

Early Pregnancy Loss in the Emergency Department, 2006-2016

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A thesis

submitted in partial fulfillment of the  
requirements for the degree of

Master of Public Health

University of Washington

2020

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Program Authorized to Offer Degree:

Health Services

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**Abstract**

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**Objectives:** Although women experiencing early pregnancy loss (EPL) often present to the emergency department (ED), the burden of EPL on the ED is not well understood. We aimed to estimate the proportion of ED visits for EPL-related care and determine the characteristics associated with seeking care for EPL in the ED in a national sample.

**Methods:** We conducted a cross-sectional analysis of the 2006 – 2016 National Hospital Ambulatory Medical Care Survey (NHAMCS), a nationally representative survey of U.S. ED visits. We identified women ages 15-44 years old who presented to the ED for EPL-related care, including those who had threatened or confirmed EPL based on a chief complaint of bleeding in pregnancy or diagnosis of missed, spontaneous, or threatened abortion, respectively. We estimated the proportion of all ED visits attributable to EPL-related care among all ED visits and among women 15-44 years old. Using multivariable logistic regression, we evaluated patient and visit characteristics associated with receiving EPL-related care. Women in this age group presenting for any other reason were used as a comparator.

**Results:** The 2006-2016 NHAMCS dataset included 325,037 visits (weighted n=1,447,144,423), including 82,871 visits among women ages 15-44 (weighted n=371,016,125). Of all ED visits from 2006 through 2016, 1.28% (95% CI, 1.21-1.34) were for EPL-related care. This is equivalent to 1.5 million visits each year, or 4.5% (95% CI, 4.3, 4.7) of visits for women ages 15-44 years old. Compared to all women ages 15-44 years old presenting to the ED for non-EPL related visits, those presenting with EPL were younger and more likely to be Black or Hispanic and publicly insured.

**Conclusions:** EPL-related care accounts for a substantial proportion of ED visits among reproductive aged women nationally. Given the prevalence, ED providers should be trained and equipped to evaluate and manage EPL.

## **Background**

Early pregnancy loss (EPL) is defined as a nonviable, intrauterine pregnancy with either an empty gestational sac or a gestational sac containing an embryo or fetus without fetal heart activity within the first 12 6/7 weeks of gestation.<sup>1</sup> In the first trimester, the terms miscarriage and spontaneous abortion are used interchangeably with EPL, and there is no consensus in terminology in the literature. EPL is common, occurring in up to one third of all clinically recognized pregnancies.<sup>1-4</sup> Between 9-17% of women ages 20-30 have experienced EPL. This increases from around 20% of pregnancies at age 35 years to 40% at age 40 and 80% at 45 years.<sup>5</sup> Between 2000 and 2014, the average age of maternity increased in the U.S.,<sup>6</sup> placing more women at risk of EPL. Using a conservative estimate of 10% of all pregnancies ending in EPL, there may be half a million EPLs each year in the U.S.;<sup>7</sup> other data suggest as many as 1 million each year.<sup>1</sup>

Several options for management of EPL exist, including expectant (“wait and watch”) management, medication management, and surgical management (aspiration of the uterus). Each management option can have varying degrees of success depending on the clinical characteristics of an individual patient’s miscarriage; however, all are safe.<sup>8</sup> Clinical practice guidelines recommend that patients are informed about effectiveness of options and that patient preference should guide treatment choice.<sup>9</sup>

Historically, surgical management of EPL has taken place in the operating room.<sup>10,11</sup> However, all three EPL management options can be offered in appropriately equipped facilities, in both outpatient clinics and in Emergency Departments (EDs).<sup>12</sup> Efforts to move surgical management of EPL out of the operating room when desired by patients have been met with challenges.<sup>13-16</sup>

Uterine aspiration care has been perceived as difficult to provide due to the emotional aspects of the procedure, because of its similarity to induced abortion procedures, and because of the difficulty of obtaining technical training.<sup>13,16</sup> Other barriers to moving surgical EPL out of the operating room include long-standing physician preference,<sup>10,11</sup> concerns about patient flow, and difficulty in finding support staff who are trained and comfortable providing EPL care.<sup>16</sup> However, moving EPL surgical management out of the OR can reduce costs and delays in patient care.<sup>17</sup>

While women can present to their primary care providers or gynecologists with symptoms of EPL, delays in accessing outpatient care and the timing of symptoms outside of workday hours results in many women seeking care for EPL in EDs. EDs are a crucial part of healthcare delivery in the U.S. Utilization of EDs has been consistently increasing in the U.S., with utilization by low-income populations and populations of color rising at higher rates over time.<sup>18</sup> Individuals seeking care in the ED are more likely to be Medicare and Medicaid beneficiaries, black, and women.<sup>18</sup> In recent years, many obstetrics, labor & delivery units have closed in various states in the U.S.,<sup>19</sup> decreasing access to women's health services for many people.<sup>20,21</sup> This increases barriers to routine outpatient care for these populations, including access to primary care and obstetrics care. EDs fill this gap in care, as they are one of the only health resources always available to uninsured and underinsured individuals.<sup>22</sup> The ED is generally thought of as a place that provides emergency services for critical, high stakes care, but in reality, a large portion of the patients seen in the ED are there for less acute conditions.

Based on data from 1996-2006, bleeding during early pregnancy made up 1.6% of all ED visits among women ages 12-54 years. Little is known about the characteristics of the patients who seek

care for EPL in the ED. We chose to focus on a larger group of women seeking EPL-related care, as well as the subset who have a definitive EPL diagnosis. EPL-related care includes a spectrum of clinical conditions that may have a range of indicators and diagnoses. While EPL care can present on a spectrum, many of these patients require the use of similar healthcare resources (imaging, labs, consults), counseling, and follow-up. Characterizing this larger group allows us to describe women who are seeking care for EPL-related concerns. We also wanted to assess those who had a definitive diagnosis of EPL, to narrow the focus and characterize the women who leave the ED with a definitive EPL diagnosis.

Although an estimated half of pregnancies among women who experience bleeding in early pregnancy are likely to end in EPL,<sup>23,24</sup> studies to date have not attempted to quantify the overall prevalence of EPL in the ED. Patients who go to the ED for EPL care report a lack of emotional support, logistical follow up, provider knowledge, and communication.<sup>25-28</sup> It is important for ED providers to understand and be able to discuss the three management options with patients, as each of these options can be initiated or completed in the ED with referral to appropriate follow-up care. Textbooks used in emergency medicine education and training only give cursory overviews of steps to take for patients bleeding in early pregnancy, but do not go in depth with respect to treatment options and counseling for patients in different stages of first trimester pregnancy loss.<sup>24,29</sup> American College of Emergency Physicians' clinical policy on early pregnancy focuses on the diagnosis and treatment of ectopic pregnancy but does not provide recommendations for addressing bleeding during early pregnancy or EPL.<sup>30</sup> Understanding the prevalence of this condition will help inform resource allocation and training priorities for EDs, medical residencies, and other training programs.

This study's primary aims were to estimate the proportion of ED visits that are attributable to all EPL-related care (including those with symptoms of EPL as well as diagnosis-confirmed EPL) as well as the proportion of emergency department visits for the subset of diagnosis-confirmed EPL. The secondary aims were to determine the predictors and characteristics associated with seeking care for EPL-related at the ED, compared to seeking care at the ED for other health concerns. We hypothesized that women of reproductive age who present to the ED with a diagnosis of EPL are more likely to be uninsured and non-white compared to women of reproductive age who present to the ED for other reasons. Additionally, we sought to estimate the rates of ultrasounds, hospital admittance, and return visits to the ED within 72 hours among patients with a diagnosis EPL that seek care at the ED.

## **Methods**

### *Study Design and Data Source*

We conducted a cross-sectional observational study using data from the National Hospital Ambulatory Medical Care Survey (NHAMCS) with data from years 2006-2016. NHAMCS is a nationally representative sample of U.S. ED visits, administered by the National Center for Health Statistics, Centers for Disease Control and Prevention. NHAMCS is an annual multi-stage probability sample survey of U.S. ED visits. Survey eligibility includes non-Federal general and short-stay hospitals, located in the 50 States and the District of Columbia, that have a 24-hour ED, an outpatient department with physician clinics, or hospital-based ambulatory surgery locations. For the purposes of this study, we exclusively focused on the ED visits. NHAMCS is conducted annually and covers geographic primary sampling units, hospitals within primary sampling units,

EDs within hospitals, and visits within EDs. Hospital staff collected data during a randomly assigned 4-week data period for each of the sampled hospitals, approximately once every 15 months. Trained hospital staff performed visit sampling and data collection, and a Bureau of Census field supervisor performed review of data collection. Experienced National Center for Health Statistics (NCHS) coders performed data abstraction centrally. Quality control included computer checks to assess inconsistencies with value ranges, a 2-way 10% independent procedure for medical and drug coding, and adjudication by NCHS for ambiguous or illegible responses for fields including reasons for visit and diagnosis. The nonresponse rate for most items was less than 5%, and error rates were less than 2% for items that required medical coding.

NHAMCS releases an annual plan detailing the plan and operation of the surveys.<sup>31</sup> The study was deemed exempt by the Internal Review Board of the University of Washington.

### *Variables*

Among all ED visits in NHAMCS between 2006 and 2016, we first identified all visits among women of reproductive age, defined as ages 15-44. We then identified visits for EPL-related care among women of reproductive age using a combination of International Classification of Diseases, 9<sup>th</sup> and 10<sup>th</sup> (ICD-9 and ICD-10) revisions diagnosis codes and ED Reason for Visit (RFV) codes. RFV codes are assigned by administrative staff when patients check-in to categorize their chief complaints upon entering the ED. Among visits for women ages 15-44, we classified EPL-related care as patients presenting clinically across the spectrum of miscarriage, from either a threatened miscarriage of a viable pregnancy to having already completed a miscarriage. To do this we used two RVF codes (17902, 17550) and 60 ICD-9/10 codes (see Table 3) for threatened abortion, hemorrhage in early pregnancy, missed or spontaneous abortion. To define a subgroup of

diagnosis-confirmed EPL, we included only those with ICD-9/10 codes for missed or spontaneous abortion. We note that individuals identifying as women are not the only populations who experience pregnancy and EPL; however, due to the limitations of this dataset, we were only able to identify EPL-related care among individuals coded as women. Of the visits included on the basis of RFV codes, we excluded patients who had a diagnosis inconsistent with EPL, including ectopic pregnancy, molar pregnancy, and abortion.

For the descriptive analysis, we chose to evaluate three categories of characteristics; demographic, visit-level, and hospital-level. We chose all characteristics variables a priori based on review of the emergency medicine literature for relevant predictors. Demographic characteristics included patient age, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and “other” - Asian, Native Hawaiian, other Asian Pacific Islander, American Indian, or Alaskan Native), payment/insurance status (private insurance, self-pay, Medicare/Medicaid or other state-based program, “other” - workers comp, no-charge or charity, or the category listed as other), and residence (private residence, homeless, “other” - a nursing home or listed as other within the dataset).

Visit characteristics included day of the week visit took place (weekend or weekday), season of the year, and year of visit. We chose these to contextualize the visits and to explore if there were differences in these variables across groups. Visit characteristic also included whether the visit included an ultrasound, if the patient was admitted to the hospital, the type of provider seen in the visit (physician, registered nurse (RN) nurse practitioner (NP), physician assistant (PA), emergency medical technician, mental health providers, or “other”), the length of visit (less than

one hour, 1-2 hours, 2-4 hours, or more than four hours) and wait time to see a provider (less than 30 minutes, 30 minutes to one hour, 1-2 hours, more than 2 hours), and whether the patient returned to the ED within 72 hours. The 72-hour re-visit variable does not give details on the reason for the initial visit, so we do not know if it was a re-visit for the same complaint or diagnosis.

Finally, we chose to describe visits based on hospital characteristics including geographic region (South, Northeast, Midwest, West), and Metropolitan Statistical Area (MSA), a measure of rurality, defining an MSA when one or more adjacent counties or county equivalents have at least one urban area of at least 50,000 people, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting tie (MSA, or non-MSA) to get a better sense of the distribution across the country and in urban versus rural communities.

### *Statistical Analysis*

We performed a descriptive analysis of patients who presented to the ED for EPL-related care. We estimated the proportion of ED visits attributable to EPL-related care among all ED visits and among women 15-44 years old. Similarly, we estimated the proportion of confirmed EPL visits (e.g., diagnosed EPL) among all ED visits and among those of women ages 15-44 years. We descriptively examined demographic, visit, and hospital characteristics listed above, including proportions and 95% confidence intervals (CIs), for each of visits for EPL-related care, diagnosed EPL, and other reasons among women of reproductive age.

Using logistic regression, we compared patient characteristics of the EPL-related care sample to the population of women ages 15-44 presenting for non-EPL related care. We first examined

unadjusted associations and then estimated multivariable logistic regression models to examine the factors independently associated with EPL-related care in the ED. Models produced odds ratios and corresponding 95% confidence intervals. In order to evaluate the demographic predictors of EPL-related care, the outcome of interest was EPL-related care in our regression model. Based on a review of related literature, the following exposure and covariates were added to the regression model a priori: age category (reference group was <35), race/ethnicity (reference group was non-Hispanic white), payment source (reference group was private insurance), residence, weekday versus weekend, season, year, geographic region, and MSA. We chose these based on our hypothesis that visits for EPL-related care were more likely to be among Black and Hispanic women and more likely to be on federal/state-funded insurance. Statistical significance was set at  $P < 0.05$  for all odds ratios.

For all analyses, weighted results are reported unless otherwise stated. We report missing data in our descriptive analyses. For our logistic regression models, we excluded visits where there was missing data. All analyses were performed using STATA 15.1 (StataCorp, College Station, TX).

## **Results**

### *Proportion of visits attributable to EPL-related care and diagnosed EPL*

The 2006-2016 NHAMCS dataset included 325,037 visits (weighted  $n=1,447,144,423$ ), including 82,871 visits among women ages 15-44 (weighted  $n=371,016,125$  visits). There were 3,838 visits for EPL-related care (weighted  $n=16,673,451$ ) and 603 visits with confirmed EPL (weighted  $n=2,535,662$ ). Weighting to national estimates, 16,673,451 ED visits between 2006 and 2016 were for EPL-related care, accounting for 1.28% (95% CI, 1.21-1.34) of all visits. This is equivalent to

an average of 1.5 million visits each year. When restricting the population to women ages 15-44 years old, visits for EPL-related care account for 4.5% (95% CI, 4.3, 4.7) of all ED visits.

*Demographic, visit, and hospital characteristics by visit type*

*Visits for EPL-related care*

Between 2006-2016, 16,673,451 of the 371,016,125 visits were among women ages 15-44 seeking EPL-related care. The average age of women presenting for EPL-related visits was 27 years, with over half (52.8%) between the ages of 20-29 years (Table 1). For visits unrelated to EPL, the average age was slightly higher at 29, with 40.3% between the ages of 20-29 years and 30.7% between 30-39. Approximately half of EPL-related and non-EPL visits were among non-Hispanic White women (45.4% EPL-related; 56.9% non-EPL) and approximately a quarter were among non-Hispanic black women (29.5% EPL-related; 25.8% non-EPL). Among both groups, visits were more likely to be paid through public insurance, with EPL-related visits having a higher proportion (39.9% EPL-related; 36.2% non-EPL), followed by private insurance in both groups (28.6% EPL-related; 32.3% non-EPL). There were very few visits among women experiencing homelessness (0.35% EPL-related; 0.45% non-EPL), most residing in a private residence.

There was an even distribution among days of the week and seasons of the year in visits both for EPL-related care and non-EPL related care. Similarly, between 2006 and 2016, the proportion of EPL-related visits per year remained stable in both groups. Of visits for EPL-related care, 3.9% were admitted to the hospital, compared to 5.1% of non-EPL related cases. There were more ultrasounds among the EPL-related visits (44.4%), compared to non-EPL visits (5.6%). There was a similar proportion that visited the ED within 72-hours of an initial ED visit (4.7% EPL-related;

4.1% non-EPL). For EPL-related and non-EPL related visit, most women saw an RN, NP, or PA rather than an MD (58.6% EPL-related; 66.4% non-EPL). There was a higher proportion of visits for EPL-related care that lasted 2-4 hours compared to non-EPL visits (37.7% EPL-related versus 30.8% non-EPL); similarly, a higher proportion of EPL visits than non-EPL visits lasted over 4 hours (35.8% EPL-related; 22.4% non-EPL). Among both EPL-related and non-EPL visits, the wait time to see a provider tended to be less than 30 minutes (52.0% EPL-related; 58.2% non-EPL).

Distribution of visits varied by geography similarly among EPL-related and non-EPL groups, with the largest proportion (41.5% EPL-related, 40.7% non-EPL ) in hospitals in the South, followed by the Midwest (21.1% EPL-related; 22.9% non-EPL), West (21.1% EPL-related; 19.7% non-EPL), and Northeast (16.3% EPL-related; 16.7% non-EPL). The majority of hospitals were located in Metropolitan/urban areas (81.4% EPL-related; 75.9% non-EPL).

#### *Subgroup of visits for EPL-related care with confirmed EPL*

Among visits for EPL-related care, 2,535,662 (15.2%) had a confirmed diagnosis of EPL. This translates to 0.18% of all ED visits and 0.68% of ED visits among women ages 15-44 years. Among the confirmed EPL visits, the age distribution was similar to the larger EPL-related group, with an average age of 27 years (50.1% between the ages of 20-29 years and 31.1% between 30-39 years). Nearly half of visits with confirmed EPL were in non-Hispanic white women (46.3%), followed by non-Hispanic black women (22.8%) and Hispanic women (25.7%). Similar to EPL-related visits, confirmed EPL visits were more likely among women with public insurance (40.8%)

than private insurance (29.1%) and there were few visits among women experiencing homelessness (0.3%).

As in the EPL-related group, visits for confirmed EPL were evenly distributed throughout days of the week and among seasons of the year. Between 2006 and 2016, the greatest number of visits for confirmed EPL occurred in 2010 (12.7% of visits across all years), followed by 2014 (10.5%), and 2011 (10.2%). Of women with confirmed EPL, 5.9% were admitted to the hospital, 53.4% received an ultrasound, and 8.4% re-visited the ED within 72-hours of the initial ED visit. Similar to the EPL-related group, the majority of visits took place with a RN, NP, or PA (56.4%). Confirmed EPL visits tended to take longer than EPL-related visits, with the majority of visits taking over 4 hours (44.4%). The wait time of confirmed EPL visits was similar to EPL-related visits, with a majority waiting less than 30 minutes (51.2%)

There was a similar distribution of hospitals among regions of the U.S. in the confirmed EPL group, with hospitals in the South (37.6%) seeing the largest number of visits for confirmed EPL, followed by the West (25.3%), Midwest (21.4%), and Northeast (15.7%). Similar to the EPL-related care visits, visits with confirmed EPL tended to be in Metropolitan/urban areas (81.9%).

### *Regression Analysis*

Table 2 shows a both unadjusted and adjusted logistic regression models examining factors associated with visits for EPL-related care in the ED. In the unadjusted model, the bivariate analyses show that age 35 and over, compared to under 35, was negatively associated with an ED visit for EPL-related care (OR 0.5, 95% CI: 0.4-0.6). This remained the same in the adjusted,

multivariate regression model. In the bivariate analyses, non-Hispanic black, Hispanic, and other race/ethnicity visits, compared to non-Hispanic white visits, were positively associated with an ED visit for EPL-related care (OR 1.4, 95% CI: 1.3-1.6 and OR 1.9, 95% CI: 1.7-2.2, OR 1.5, 95% CI: 1.1-1.9, respectively). Similarly, the adjusted model showed non-Hispanic black (OR 1.3, 95%CI: 1.1-1.5) and Hispanic visits (OR 1.8, 95%CI: 1.5-2.0), or another race/ethnicity (OR 1.5, 95%CI 1.1-2.0) compared to non-Hispanic white visits, were positively associated with an ED visit for EPL-related care. Use of Medicare, Medicaid or another state-based insurance program, and paying out of pocket, compared private insurance, was positively associated with ER visits for EPL in both the bivariate and multivariate analyses (OR 1.3, 95% CI: 1.1-1.4 and OR 1.2, 95% CI: 1.02-1.3, respectively). Beyond this there were no other significant predictors of visiting the ED for EPL-related care versus non-EPL-related care. Both the unadjusted and adjusted models show that non-MSA, compared to MSA is negatively associated ED visits for EPL-related care (OR 0.6, 95% CI: 0.5-0.8 and OR 0.7, 95% CI: 0.6-0.8, respectively).

## **Discussion**

In this analysis, we found that EPL-related visits comprised of 4.5% of ED visits among women aged 15-44 years. This translates to an average of 1.5 million ED visits per year that are related to EPL care, or about 1 in 20 visits among women of reproductive age. Of these EPL-related visits, approximately 15% had a confirmed EPL diagnosis in the ED. Given that about 1 in 20 visits among women of reproductive age are for EPL-related care, EDs should prioritize training their staff to provide high quality care for these women.

Understanding the burden of this condition and the characteristics of patients seeking care for EPL in the ED will help inform education, policies, and resource allocation to best serve these patients. Patients seeking EPL care in the ED report dissatisfaction and experience frustrations around their diagnosis, provider sensitivity to the topic, and inefficient care.<sup>32</sup> Additionally, women experiencing EPL in the ED are less satisfied given negative attitudes from healthcare providers, the lack of information shared, and an inadequate focus on the emotional aspects of the EPL experience.<sup>25,27</sup> Given the volume of visits for EPL-related care each year that are related to EPL care, more attention should be paid to educating ED providers in EPL management options and provision. Given the cost-effectiveness of medical management as opposed to surgical management,<sup>33</sup> training ED providers in management options is likely to reduce costs in the ED as well as improve the quality of care.

The overall prevalence of EPL in the ED has not been previously reported. Wittels et al. published results from an analysis of the 1996-2006 NHAMCS data, finding that 1.6% of ED visits among women ages 12-54 years were due to vaginal bleeding in early pregnancy. While vaginal bleeding in early pregnancy is the most common predictor for miscarriage, many present with abdominal pain or other predictors, or present to the ED without symptoms suggestive of EPL at all. We chose to only include the bleeding RfV codes, as other predictors of EPL are significantly less specific to EPL. We chose to expand on the previous work to more completely describe the utilization of resources on EDs of EPL-related care with data from more recent EPL-related ED visits. To do this we included reason for visit and diagnosis beyond the presentation of vaginal bleeding in early pregnancy to include a more comprehensive group of EPL-related care in the ED.

As we hypothesized, compared to women ages 15-44 years old presenting to the ED for non-EPL related care, those with possible EPL were younger, more likely to be non-Hispanic Black or Hispanic, and publicly insured or paying out of pocket. Women ages 20-29 had the highest rates of EPL-related care in the ED, which is concurrent with average age of first pregnancy in the U.S.<sup>34,35</sup> While there is an increased risk of EPL as women age, many women over the age of 35 may have completed their families, so may be less likely to experience any pregnancy. Additionally, older individuals are more likely to be insured, which could explain why younger women are more likely to seek care at the ED for possible EPL. Higher representation of those without private insurance among visits to the ED for EPL may be explained by lack of access or lack of established care with a primary care provider or obstetrician among those on federal/state insurance or without any insurance. Overall, the U.S. has seen a steady increased use of EDs, underscoring the vital role they play in caring for those who are socioeconomically vulnerable.<sup>18</sup>

Our data showed that among the four regions in the U.S., a higher proportion of visits for EPL-related care took place in hospitals in the Southern region. Obstetrics, labor & delivery unit closures have disproportionately affected the South, which may contribute to these findings.<sup>19-21</sup> Women in the South also face greater barriers to seeking family planning care, due to state-level restrictions.<sup>36,37</sup> This points to a lack of access to reproductive health and OBGYN services for women, who may then turn to the ED for pregnancy and EPL-related care.

### *Limitations*

This study had several limitations. The number of confirmed EPL visits is likely an underestimate, due to inaccuracies in the ICD-9/ICD-10 codes related to EPL in the ED.<sup>38</sup> Some emergency

medicine providers may be hesitant to declare a pregnancy non-viable in the emergency department, or may lack the ultrasound training to make the diagnosis of fetal demise in the absence of formal ultrasound availability, and therefore may choose an EPL-related ICD code that does not suggest fetal non-viability.<sup>38</sup> As noted previously, we used both the ‘Reason for Visit’ codes and ICD-9/ICD-10 diagnosis codes to capture visits for EPL-related care. ICD-9/ICD-10 codes can be incomplete and imprecise, which can lead to incorrect estimations of EPL cases.<sup>39</sup> Similarly, the ‘Reason for Visit’ variable has room for error, since it is usually documented by triage nurses when patients present to the ED and prior to full evaluation and diagnosis by a medical provider. These coding errors may result in misclassification of visits. Since the larger EPL-related group includes both RFV and ICD-9/10 codes, we believe it is a more accurate representation of women seeking EPL-related care.

We were unable to assess the outcome of confirmed EPL visits (expectant, medication, aspiration management), which is an important metric given the literature around the benefits of moving EPL surgical management out of the OR.<sup>17</sup> Similarly, we were unable to assess the factors that went into making these decisions as these data are not collected through NHAMCS. While we did not aim to explore these factors through this study, we acknowledge the need for this research to be done. We do not know how many patients had established care with an obstetrician prior to their ED visit, had previously received ultrasound, or had previous complications in this, or a previous pregnancy. There are many factors that go into decisions around EPL treatment that we were unable to evaluate. Additional research, including qualitative investigation, is needed to learn more about factors that go into providers’ decision making around outcomes of early pregnancy loss.

There are a few other notable limitations of this study. In 2006, NHAMCS only collected the first three diagnosis codes and reason for visit codes. From 2007 – 2016, NHAMCS collected and recorded the first five diagnoses and reason for visits codes for ED visits. Although unlikely, patients may present to the ED for three to five other reasons of higher importance than EPL. If so, the visit would not be identified as for EPL-related care, leading to an underestimate of the prevalence of EPL in the ED. NHAMCS sampling also excludes federal and long-term hospitals, which means the results from any analysis can only apply to approximately 85% of U.S. hospitals. The NHAMCS dataset does not allow for analysis of individual patients, but rather visits. NHAMCS samples over a 4-week period, such that a particular woman could contribute multiple hospitalizations in that period or over multiple years of data collection, resulting in correlations for which we cannot statistically account.

### *Conclusions*

These new findings can inform priorities and discussions regarding EPL management training for ED providers and staff in the U.S. With an estimated 1.5 million ED visits per year for EPL-related care, ED personnel should be equipped and educated to provide comprehensive medical care for individuals seeking EPL-related care. Given the closures of obstetrics, labor & delivery units around the U.S., limiting access to women's health services,<sup>19-21</sup> EDs are filling gaps in care, as they are one of the only health resources always available to uninsured and underinsured individuals.<sup>22</sup> This may result in increasing reliance on EDs for EPL-related care over time. Individuals presenting to the ED for EPL related care were younger, more likely to be Black or Hispanic, and more likely to be publicly insured. This shows that disproportionate effects on patient populations that may already experience more barriers to care and may be more vulnerable.

Future research is needed to link clinical data with national billing codes to determine the accuracy of coding for threatened and confirmed EPL, and to determine the prevalence of aspiration, medication, and expectant management being offered in the ED setting. While a significant number of women experiencing EPL present to the ED for their care, there are knowledge gaps in how EPL care in the ED compares to its counterpart in an outpatient clinic setting. As interest in providing comprehensive EPL counseling and management within the ED increases, it will be important to evaluate outcomes and complications with ED-based EPL management.

## Tables

**Table 1.** Characteristics of patients with EPL-related care, confirmed EPL diagnosis, and ED visits of women of reproductive age unrelated to EPL; 2006-2016, weighted

| Patient Characteristics                | <i>Visits for EPL-related Care<br/>(threatened or confirmed)</i> |          | <i>Visits with confirmed EPL diagnosis</i> |          | <i>Visits unrelated to EPL</i> |          |
|--|--|----------|--|----------|--------------------------------|----------|
|  | <i>N=16,673,451</i>  | <i>%</i> | <i>N=2,535,662</i>                         | <i>%</i> | <i>N=354,342,674</i>           | <i>%</i> |
| Age                                    |  |          |  |          |                                |          |
| 15-19                                  | 2,301,388  | 13.80%   | 334,540                                    | 13.19%   | 53,137,508                     | 15.00%   |
| 20-29                                  | 8,800,638  | 52.78%   | 1,270,887                                  | 50.12%   | 142,850,139                    | 40.31%   |
| 30-39                                  | 4,437,669  | 26.62%   | 788,821                                    | 31.11%   | 108,702,176                    | 30.68%   |
| 40-44                                  | 1,133,756  | 6.80%    | 141,416                                    | 5.58%    | 49,652,851                     | 14.01%   |
| Age < 35                               | 13,978,959   | 83.84%   | 2,117,825                                  | 83.52%   | 253,786,926                    | 71.62%   |
| Age ≥ 35                               | 2,694,492  | 16.16%   | 417,838                                    | 16.48%   | 100,555,748                    | 28.38%   |
| Mean age (SD)                          | 26.9 (26.6, 27.3)  |          | 27.3 (26.6, 28.0)                          |          | 28.83 (28.7, 28.9)             |          |
| Race /Ethnicity                        |  |          |  |          |                                |          |
| Non-Hispanic White                     | 7,573,968  | 45.43%   | 1,174,802                                  | 46.33%   | 201,707,254                    | 56.92%   |
| Non-Hispanic Black                     | 4,918,427  | 29.50%   | 651,071                                    | 25.68%   | 91,441,780                     | 25.81%   |
| Hispanic                               | 3,522,022  | 21.12%   | 584,870                                    | 23.07%   | 49,102,909                     | 13.86%   |
| Other                                  | 659,034  | 3.95%    | 124,921                                    | 4.93%    | 12,090,731                     | 3.41%    |
| Payment Source                         |  |          |  |          |                                |          |
| Self-Pay                               | 2,955,159  | 17.72%   | 444,571                                    | 17.53%   | 60,712,617                     | 17.13%   |
| Private Insurance                      | 4,767,170  | 28.59%   | 737,545                                    | 29.09%   | 114,402,877                    | 32.29%   |
| Medicare/Medicaid or other state-based | 6,650,311  | 39.89%   | 1,033,090                                  | 40.74%   | 128,089,961                    | 36.15%   |
| Other                                  | 1,149,746  | 6.90%    | 151,466                                    | 5.97%    | 23,188,031                     | 6.54%    |
| Unknown                                | 1,020,192  | 6.12%    | 164,223                                    | 6.48%    | 25,036,902                     | 7.07%    |
| Missing                                | 130,873  | 0.78%    | 4,768                                      | 0.19%    | 2,912,286                      | 0.82%    |
| Residence                              |  |          |  |          |                                |          |
| Private Residence                      | 15,943,354   | 95.62%   | 2,440,439                                  | 96.24%   | 337,575,114                    | 95.27%   |
| Homeless                               | 58,156   | 0.35%    | 7,498                                      | 0.30%    | 1,577,323                      | 0.45%    |
| Other                                  | 86,083   | 0.52%    | 5,168                                      | 0.20%    | 3,117,459                      | 0.88%    |
| Unknown                                | 585,859  | 3.51%    | 82,557                                     | 3.26%    | 12,072,778                     | 3.41%    |
| <b>Visit characteristics</b>           |  |          |  |          |                                |          |
| ED visit day                           |  |          |  |          |                                |          |
| Weekend                                | 4,632,757  | 27.79%   | 599,803                                    | 23.65%   | 96,371,700                     | 27.20%   |
| Weekday                                | 12,040,694   | 72.21%   | 1,935,860                                  | 76.35%   | 257,970,974                    | 72.80%   |
| ED visit season                        |  |          |  |          |                                |          |
| Fall                                   | 4,119,161  | 24.70%   | 646,609                                    | 25.50%   | 89,659,442                     | 25.30%   |
| Winter                                 | 3,889,696  | 23.33%   | 588,769                                    | 23.22%   | 83,126,062                     | 23.46%   |
| Spring                                 | 4,491,422  | 26.94%   | 612,389                                    | 24.15%   | 91,146,163                     | 25.72%   |

|                                 |           |        |           |        |             |        |
|---------------------------------|-----------|--------|-----------|--------|-------------|--------|
| Summer                          | 4,173,173 | 25.03% | 687,896   | 27.13% | 90,411,007  | 25.52% |
| Year                            |           |        |           |        |             |        |
| 2006                            | 1,508,222 | 9.05%  | 243,159   | 9.59%  | 29,679,860  | 8.38%  |
| 2007                            | 1,458,864 | 8.75%  | 236,703   | 9.33%  | 28,331,394  | 8.00%  |
| 2008                            | 1,339,198 | 8.03%  | 193,277   | 7.62%  | 30,419,439  | 8.58%  |
| 2009                            | 1,385,036 | 8.31%  | 217,320   | 8.57%  | 32,839,077  | 9.27%  |
| 2010                            | 1,548,348 | 9.29%  | 321,992   | 12.70% | 32,362,350  | 9.13%  |
| 2011                            | 1,746,137 | 10.47% | 258,108   | 10.18% | 34,076,565  | 9.62%  |
| 2012                            | 1,392,319 | 8.35%  | 184,099   | 7.26%  | 32,456,950  | 9.16%  |
| 2013                            | 1,368,292 | 8.21%  | 163,307   | 6.44%  | 32,218,067  | 9.09%  |
| 2014                            | 1,567,229 | 9.40%  | 266,128   | 10.50% | 34,279,781  | 9.67%  |
| 2015                            | 1,732,418 | 10.39% | 239,298   | 9.44%  | 33,743,694  | 9.52%  |
| 2016                            | 1,627,388 | 9.76%  | 212,272   | 8.37%  | 33,935,497  | 9.58%  |
| Hospital Admittance (yes)       | 646,782   | 3.88%  | 148,508   | 5.86%  | 18,017,912  | 5.08%  |
| Ultrasound (yes)                | 7,406,205 | 44.42% | 1,362,769 | 53.74% | 19,826,960  | 5.60%  |
| 72-Hour Revisit (yes)           | 786,136   | 4.71%  | 180,156   | 7.10%  | 49,694,436  | 4.13%  |
| Provider                        |           |        |           |        |             |        |
| Physician                       | 553,285   | 3.32%  | 91,282    | 3.60%  | 12,790,507  | 3.61%  |
| RN, NP, PA                      | 9,775,276 | 58.63% | 1,429,945 | 56.39% | 235,409,428 | 66.44% |
| Other                           | 6,218,675 | 37.30% | 1,000,488 | 39.46% | 103,006,413 | 29.07% |
| Unknown                         | 122,029   | 0.73%  | 13,947    | 0.55%  | 3,089,665   | 0.87%  |
| Missing                         | 4,187     | 0.03%  | 0         | 0.00%  | 46,661      | 0.01%  |
| Length of Visit                 |           |        |           |        |             |        |
| <1hr                            | 1,060,500 | 6.38%  | 115,645   | 4.57%  | 52,518,041  | 14.89% |
| 1hr-2hrs                        | 1,721,088 | 10.35% | 162,473   | 6.42%  | 78,742,525  | 22.33% |
| 2-4hr                           | 6,274,334 | 37.72% | 918,070   | 36.26% | 108,599,231 | 30.80% |
| >4hrs                           | 5,949,681 | 35.77% | 1,123,776 | 44.38% | 78,816,640  | 22.35% |
| Missing                         | 1,627,388 | 9.78%  | 212,272   | 8.38%  | 33,935,497  | 9.62%  |
| Wait time                       |           |        |           |        |             |        |
| <30m                            | 8,670,991 | 52.00% | 1,299,087 | 51.23% | 206,126,915 | 58.17% |
| 30-1hr                          | 3,100,431 | 18.60% | 378,907   | 14.94% | 63,261,287  | 17.85% |
| 1hr-2hrs                        | 2,623,418 | 15.73% | 497,994   | 19.64% | 48,085,671  | 13.57% |
| >2hrs                           | 2,278,610 | 13.67% | 359,674   | 14.18% | 36,868,801  | 10.40% |
| <b>Hospital characteristics</b> |           |        |           |        |             |        |
| Geographic Region               |           |        |           |        |             |        |
| Northeast                       | 2,709,143 | 16.25% | 397,000   | 15.66% | 59,070,120  | 16.67% |
| Midwest                         | 3,523,639 | 21.13% | 541,786   | 21.37% | 81,275,952  | 22.94% |
| South                           | 6,918,826 | 41.50% | 954,279   | 37.63% | 144,137,203 | 40.68% |
| West                            | 3,521,843 | 21.12% | 642,598   | 25.34% | 69,859,399  | 19.72% |
| Metropolitan Statistical Area   |           |        |           |        |             |        |

|         |            |        |           |        |             |        |
|---------|------------|--------|-----------|--------|-------------|--------|
| MSA     | 13,600,000 | 81.37% | 2,076,277 | 81.88% | 269,100,789 | 75.94% |
| Non-MSA | 1,714,465  | 10.28% | 275,286   | 10.86% | 52,784,935  | 14.90% |
| Missing | 1,392,319  | 8.35%  | 184,099   | 7.26%  | 32,456,950  | 9.16%  |

**Table 2.** Bivariate and multivariate model: predictors and characteristics of visits of women who present to the ED for EPL-related care

|   | Unadjusted Odds Ratio | 95% Confidence Interval |     | Adjusted Odds Ratio | 95% Confidence Interval |     |
|---|-----------------------|-------------------------|-----|---------------------|-------------------------|-----|
| Age   |                       |                         |     |                     |                         |     |
| <35   | 1.0                   | reference               |     | 1.0                 | reference               |     |
| ≥35   | 0.5                   | 0.4                     | 0.6 | 0.5                 | 0.4                     | 0.6 |
| Race/Ethnicity                              |                       |                         |     |                     |                         |     |
| Non-Hispanic White                          | 1.0                   | reference               |     | 1.0                 | reference               |     |
| Non-Hispanic Black                          | 1.4                   | 1.3                     | 1.6 | 1.3                 | 1.1                     | 1.5 |
| Hispanic                                    | 1.9                   | 1.7                     | 2.2 | 1.8                 | 1.5                     | 2.0 |
| Other                                       | 1.5                   | 1.1                     | 1.9 | 1.5                 | 1.1                     | 2.0 |
| Payment Source/Insurance                    |                       |                         |     |                     |                         |     |
| Private Insurance                           | 1.0                   | reference               |     | 1.0                 | reference               |     |
| Self-Pay                                    | 1.2                   | 1.1                     | 1.4 | 1.1                 | 0.97                    | 1.3 |
| Medicare/Medicaid/Other state-based program | 1.3                   | 1.1                     | 1.4 | 1.2                 | 1.02                    | 1.3 |
| Other                                       | 1.2                   | 0.9                     | 1.5 | 1.1                 | 0.8                     | 1.3 |
| Unknown                                     | 0.9                   | 0.7                     | 1.2 | 0.8                 | 0.7                     | 1.0 |
| Residence                                   |                       |                         |     |                     |                         |     |
| Private Residence                           | 1.0                   | reference               |     | 1.0                 | reference               |     |
| Homeless                                    | 0.8                   | 0.4                     | 1.8 | 0.9                 | 0.4                     | 1.9 |
| Other                                       | 0.6                   | 0.3                     | 1.1 | 0.6                 | 0.3                     | 1.1 |
| Unknown                                     | 1.1                   | 0.8                     | 1.4 | 1.1                 | 0.9                     | 1.5 |
| ED visit day                                |                       |                         |     |                     |                         |     |
| Weekday                                     | 1.0                   | reference               |     | 1.0                 | reference               |     |
| Weekend                                     | 1.0                   | 0.9                     | 1.1 | 1.0                 | 0.9                     | 1.1 |
| ED visit season                             |                       |                         |     |                     |                         |     |
| Fall  | 1.0                   | reference               |     | 1.0                 | reference               |     |
| Winter                                      | 1.0                   | 0.9                     | 1.2 | 1.0                 | 0.9                     | 1.2 |
| Spring                                      | 1.1                   | 0.9                     | 1.2 | 1.0                 | 0.9                     | 1.2 |
| Summer                                      | 1.0                   | 0.9                     | 1.1 | 1.0                 | 0.9                     | 1.2 |
| Year  |                       |                         |     |                     |                         |     |
| 2006  | 1.0                   | reference               |     | 1.0                 | reference               |     |
| 2007  | 1.0                   | 0.8                     | 1.2 | 1.0                 | 0.8                     | 1.2 |
| 2008  | 0.9                   | 0.7                     | 1.1 | 0.9                 | 0.7                     | 1.1 |
| 2009  | 0.8                   | 0.7                     | 1.0 | 0.8                 | 0.7                     | 1.0 |
| 2010  | 0.9                   | 0.8                     | 1.1 | 0.9                 | 0.8                     | 1.1 |
| 2011  | 1.0                   | 0.8                     | 1.2 | 1.0                 | 0.8                     | 1.2 |
| 2012  | 0.8                   | 0.7                     | 1.1 | 0.8                 | 0.6                     | 0.9 |
| 2013  | 0.8                   | 0.6                     | 1.1 | 0.8                 | 0.6                     | 1.1 |

|                               |     |           |     |     |           |     |
|-------------------------------|-----|-----------|-----|-----|-----------|-----|
| 2014                          | 0.9 | 0.7       | 1.2 | 0.9 | 0.7       | 1.1 |
| 2015                          | 1.0 | 0.8       | 1.3 | 1.0 | 0.8       | 1.2 |
| 2016                          | 0.9 | 0.8       | 1.2 | 0.9 | 0.8       | 1.2 |
| Geographic Region             |     |           |     |     |           |     |
| South                         | 1.0 | reference |     | 1.0 | reference |     |
| Northeast                     | 1.0 | 0.8       | 1.2 | 0.9 | 0.8       | 1.1 |
| Midwest                       | 0.9 | 0.8       | 1.1 | 0.9 | 0.8       | 1.1 |
| West                          | 1.1 | 0.9       | 1.2 | 0.9 | 0.8       | 1.1 |
| Metropolitan Statistical Area |     |           |     |     |           |     |
| MSA                           | 1.0 | reference |     | 1.0 | reference |     |
| Non-MSA                       | 0.6 | 0.5       | 0.8 | 0.7 | 0.6       | 0.8 |

**Table 3.** Reason for Visit and ICD9/ICD10 diagnosis codes and definitions consistent with EPL-related care

| <b>ICD Code</b> | <b>ICD Description</b>   | <b>ICD Version</b> |
|-----------------|--|--------------------|
| 632*            | Missed abortion  | ICD 9              |
| 634*            | Spontaneous abortion   | ICD 9              |
| 6340*           | Spontaneous abortion complicated by genital tract and pelvic infection               | ICD 9              |
| 6341*           | Spontaneous abortion complicated by delayed or excessive hemorrhage                  | ICD 9              |
| 6342*           | Spontaneous abortion complicated by damage to pelvic organs or tissues               | ICD 9              |
| 6343*           | Spontaneous abortion complicated by renal failure                                    | ICD 9              |
| 6344*           | Spontaneous abortion complicated by metabolic disorder                               | ICD 9              |
| 6345*           | Spontaneous abortion complicated by shock  | ICD 9              |
| 6346*           | Spontaneous abortion complicated by embolism   | ICD 9              |
| 6347*           | Spontaneous abortion with other specified complications                              | ICD 9              |
| 6348*           | Spontaneous abortion with unspecified complication                                   | ICD 9              |
| 6349*           | Spontaneous abortion without mention of complication                                 | ICD 9              |
| 63400*          | Spontaneous abortion, complicated by genital tract and pelvic infection, unspecified | ICD 9              |
| 63401*          | Spontaneous abortion, complicated by genital tract and pelvic infection, incomplete  | ICD 9              |
| 63402*          | Spontaneous abortion, complicated by genital tract and pelvic infection, complete    | ICD 9              |
| 63410*          | Spontaneous abortion, complicated by delayed or excessive hemorrhage, unspecified    | ICD 9              |
| 63411*          | Spontaneous abortion, complicated by delayed or excessive hemorrhage, incomplete     | ICD 9              |
| 63412*          | Spontaneous abortion, complicated by delayed or excessive hemorrhage, complete       | ICD 9              |
| 63420*          | Spontaneous abortion, complicated by damage to pelvic organs or tissues, unspecified | ICD 9              |
| 63421*          | Spontaneous abortion, complicated by damage to pelvic organs or tissues, incomplete  | ICD 9              |
| 63422*          | Spontaneous abortion, complicated by damage to pelvic organs or tissues, complete    | ICD 9              |
| 63430*          | Spontaneous abortion, complicated by renal failure, unspecified                      | ICD 9              |
| 63431*          | Spontaneous abortion, complicated by renal failure, incomplete                       | ICD 9              |
| 63432*          | Spontaneous abortion, complicated by renal failure, complete                         | ICD 9              |
| 63440*          | Spontaneous abortion, complicated by metabolic disorder, unspecified                 | ICD 9              |
| 63441*          | Spontaneous abortion, complicated by metabolic disorder, incomplete                  | ICD 9              |
| 63442*          | Spontaneous abortion, complicated by metabolic disorder, complete                    | ICD 9              |
| 63450*          | Spontaneous abortion, complicated by shock, unspecified                              | ICD 9              |
| 63451*          | Spontaneous abortion, complicated by shock, incomplete                               | ICD 9              |
| 63452*          | Spontaneous abortion, complicated by shock, complete                                 | ICD 9              |
| 63460*          | Spontaneous abortion, complicated by embolism, unspecified                           | ICD 9              |
| 63461*          | Spontaneous abortion, complicated by embolism, incomplete                            | ICD 9              |
| 63462*          | Spontaneous abortion, complicated by embolism, complete                              | ICD 9              |
| 63470*          | Spontaneous abortion, with other specified complications, unspecified                | ICD 9              |

|                              |   |        |
|------------------------------|---|--------|
| 63471*                       | Spontaneous abortion, with other specified complications, incomplete                                      | ICD 9  |
| 63472*                       | Spontaneous abortion, with other specified complications, complete  | ICD 9  |
| 63480*                       | Spontaneous abortion, with unspecified complication, unspecified  | ICD 9  |
| 63481*                       | Spontaneous abortion, with unspecified complication, incomplete   | ICD 9  |
| 63482*                       | Spontaneous abortion, with unspecified complication, complete   | ICD 9  |
| 63490*                       | Spontaneous abortion, without mention of complication, unspecified  | ICD 9  |
| 63491*                       | Spontaneous abortion, without mention of complication, incomplete   | ICD 9  |
| 63492*                       | Spontaneous abortion, without mention of complication, complete   | ICD 9  |
| 640                          | Threatened abortion   | ICD 9  |
| 64000                        | Threatened abortion, unspecified as to episode of care or not applicable                                  | ICD 9  |
| 64001                        | Threatened abortion, delivered, with or without mention of antepartum condition                           | ICD 9  |
| 64003                        | Threatened abortion, antepartum condition or complication   | ICD 9  |
| 64080                        | Other specified hemorrhage in early pregnancy, unspecified as to episode of care or not applicable        | ICD 9  |
| 64081                        | Other specified hemorrhage in early pregnancy, delivered, with or without mention of antepartum condition | ICD 9  |
| 64083                        | Other specified hemorrhage in early pregnancy, antepartum condition or complication                       | ICD 9  |
| 64090                        | Unspecified hemorrhage in early pregnancy, unspecified as to episode of care or not applicable            | ICD 9  |
| 64091                        | Unspecified hemorrhage in early pregnancy, delivered, with or without mention of antepartum condition     | ICD 9  |
| 64093                        | Unspecified hemorrhage in early pregnancy, antepartum condition or complication                           | ICD 9  |
| O200                         | Threatened abortion (also the code that shows up for anembryonic)   | ICD 10 |
| O021*                        | Missed abortion   | ICD 10 |
| O029                         | Abnormal product of conception, unspecified   | ICD 10 |
| O03*                         | Spontaneous abortion  | ICD 10 |
| O0339*                       | Incomplete spontaneous abortion with other complications  | ICD 10 |
| O034*                        | Incomplete spontaneous abortion without complication  | ICD 10 |
| O0389*                       | Complete or unspecified spontaneous abortion with other complications                                     | ICD 10 |
| O039*                        | Complete or unspecified spontaneous abortion without complication   | ICD 10 |
| <b>Reason for Visit Code</b> | <b>Definition</b>   |        |
| 17902                        | Spotting, bleeding during pregnancy   |        |
| 17550                        | Uterine and vaginal bleeding  |        |

\* Indicates confirmed EPL

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