

## Management of Pre-eclampsia and Eclampsia: A Simulation

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### Abstract

**Introduction:** Pre-eclampsia is a hypertensive disorder in pregnancy. Maternal sequelae that may occur include impaired liver function, disseminated intravascular coagulation, seizures (eclampsia), stroke, and death. Thus, providers should know how to recognize (diagnose) and treat pre-eclampsia and eclampsia. **Methods:** A simulator with noninvasive blood pressure monitoring was used. Transducers for fetal heart rate and contraction monitoring were placed on the simulator, which represented the patient. After obtaining a history and performing a physical examination, resident physician (postgraduate years 1-4) and nurse learners had to diagnose pre-eclampsia and treat this condition. They also had to treat severe-range blood pressures and manage eclampsia. Learner performance was assessed with a checklist. Debriefing followed the simulation. **Results:** Thirty resident learners participated in the study. Nurses did not participate. All resident learners indicated familiarity with the diagnosis and management of pre-eclampsia and emergent hypertension and managed these conditions correctly. All resident learners reported not being confident in managing eclampsia. None of the learners were able to stop the eclamptic seizure. All resident learners were more confident in managing eclampsia after the scenario compared with before (mean confidence level  $3.6 \pm 0.5$  vs.  $1.1 \pm 0.4$ ,  $p < .001$ ). **Discussion:** Resident learners were familiar with the management of pre-eclampsia and emergent hypertension but not with eclampsia. We recommend that eclampsia simulations occur in a laboratory and in situ on the labor and delivery floor with interprofessional team members including obstetricians, nurses, anesthesiologists, emergency and family medicine physicians, nurse practitioners, and physician assistants.

### Keywords

Pre-eclampsia, Eclampsia, Emergent Hypertension, Pregnancy, Simulation

### Educational Objectives

By the end of this simulation, participants will be able to:

1. Diagnose pre-eclampsia.
2. Manage pre-eclampsia correctly.
3. Manage emergent hypertension effectively and in a timely fashion.
4. Manage eclampsia correctly.
5. Demonstrate teamwork and appropriate communication.

### Introduction

Pre-eclampsia is a hypertensive disorder in pregnancy. Hypertensive disorders affect 10% to 15% of pregnancies and contribute significantly to pregnancy-associated morbidity and

mortality. The incidence of pre-eclampsia in the United States has increased by 25% over the past two decades.<sup>1</sup>

A diagnosis of pre-eclampsia is made based on the (1) presence of systolic blood pressure greater than 140 mm Hg or diastolic blood pressure greater than 90 mm Hg on two occasions at least 4 hours apart and (2) presence of proteinuria or severe features.

Proteinuria is defined as a urine protein/creatinine ratio of greater than or equal to 0.3. Severe features include (1) systolic blood pressure greater than 160 mm Hg or diastolic blood pressure greater than 110 mm Hg on two occasions at least 4 hours apart; (2) thrombocytopenia (platelet count  $< 100,000$ ); (3) impaired liver function (elevated blood levels of liver transaminases to twice normal concentration); (4) severe persistent right upper quadrant or epigastric pain unresponsive to medication and not accounted for by alternative diagnoses, or both; (5) new development of renal insufficiency (elevated serum creatinine  $> 1.1$  mm/dL, or doubling of serum creatinine in the absence of other renal disease); (6) pulmonary edema; and (7) new-onset cerebral or visual disturbances.<sup>1,2</sup>

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Maternal sequelae of pre-eclampsia that may occur include disseminated intravascular coagulation, seizures (eclampsia), stroke, and death. Fetal sequelae that may occur include intrauterine growth restriction, heart rate abnormalities, and demise. Thus, it is paramount that those caring for pregnant patients know how to diagnose this disorder promptly.<sup>1,2</sup>

The cure for pre-eclampsia is delivery. For those with pre-eclampsia without severe features, delivery is recommended as early as 37 weeks' gestation. For those with pre-eclampsia with severe features, delivery is recommended as early as 34 weeks' gestation. Delivery may be indicated prior to 34 weeks' gestation in the setting of blood pressures refractory to medication administration, worsening laboratory abnormalities, or fetal compromise.<sup>1,2</sup>

Additionally, it is imperative that providers know how to treat elevated blood pressures, which are the hallmark of this disorder. The American College of Obstetricians and Gynecologists (ACOG) supports administration of labetalol, hydralazine, or nifedipine in the setting of emergent hypertension in pregnancy. Furthermore, those caring for pregnant patients must know how to prevent and treat eclampsia, a condition in which convulsions may occur in the presence of this disorder. The incidence of eclampsia in the United States has been reported to be 1 in 3,250 births.<sup>3</sup> Administration of magnesium sulfate for seizure prophylaxis (in the absence of contraindications) has been the standard of care since the publication of the Magpie Trial in 2007.<sup>4</sup> A Canadian study found that the incidence of eclampsia declined dramatically from 12.4 per 10,000 deliveries in 2003 to 5.9 in 2009, likely due to increased use of magnesium sulfate for seizure prophylaxis.<sup>5</sup> Contraindications to magnesium sulfate use are myasthenia gravis, pulmonary edema, and renal failure. Alternatives to magnesium sulfate are phenytoin and levetiracetam.

Although medical knowledge is important in the management of pre-eclampsia and eclampsia, the ability to communicate to the patient and fellow staff members is also essential. The management of these conditions uses a team-based approach that involves obstetricians, anesthesiologists, labor and delivery nurses, certified nurse midwives and nurse anesthetists. Simulation is an ideal approach in solidifying the management of pre-eclampsia and eclampsia. Moreover, in an article published by Fisher et al.<sup>6</sup> in which eclampsia management was compared between residents assigned to lecture and those assigned to simulation-based education, those in the latter group performed better when faced with a simulated eclamptic seizure.

The literature on simulation of pre-eclampsia and eclampsia is limited.<sup>6,7</sup> In a search in *MedEdPORTAL*, one article specifically focused on the management of pre-eclampsia and eclampsia that was published in 2014 was found.<sup>7</sup> Since publication of this article, the management of eclampsia has not changed, but the criteria for diagnosis of pre-eclampsia and the management of emergent hypertension have changed.

Therefore, in this report, we present a simulation focused on providing obstetric residents and nurses with the skills to manage pre-eclampsia, eclampsia, and emergent hypertension in concordance with current guidelines.

## Methods

### Development

This simulation was performed in the simulation laboratory at Hofstra University–Northwell Health System–Staten Island University Hospital's Patient Safety Institute as part of a mandatory comprehensive simulation curriculum focused on obstetrics. In this curriculum, simulations are performed in a laboratory and on the labor and delivery unit.

Learners were given guidelines on management of pre-eclampsia and eclampsia prior to performance of the simulation. These included the following: the ACOG Task Force on Hypertension in Pregnancy Executive Summary,<sup>1</sup> the ACOG Committee Opinion on Emergent Therapy for Acute-Onset, Severe Hypertension During Pregnancy and the Postpartum Period,<sup>2</sup> and a modified version of ACOG's District II Eclampsia Checklist (Appendix A). These articles were emailed to learners 1 week prior to the simulation.

The learners were obstetrics residents and nurses. Only the resident learners completed a questionnaire before the simulation and after debriefing. We were not able to obtain approval to give questionnaires to nurses, because they did not have protected educational time and there was a possibility of them having to leave the simulation exercise early to attend to patients.

The questionnaire inquired how confident learners were in diagnosing and managing pre-eclampsia, managing emergent hypertension, and managing eclampsia. The confidence level was measured on a 5-point Likert scale (1 = *not confident at all*, 3 = *neutral*, and 5 = *very confident*; Appendix B). Confidence levels before and after the simulation were compared using Student's *t* test. A *p* value less than .05 was considered significant.

## Equipment

We recommend the following equipment for successful implementation of this simulation case:

- Simulator that can appear gravid, can have breath sounds programmed, and can seize.
- Plastic fetus that is attached to the simulator's motor.
- Noninvasive blood pressure cuff and pulse oximeter that is attached to the mannequin.
- Adult non-rebreather oxygen mask.
- Transducers for fetal heart rate and contraction monitoring to be placed on the mannequin's abdomen.
- Monitor with capability to display the patient's heart rate, pulse oximetry, respiratory rate, noninvasive blood pressure, fetal heart rate, and uterine contractions.
- Ultrasound machine.
- Supplies for intravenous line placement.
- Suction.
- Syringes and needles of various sizes.
- Vials marked labetalol and hydralazine; pill container marked nifedipine.
- Bag labeled magnesium sulfate solution.
- Adult code cart.

## Personnel

In each simulation, the learners were obstetrics residents (one senior, one junior) and one nurse. The facilitator was an attending obstetrician who provided information regarding the patient's chief complaint, history, and physical examination findings. The facilitator was the voice of the patient and provided additional pertinent information on learner request. A simulation technician was responsible for changing vital signs, the fetal heart rate pattern, and the contraction pattern during the course of the simulation.

## Implementation

This simulation was performed in a room in the simulation laboratory with the equipment mentioned earlier. The facilitator took the learners to the simulation room and told them that the setting was a labor and delivery room and that they were going to evaluate a patient who was transferred from the emergency room. The facilitator then went to a different room with a one-way mirror so as to be able to observe the learners. The facilitator went into this room with the simulation technician. The facilitator and simulation technician were able to hear the learners. The facilitator used an intercom to communicate relevant information. Additionally, after medication was administered, the facilitator was responsible for telling the learners that 10, 15, or 20 minutes had elapsed in the simulation so as to

prompt learners to move on to the next step. We found that the simulation took approximately 10 minutes to complete. The case is fully presented in Appendix C. The critical actions checklist is presented in Appendix D.

## Assessment

The facilitator reviewed completion of the critical actions checklist. Learners received formative feedback following the case during the debriefing, which lasted 15 minutes.

## Debriefing

The facilitator first asked one of learners to summarize the simulation. The facilitator then asked learners what they felt they did successfully and what they would do differently. These inquiries were designed for the learner to self-reflect. The facilitator then reviewed the learning objectives and critical actions and answered all learners' questions.

Examples of questions the facilitator asked that pertained to the scenario overall were as follows:

1. Would anyone like to describe the scenario?
2. What went well?
3. What could have been done differently?
4. How did you work as a team?

Examples of questions the facilitator asked that were focused on the critical actions checklist were as follows:

1. How is a diagnosis of pre-eclampsia made?
2. How is emergent hypertension in pregnancy managed?
3. How can eclampsia be prevented?
4. How is eclampsia managed?

The facilitator then asked all learners how educational they felt the simulation was. The ACOG District II Eclampsia Checklist that was sent prior to the simulation was reviewed. After the debriefing, all learners completed the same questionnaire that they completed prior to the simulation. Debriefing materials are presented in Appendix E.

## Results

Thirty resident learners participated in this simulation between April 2014 and May 2017. Three of the resident learners were male, and 27 were female. With respect to postgraduate year level, 8 were first-year residents, 7 were second-year residents, 7 were third-year residents, and 8 were fourth-year residents.

All learners reported that they had reviewed the articles that were sent to them prior to the simulation. As expected, during

the simulation, all learners correctly made a diagnosis of pre-eclampsia with severe features, appropriately managed this condition, and treated severe-range blood pressures correctly. All learners reported that the articles they read before the simulation were helpful in solidifying their ability to diagnose and manage pre-eclampsia.

In regard to diagnosing and managing pre-eclampsia, mean resident learner confidence levels before the simulation and after the simulation were  $4.8 \pm 0.4$  and  $4.9 \pm 0.3$ , respectively. In regard to managing emergent hypertension, mean resident learner confidence levels before the simulation and after the simulation were  $4.7 \pm 0.4$  and  $4.9 \pm 0.3$ , respectively. The confidence level range for each of these two parameters was 4 to 5.

All learners communicated to the patient appropriately and among each other. They all informed the patient of the diagnosis of pre-eclampsia, the need to treat blood pressures emergently, and the necessity of starting magnesium sulfate for seizure prophylaxis. All learners checked back with each other regarding medication administration. There were no elements of communication noted during the simulations that were detrimental to the care of the patient.

The articles sent to learners prior to the simulation also included information on the management of eclampsia. However, in regard to the management of eclampsia, the mean resident learner confidence level before the simulation was  $1.1 \pm 0.4$ . The confidence level range was 1 to 2. During the eclampsia simulation, all learners addressed the basics of cardiopulmonary resuscitation (airway, breathing, circulation) and identified the need to continue the magnesium sulfate infusion and monitor the fetus. All learners called for help and requested anesthesia staff and pediatric staff. However, none of the learners were able to stop the eclamptic seizure. After the simulation, the mean resident learner confidence level, in relation to management of eclampsia, was  $3.6 \pm 0.5$ . This difference was significantly different from before the simulation ( $p < .001$ ). The confidence level range was 3 to 5. Confidence levels are outlined in the Table.

During debriefing, all learners reported that the simulation was immensely valuable in the management of eclampsia, as none had exposure to this complication prior to the simulation.

## Discussion

The construction of the pre-eclampsia simulation was created to not only address management of eclampsia, a sequela

**Table.** Confidence Levels Before and After Simulation (N = 30)

Confidence Level	Presimulation Confidence Level		Postsimulation Confidence Level		p
	M	SD	M	SD	
Rate your confidence in:					
Diagnosing and managing pre-eclampsia	4.8	0.4	4.9	0.3	.13
Managing emergent hypertension	4.7	0.4	4.9	0.3	.10
Managing eclampsia	1.1	0.4	3.6	0.5	<.001

associated with this condition, but to also refine the management of pre-eclampsia and emergent hypertension. This simulation was performed 15 times between April 2014 and May 2017 in the simulation laboratory. It took 3 years to perform this simulation 15 times, as resident learners have to rotate through simulations focused on other obstetric emergencies.

In this simulation, all learners indicated that they were familiar with the management of pre-eclampsia and emergent hypertension and subsequently managed these conditions correctly. However, we found that none of the learners were able to stop the eclamptic seizure. The inability to manage eclampsia correctly highlights the need for further training in the treatment of this complication. In fact, all learners indicated that the simulation was immensely valuable, as they had no exposure to eclampsia. We surmise that learners were able to manage pre-eclampsia and emergent hypertension appropriately because of frequent instances in real life in which they have had to manage these conditions.

Pre-eclampsia occurs in 3% to 5% of pregnant women.<sup>8</sup> We infer that learners were not able to manage eclampsia appropriately due to the low incidence of this obstetric emergency and due to their ability to recognize pre-eclampsia and initiate magnesium sulfate for seizure prophylaxis promptly.

One limitation of this simulation is its dependence on a high-fidelity simulator. However, this simulation can easily be performed in a low-resource setting. For instance, the facilitator can verbally inform learners that the mannequin is seizing (even though it is not) so as to still be able to address key learning points. Another option for facilitators running this simulation would involve having an actor play the role of the patient. Additionally, in the absence of a laboratory with monitors, facilitators can report maternal vital signs and fetal heart rate and contraction patterns verbally. This simulation does not necessarily need to be performed in a laboratory. It can be performed in any room with sufficient space. Moreover, in the absence of supplies,

facilitators can prompt learners to mimic what they would do if supplies were present. Our pre-eclampsia simulation curriculum can thus be implemented in a variety of institutions.

Another limitation to this study is its primary outcome being a confidence level instead of an objective outcome such as retention of knowledge. A future direction for this study would entail repeating this simulation at multiple time points to assess knowledge retention related to management of pre-eclampsia and eclampsia. This would aid in determining effectiveness of this simulation in accordance with the Kirkpatrick pyramid.

Moreover, performance of this simulation on the labor and delivery unit would be essential because more providers including anesthesia staff would be involved. In situ simulation would assist in determining accessibility and availability of equipment, medications, and rooms. Additionally, this simulation can also be performed with emergency resident physicians and family medicine physicians. Knowledge pertaining to the management of pre-eclampsia and eclampsia would be pertinent to their training, especially if they were to work in communities with limited access to obstetric care.

## Appendices

- A. Pre-eclampsia and Eclampsia Checklist.docx
- B. Learner Questionnaire.docx
- C. Simulation Case Template.docx
- D. Critical Actions Checklist.docx
- E. Debriefing Materials.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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## Ethical Approval

Reported as not applicable.

## References

1. Hypertension in pregnancy: executive summary. *Obstet Gynecol.* 2013;122(5):1122-1131. <http://doi.org/10.1097/01.AOG.0000437382.03963.88>
2. Committee Opinion No. 692 summary: emergent therapy for acute-onset, severe hypertension during pregnancy and the postpartum period. *Obstet Gynecol.* 2017;129(4):769-770. <https://doi.org/10.1097/AOG.0000000000002010>
3. Ventura SJ, Martin JA, Curtin SC, Mathews TJ, Park MM. Births: final data for 1998. *Natl Vital Stat Rep.* 2000;48(3):1-100.
4. Magpie Trial Follow-Up Study Collaborative Group. The Magpie Trial: a randomised trial comparing magnesium sulphate with placebo for pre-eclampsia. Outcome for women at 2 years. *BJOG.* 2007;114(3):300-309. <https://doi.org/10.1111/j.1471-0528.2006.01166.x>
5. Liu S, Joseph KS, Liston RM, et al; for Maternal Health Study Group of the Canadian Perinatal Surveillance System (Public Health Agency of Canada). Incidence, risk factors, and associated complications of eclampsia. *Obstet Gynecol.* 2011;118(5):987-994. <https://doi.org/10.1097/AOG.0b013e31823311c1>
6. Fisher N, Bernstein PS, Satin A, et al. Resident training for eclampsia and magnesium toxicity management: simulation or traditional lecture? *Am J Obstet Gynecol.* 2010;203(4):379.e1-379.e5. <https://doi.org/10.1016/j.ajog.2010.06.010>
7. Bhatia K. Preeclampsia-eclampsia: altered mental status in a third-trimester pregnant patient. *MedEdPORTAL.* 2014;10:9826. [https://doi.org/10.15766/mep\\_2374-8265.9826](https://doi.org/10.15766/mep_2374-8265.9826)
8. Mol BWJ, Roberts CT, Thangaratnam S, Magee LA, De Groot CJM, Hofmeyr GJ. Pre-eclampsia. *Lancet.* 2016;387(10022):999-1011. [https://doi.org/10.1016/S0140-6736\(15\)00070-7](https://doi.org/10.1016/S0140-6736(15)00070-7)

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