

# Is one elevated blood pressure enough? A retrospective analysis of preeclampsia labs sent from the emergency room

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## Abstract

**Background:** In the emergency department, where providing efficient, cost-effective medical care is becoming increasingly important, care of pregnant women with elevated blood pressures is varied. Currently, there are no recommendations designating when laboratory evaluation for preeclampsia should be initiated in the emergency department.

**Objective:** This study sought to compare the incidence of positive laboratory findings in women with isolated initial versus repetitive elevated blood pressure in the emergency department.

**Study Design:** This retrospective cohort included women  $\geq 20$  weeks gestation who presented to a tertiary care emergency department between January and July 2014 with an elevated blood pressure ( $\geq 140$  mmHg systolic or  $\geq 90$  mmHg diastolic) and without significant co-morbidities (chronic hypertension, diabetes mellitus, preexisting renal or liver disease, or thrombocytopenia). The primary outcome was abnormal laboratory values suggesting preeclampsia (platelets, creatinine, liver enzymes, and urine protein/creatinine ratio). The association between one versus more than one elevated blood pressure in the emergency department and abnormal laboratory evaluation for preeclampsia was evaluated using Fisher's exact test. Secondary outcomes included diagnoses of preeclampsia at emergency department discharge or delivery.

**Results:** Of 4,208 charts screened, 271 met inclusion criteria and had complete preeclampsia labs sent per hospital policy. Of these, 122 had an isolated elevated blood pressure and 149 had more than one elevated blood pressure. Women with multiple elevated blood pressures were more likely to have abnormal preeclampsia labs than women with an isolated elevated blood pressure, 34.2% vs 15.6% ( $p < 0.001$ ). Only one woman with an isolated elevated blood pressure had a laboratory abnormality consistent with a severe feature of preeclampsia. Compared to women with an isolated elevated blood pressure, women with multiple elevated blood pressures were more likely to carry the diagnosis of preeclampsia at the time of discharge from the emergency department (14.8% vs 5.3%,  $p = 0.003$ ), and at the time of delivery (17.9% vs 4.2%,  $p < 0.001$ ).

**Conclusion:** Women with multiple elevated blood pressures are at significantly higher risk for lab abnormalities consistent with preeclampsia and at significantly greater risk for developing preeclampsia by delivery than women with only one elevated blood pressure in the emergency department. Delaying serum laboratory evaluation for preeclampsia in patients presenting to the emergency department until two abnormal blood pressures are noted may be reasonable to decrease costs without significantly increasing morbidity.

## Introduction

Worldwide, 10% of pregnancies are complicated by hypertension leading to significant maternal and perinatal morbidity and mortality [1]. In the United States, the prevalence of preeclampsia has been increasing, rising from 3.4% in 1980 to 3.8% in 2010 [2,3]. Due to increasing incidence and potential for poor outcomes including preterm delivery, placental abruption, intrauterine growth restriction and perinatal mortality [4-6], healthcare providers should have a heightened awareness of hypertensive disorders in pregnancy. This heightened awareness, however, should not be at the cost of evidence-based assessment of patients with newly elevated blood pressures.

The diagnosis of gestational hypertension and preeclampsia require the development of hypertension which is defined as a persistent systolic blood pressure (BP) of 140mm Hg or higher, or a diastolic BP of 90mm Hg or higher after 20 weeks gestation in women with previously normal blood pressure [1]. Blood pressures should be elevated on 2 or

more occasions at least 4 hours apart. Recommendations from The American College of Obstetricians and Gynecologists (ACOG) *Task Force on Hypertension in Pregnancy* clearly state that a blood pressure reading should be taken at least 5 minutes after the patient has been in a relaxed sitting position and if the initial BP measurement is elevated it should be repeated after several minutes in attempt to eliminate spuriously elevated BP determinations [1].

Preeclampsia is differentiated from gestational hypertension by the presence of proteinuria or additional serum markers that may be present in more severe forms of the disease even in the absence of proteinuria. Currently there are no guidelines indicating when to perform a

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laboratory evaluation for preeclampsia in the emergency department, a setting in which waiting four hours for an additional elevated blood pressure is typically not feasible. Given a lack of data, in some emergency room settings, such as ours, 'preclampsia labs' (complete blood count, liver transaminases, serum creatinine, urinalysis and urine protein/creatinine ratio) are sent after any elevated blood pressure reading that occurs once a woman has been sitting for more than 5 minutes. Due to this practice, many women are committed to a "preeclampsia workup" following an isolated elevated blood pressure reading often resulting in normal lab results and leading to increased hospital charges, longer length of stay and heightened patient anxiety.

The objective of our study was to compare the rate of abnormal preeclampsia labs in women with isolated (only 1) versus repetitive ( $\geq 2$ ) elevated blood pressures in the emergency department setting. Additionally, we sought to assess the rate of hypertensive disorders of pregnancy at the time of delivery in women with isolated compared to repetitive elevated blood pressures in the emergency department.

## Methods

This retrospective cohort study was performed at Women & Infants Hospital Emergency Department in Providence, Rhode Island, which is responsible for nearly 80% of Rhode Island's deliveries and is the referral hospital for high-risk pregnancies in the state. Women were included in the study if they presented to the Emergency Room between January 2014 and July 2014, at 20 weeks gestation or later and with an initial elevated blood pressure (systolic  $>140$  mm Hg or diastolic  $>90$  mm Hg). Women were excluded if they had chronic hypertension, diabetes mellitus (type I or II), preexisting renal disease, preexisting liver disease, gestational thrombocytopenia, immune thrombocytopenia or current diagnosis of preeclampsia. Additionally, women were excluded if they had no prenatal care or did not go on to deliver at Women & Infants Hospital. This study was approved by the Women & Infants Hospital Institutional Review Board (IRB).

Charts were obtained from Women & Infants Hospital medical records based on the date of presentation and coding data on the gestational age at time of presentation to the emergency department. Three investigators abstracted baseline characteristics, antepartum, intrapartum, neonatal and postpartum information from the medical record onto a data abstraction sheet. No prior pregnancy charts were reviewed for this study and history from prior pregnancies was obtained by review of the current pregnancy chart. Ten percent of study records were reviewed by the primary investigator to ensure accuracy and a concordance rate of 99% was identified.

The primary study outcome was abnormal laboratory values suggesting preeclampsia as identified in the 2013 Task Force Guidelines. These values included protein/creatinine  $\geq 0.3$ , 24 hour urine protein  $\geq 300$ mg, platelets  $<100,000$ /microliter, serum creatinine  $>1.1$ mg/dL, and liver transaminases twice the normal concentration which at our laboratory are an AST or ALT  $\geq 60$ . The secondary outcomes included discharge disposition from emergency department, provider documented diagnoses at the time of discharge from the emergency department, provider documented diagnosis of preeclampsia at the time of delivery, diagnosis of preeclampsia based on the 2013 Task Force Guidelines [1] at the time of delivery, and neonatal birthweight. Diagnosis of preeclampsia based on the Task force guidelines requires a systolic blood pressure of  $\geq 140$  mm Hg or a diastolic blood pressure  $\geq 90$  mm Hg on two occasions at least 4 hours apart after 20 weeks gestation, and the presence of proteinuria defined as a protein/creatinine ratio  $\geq 0.3$ mg/dL or  $\geq 300$ mg of protein on a 24hr urine collection. In the

absence of proteinuria preeclampsia can be diagnosed in the setting of new-onset hypertension and one of the following: thrombocytopenia (platelets count  $<100,000$ /microliter), renal insufficiency (creatinine  $>1.1$ mg/dL or doubling of serum creatinine in the absence of renal disease), impaired liver function (liver transaminases to twice normal concentration), pulmonary edema or cerebral/ visual symptoms.

Data analysis was performed using Stata/SE 13.1 (StataCorp; College Station, TX). Categorical variables were compared by Chi-square or Fisher's exact test. Continuous variables were compared using t-test or nonparametric Wilcoxon rank-sum test for two groups.

Prior to undertaking this study, we collected pilot data from Women & Infants Hospital to estimate the necessary sample size. Based on these preliminary data, we anticipated that 70% of all women who present to the ED at  $>20$  weeks gestation with a single elevated blood pressure would go on to have an additionally elevated blood pressure. We powered the study to detect at least a 50% reduction in the rate of abnormal preeclampsia labs in women with multiple versus a solitary elevated blood pressure. We assumed a power of 80% and a two-sided alpha of 0.05.

## Results

A total of 4056 charts were reviewed meeting the gestational age criteria. Of those, 3587 patients were excluded because their blood pressure on presentation to the emergency department was within normal limits. Of the remaining 469 patients, 107 were excluded due to medical history (chronic hypertension, diabetes, liver disease, kidney disease, thrombocytopenia), 11 were excluded secondary to no prenatal care or delivering at a hospital other than Women & Infants Hospital and 80 were excluded due to lack of preeclampsia labs (Figure 1).

Of the 271 women who met inclusion criteria with at least one elevated blood pressure and completed preeclampsia labs, 122 had an isolated elevated blood pressure and 149 had greater than one elevated blood pressure. Women with one elevated blood pressure were very similar to women with multiple elevated blood pressures except that women with one elevated blood pressure had slightly higher gravidity (Table 1). There were no differences in past obstetric history including past diagnosis of: gestational hypertension, preeclampsia, preeclampsia with severe features, gestational diabetes, intrauterine growth restriction or intrauterine fetal demise. There were no statistically significant differences in the chief complaint on presentation to the emergency department. Additionally, there were no differences in the rate of multiple gestations.

Women with multiple elevated blood pressures were more likely to have abnormal preeclampsia labs at the time of presentation than women with an isolated elevated blood pressure, 34.2% vs 15.6% ( $p < 0.001$ ) (Table 2). The majority of lab abnormalities in this cohort were characterized by elevated protein/creatinine ratios. Of the 70 women with abnormal labs, 68 (97%) had a protein/creatinine ratio  $\geq 0.3$ . Among the women with an isolated blood pressure, only one was noted to have a laboratory abnormality other than increased protein/creatinine.

Women with an isolated elevated blood pressure were less likely to be diagnosed with any type of hypertensive disorder in pregnancy either at the time of discharge from the emergency department or at the time of delivery compared to women with multiple elevated blood pressures (Table 2). Women with an isolated elevated blood pressure were also more likely to be discharged home from the emergency department than women with more than one elevated blood pressure

**Table 1.** Demographics

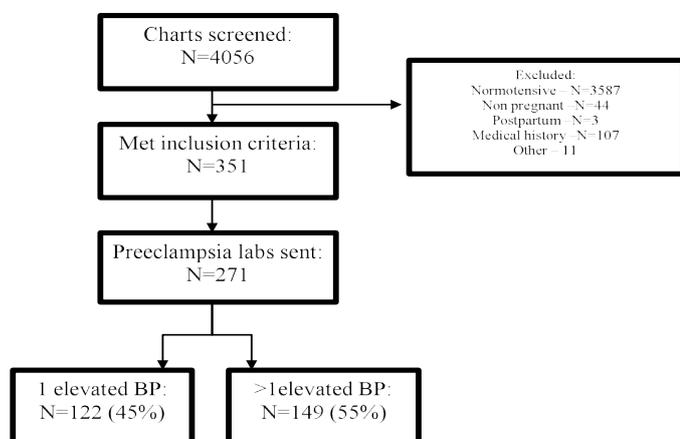
|  | 1 elevated BP (n=122) | ≥ 2 elevated BPs (n=149) | p-value           |
|--|-----------------------|--------------------------|-------------------|
| Age (continuous), mean (SD)                          | 28.3 (5.8)            | 27.7 (6.4)               | 0.36 <sup>1</sup> |
| Race, n (%)  |                       |                          |                   |
| Black  | 12 (9.8)              | 9 (6.0)                  | 0.17 <sup>2</sup> |
| White  | 79 (64.8)             | 102 (68.5)               |                   |
| Other  | 27 (22.1)             | 25 (16.8)                |                   |
| Multiracial  | 2 (1.6)               | 10 (6.7)                 |                   |
| Unknown  | 2 (1.6)               | 3 (2.0)                  |                   |
| Ethnicity, n(%)                                      |                       |                          |                   |
| Hispanic   | 25 (30.5)             | 34 (22.8)                | 0.56 <sup>2</sup> |
| Not Hispanic   | 84 (68.9)             | 102 (68.5)               |                   |
| Other  | 11 (9.0)              | 7 (4.7)                  |                   |
| Multi-ethnic   | 1 (0.82)              | 3 (2.0)                  |                   |
| Unknown  | 1 (0.82)              | 3 (2.0)                  |                   |
| BMI at initial visit (kg/m <sup>2</sup> ), mean (SD) | 29.9 (7.8)            | 29.3 (6.9)               | 0.51 <sup>1</sup> |
| Trimester at 1 <sup>st</sup> prenatal visit, n (%)   |                       |                          |                   |
| First  | 83 (68.6)             | 117 (79.6)               | 0.10 <sup>2</sup> |
| Second   | 34 (28.1)             | 26 (17.7)                |                   |
| Third  | 4 (3.3)               | 4 (2.7)                  |                   |
| Gravidity, mean (SD)                                 | 2.3 (1.5)             | 2.0 (1.5)                | 0.03 <sup>1</sup> |
| GA at ED visit(wk), mean (SD)                        | 36.1 (4.9)            | 36.5 (4.2)               | 0.95 <sup>1</sup> |
| Singleton, n (%)                                     | 119 (97.5)            | 141 (94.6)               | 0.36 <sup>2</sup> |

n=number in sample, SD=standard deviation, %=percentage  
<sup>1</sup>Wilcoxon rank-sum; <sup>2</sup>Fisher's exact test

**Table 2.** Outcomes of cohort (n,%)

|  | 1 Elevated BP (n=122) | ≥ 2 elevated BPs (n=149) | p-value <sup>2</sup> |
|--|-----------------------|--------------------------|----------------------|
| Abnormal PEC labs                      |                       |                          |                      |
| PLT                                    | 0                     | 2                        | 0.50                 |
| Cr(>1.1mg/dL)                          | 0                     | 0                        | ---                  |
| AST (≥ 60)                             | 0                     | 2                        | 0.50                 |
| ALT (≥ 60)                             | 1                     | 1                        | ---                  |
| P/C (≥ 0.3)                            | 18                    | 50                       | <0.001               |
| Any abnormality                        | 19 (15.6)             | 51 (34.2)                | <0.001               |
| Diagnosis in ED                        | PEC 8 (5.3)           | 18 (14.8)                | 0.003                |
| Provider diagnosis at delivery         |                       |                          |                      |
| gHTN                                   | 32 (26.2)             | 64 (42.9)                | 0.005                |
| PEC                                    | 8 (6.6)               | 29 (19.5)                | 0.002                |
| sPEC                                   | 7 (5.7)               | 22 (14.8)                | 0.02                 |
| Objective diagnosis of PEC at delivery | 23 (19.0)             | 58 (38.9)                | <0.001               |

n=number in sample, %=percentage  
<sup>2</sup>Fisher's exact test



**Figure 1.** Study recruitment

(39.4 vs 22.2%, P=0.001) and more likely to be in labor (26.9% vs 15.4%, p=0.009) than women with multiple elevated blood pressures. In terms of delivery outcomes, women with multiple elevated blood pressures were more likely to deliver prior to 39 weeks (60.5% vs 47.1%, p=0.01), but there were no differences in the rate of induction of labor or mode of delivery. Women with more than one elevated blood pressure were more likely to have a delivery complicated by post-partum hemorrhage (5.4 vs 0.82%, P=0.04) compared to those with multiple elevated blood pressures but there were no differences in the rates of abruption or disseminated intravascular coagulopathy. Finally, there were no differences in birthweight or rate of neonatal intensive care unit admission in women with one versus multiple elevated blood pressures.

**Discussion**

Correct management of pregnant women who present to the emergency room or triage with an initially elevated blood pressure is unclear. The Task Force recommendations suggest that blood pressure measurements should be obtained in women who are sitting in a relaxed position for at least 5 minutes prior to obtaining vitals and if abnormal on the initial assessment allowing several minutes to pass before repeating vitals to avoid spurious values [1,7,8]. Obtaining an accurate measurement is crucial and involves selection of the correct cuff (cuff width >40% of arm circumference) and correct body placement with patients in the sitting position with back supported, legs uncrossed, feet on floor and the upper arm at the level of the right atrium [9-14]. Once an elevated blood pressure is confirmed, however, there are no recommendations for when to obtain preeclampsia labs. This study sought to determine if laboratory evaluation for preeclampsia should be delayed until multiple elevated blood pressures are obtained; a question of importance in the Emergency Department where length of stay and efficient use of resources is imperative especially in an environment promoting reduction of healthcare expenditures such as the American Board of Internal Medicine's *Choosing Wisely* initiative which seeks to avoid wasteful or unnecessary medical tests, treatments and procedures.

Results from this study demonstrate that women with an isolated elevated blood pressure were less likely to have preeclampsia both at the time of the emergency room visit and at the time of delivery. Furthermore, when women with an isolated elevated blood pressure had abnormal labs, they were almost always due to an elevated urine protein/creatinine with more than 99% of women with an isolated elevated blood pressure having normal serum labs. This suggests that a urine protein to creatinine ratio may be a reasonable first line screen after the first elevated blood pressure in an effort to tier laboratory evaluation and minimize length of stay and cost in the emergency room (Figure 2). Review of literature from the Emergency Medicine and Trauma community sets precedence for sequential laboratory evaluation, or evaluation based on acuity in an effort to minimize costs and unnecessary use of resources while allowing for quality care [15-18]. Specifically in the trauma setting, classification of patients into 'severe injury likely' or 'severe injury unlikely' with associated changes in laboratory panels leads to a reduction in laboratory costs with no change in quality of patient care [15].

At our institution, laboratory evaluation for preeclampsia (platelets, creatinine, liver enzymes, urine protein/creatinine ratio) takes approximately 60 minutes to perform and based on Medicaid reimbursement rates costs \$37.28 for a full evaluation [14]. The price of the protein to creatinine ratio alone is \$7.01 allowing for a cost savings of

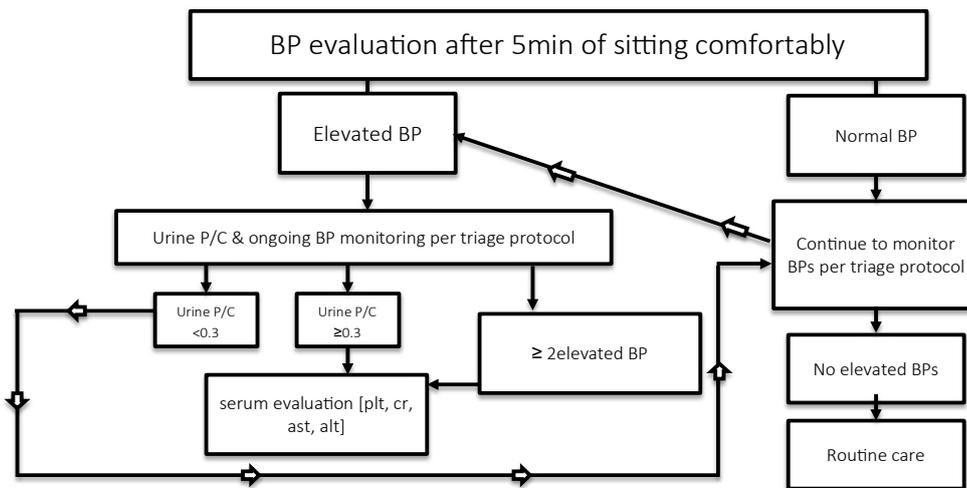


Figure 2. Algorithm for management of elevated BP in the ED during pregnancy

\$30.27 for patients who do not require a serum evaluation for preeclampsia. In summary, if the proposed algorithm was adopted nationwide, based on 4 million pregnancies a year and assuming nearly 3% of pregnant women presenting to an emergency room >20 weeks pregnant will have an isolated elevated blood pressure, \$2,592,000 could be saved.

This is a unique study asking a clinically relevant question that has not been previously answered in the literature. Its strengths include the diverse patient population studied at a tertiary referral center leading to the ability to generalize to the state's population. This study is not without limitations. Firstly, initial blood pressures obtained in the emergency department are uniformly collected manually which is associated with provider error and differences in patient positioning and length of time at rest. Additionally, 23% of patients who met initial inclusion criteria did not have preeclampsia labs sent demonstrating some inherent provider bias.

Providing efficient, cost-effective medical care is becoming increasingly important. Pregnant women with an initially isolated elevated blood pressure provide a challenge in the emergency setting where correct diagnosis needs to be paired with efficiency and cost consciousness. Although further investigation is warranted, we believe a tiered approach in laboratory evaluation for preeclampsia is reasonable, safe and cost efficient.

### Conflicts of interest

No conflict of interest – MK, PH, SD, SG, VD, and EW report no conflict of interest.

### Sources

Funded by the Department of Obstetrics and Gynecology at Women & Infants Hospital

### Presentations

This work was presented in poster form at the Society for Reproductive Investigation in Orlando, FL on March 18<sup>th</sup>, 2017.

### Condensation

Delaying serum laboratory evaluation for PEC in pregnant patients presenting to the ED until two abnormal blood pressures are noted may be reasonable.

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