher's exact tests. Bold characters highlight significant results.
SOGC: Society of Obstetricians and Gynaecologists of Canada.

thrombocytopenia as factors contributing significantly to an accurate diagnosis of ''severe preeclampsia''; elevated serum creatinine was retained as well, though did not quite attain statistical significance (see Table 4 for significance, odds ratios, and 95% confidence intervals).

Eclampsia

Eight cases of eclampsia were attended to at the CHUS in the selected timeframe (Table 1). None of the patients were being treated prophylactically with $MgSO_4$ at the time of the seizure. Seven patients were treated with $MgSO_4$ after seizure. The remaining patient, whose diagnosis was uncertain at the time, did not receive anticonvulsants, but was subsequently diagnosed with eclampsia by exclusion of other diagnoses. Three of the eight eclampsia cases presented to the hospital during or just after a seizure. Three other cases presented episodes of severe hypertension or other adverse conditions indicative of severe preeclampsia before the seizure.

Discussion

Our report reveals an underutilization of $MgSO_4$ prophylactically in women with severe preeclampsia despite what is clearly recommended in the guidelines. A high proportion of erroneous diagnoses is likely to

Table 3. Identification of patient characteristics involved in the diagnosis of preeclampsia severity.

Patient characteristics	Severe preeclampsia correctly diagnosed (%)	Severe preeclampsia incorrectly diagnosed (%)	*p* value
Subset of patients: all severe preeclampsia cases ($n = 59$)			
Number of cases	36(100)	23(100)	–
Primiparous	33(92)	20(87)	0.669
Age group (years)			
16–24	7(19)	7(30)	0.425
25–34	25(69)	12(52)	
35–45	4(11)	4(17)	
Adverse conditions[a]			
Persistent new/unusual headaches	19(53)	10(43)	0.486
Visual disturbances	11(31)	5(22)	0.458
Persistent abdominal/right upper quadrant pain	10(28)	5(22)	0.603
Severe hypertension	30(83)	10(43)	**0.001**
Elevated serum creatinine	14(39)	3(13)	**0.033**
Elevated liver enzymes	21(58)	10(43)	0.265
Thrombocytopenia	10(28)	2(9)	0.103
Intrauterine growth restriction	3(8)	2(9)	1.000
Absent/reversed end-diastolic flow in umbilical artery	1(3)	3(13)	0.289
Other conditions			
Proteinuria	29(81)	19(83)	1.000
Hyperreflexia	23(64)	7(30)	**0.012**
Hyponatremia	2(6)	–	0.250
Management			
Antihypertensive medication	26(72)	6(26)	**0.001**
Concurrent SOGC symptoms[b]			
0	10(28)	8(35)	0.676
1	15(42)	10(43)	
2	8(22)	5(22)	
3	3(8)	–	
Concurrent SOGC signs[c]			
0	2(6)	5(22)	**0.011**
1	9(25)	8(35)	
2	10(28)	9(39)	
3	10(28)	–	
4	5(14)	1(4)	

[a]As defined by the Clinical Practice Guidelines endorsed by the Society of Obstetricians and Gynaecologists of Canada.[2]
[b]Includes: persistent new/unusual headaches, visual disturbances, and persistent abdominal/right upper quadrant pain.
[c]Includes: eclampsia, severe hypertension, elevated creatinine, elevated liver enzymes, thrombocytopenia, intrauterine growth restriction, and absent/reversed end-diastolic flow in umbilical artery.
Data are presented as: number of patients (%). p values correspond to Chi-square or Fisher's exact tests. Bold characters highlight significant results.
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Table 4. Variables associated with an accurate diagnosis of preeclampsia severity as identified by binary logistic regression analysis using backward stepwise model selection.

Variables	*p* value	Odds ratio	95% confidence interval
Severe hypertension	0.004	7.411	1.885–29.136
Elevated serum creatinine	0.064	4.391	0.916–21.060
Thrombocytopenia	0.040	7.446	1.095–50.629

be partly responsible, but even among women correctly diagnosed with severe preeclampsia, only 69% received $MgSO_4$. While the lack of significant associations between specific patient characteristics and $MgSO_4$ administration may result from our limited sample size, it may also reflect the absence of a clearly defined protocol for $MgSO_4$ use in our institution – one of the motivating factors for this audit. Among women having received $MgSO_4$, no calcium gluconate was required, suggesting that $MgSO_4$ was used appropriately with no severe negative side-effects.

In addition, our audit revealed considerable inconsistency in the accurate diagnosis of severe preeclampsia. This seems to be the result

of clinicians not having considered all the adverse conditions presented in the guidelines as warranting diagnosis as "severe." The logistic regression analysis identified only severe hypertension and two abnormal laboratory tests as signs consistently relied on by clinicians to accurately diagnose severe preeclampsia. If the guidelines had been fully implemented, all of the adverse conditions considered in the analysis would have shown an association with an accurate diagnosis.

As per guidelines recommendations, all patients with eclampsia received $MgSO_4$ as treatment when a clear diagnosis was established. However, we estimate that of the five patients that were in the hospital prior to starting convulsions, eclampsia could have been prevented in three of these patients by administering prophylactic $MgSO_4$, given that adverse conditions were present before the seizure. In a Canadian study, the incidence of eclampsia was shown to have declined by 50% between 2003 and 2010.[13] While improved antenatal care, premature delivery in cases of preeclampsia, and improved maternal and neonatal intensive care are believed to have contributed to this decline, the authors presume that the main factor responsible was the increased prophylactic use of $MgSO_4$ in women with severe preeclampsia.[13]

Our study was limited statistically as a result of 35% of cases being rejected outright due to the extraction of patient files classified under code O13 of the 2010 International Classification of Diseases (uncomplicated gestational hypertension). In combination with the high misdiagnosis rate, it was difficult to pursue additional statistical avenues; however, it is clear that our use of $MgSO_4$ in patients with severe preeclampsia was suboptimal.

Conclusion

In order to improve our personnel's ability to accurately diagnose preeclampsia severity and increase their use of $MgSO_4$ when appropriate, a $MgSO_4$ protocol and informative poster were developed emphasizing the guidelines' criteria for severity, as well as providing recommendations for using $MgSO_4$ to treat severe preeclampsia in the maternity ward. Also, a similar analysis will be repeated after an adjustment period to see whether the measures undertaken have a positive impact on diagnostic accuracy and $MgSO_4$ prescription when indicated.

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Declaration of conflicting interests

PG, AQ, YAB, and NS have no conflicts of interests to disclose. Sauvé is member of the FRQS-funded Étienne-Le Bel Clinical Research Center.

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Ethical approval

The Research Ethics Board of the Centre Hospitalier Universitaire de Sherbrooke approved this study.

Guarantor

NS.

Contributorship

PG, AQ, and NS researched the literature, conceived the study and obtained ethical approval. PG, AQ, YAB, and NS were involved in protocol development. PG and AQ reviewed all charts and wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved its final version.

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