

OBSTETRICS

Injury hospitalizations of pregnant women in the United States, 2002

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OBJECTIVE: To estimate the number of injury-related hospitalizations of pregnant women in the United States and to identify injury mechanisms associated with hospitalizations that end in delivery.

STUDY DESIGN: Using data on injury hospitalizations of pregnant women from the 2002 Healthcare Cost and Utilization Project Nationwide Inpatient Sample, we compared the mechanism of injuries of non-delivery hospitalizations with those of delivery hospitalizations.

RESULTS: Of an estimated 16,982 injury hospitalizations involving pregnant women in 2002, a delivery occurred in 37.7%. Hospitalizations with injuries caused by overexertion had significantly increased odds of including delivery (odds ratio OR 4.55, confidence interval

95% CI 2.21-9.39) compared with hospitalizations with other causes of injury. Hospitalizations with injuries caused by motor vehicle traffic (OR 0.36, 95% CI 0.23-0.58) had significantly lower odds of including delivery.

CONCLUSION: We estimated that there were 4.1 injury hospitalizations of pregnant women per 1000 deliveries in 2002. The majority of injury mechanisms did not significantly increase the odds of the hospitalization ending in delivery. Providers should broaden injury prevention messages to address poisonings and overexertion.

Key words: trauma in pregnancy, injury, hospitalization, delivery

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Traumatic injuries during pregnancy are major causes of maternal morbidity and mortality. Fatal and nonfatal injuries occur in approximately 7% of all pregnancies.¹ These injuries, regardless of severity, have been associated with an increased risk for adverse pregnancy

outcomes such as spontaneous abortion, premature labor, uterine rupture, fetal distress, maternal death, and stillbirth.²⁻⁴ Prior studies have examined how to identify and manage pregnant patients with injury risk factors.⁵⁻⁷ These studies often focused on automotive

safety and showed that educational tools (eg, counseling pregnant patients on proper seatbelt use) can reduce injury risk behaviors.^{5,6}

The total number of injury hospitalizations that occur among pregnant women in the United States is unknown. Previous analyses of national data on nonobstetric causes of hospitalizations during pregnancy have not focused on injuries.^{8,9} To know the scope of injury hospitalizations and major causes of injury that lead to injury hospitalizations will help focus injury prevention messages during prenatal visits.

After reviewing the results of several statewide injury studies, we hypothesized that the national rate of injury hospitalization during pregnancy would be similar to the corresponding state rates.^{2,10,11} We also hypothesized that certain injury mechanisms would be associated with hospitalizations that end in delivery and might therefore be associated with worse maternal outcomes. Knowing which injury mechanisms are associated with delivery hospitalizations may help prepare the obstetrician for the

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potential of delivery in a hospitalized injury patient.

MATERIALS AND METHODS

We used data from the 2002 Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP). The project is a partnership between state data organizations and the Agency for Healthcare Research and Quality (AHRQ). State partners contribute their statewide hospital discharge data to HCUP, which then translates and consolidates them into uniformly formatted datasets called the HCUP State Inpatient Databases (SID). The 35 states contributing data to HCUP in 2002 accounted for approximately 87% of all hospitalizations in the United States.

The NIS is drawn from the SID and approximates a 20% stratified sample of US community hospitals, which the American Hospital Association Annual Survey defines as all nonfederal, short-term, general, and other specialty hospitals whose facilities are open to the general public.¹² Hospitals are selected on the basis of a sampling frame that uses five hospital characteristics: ownership/control, bed size, teaching status, urban versus rural location, and US region. All discharges from sampled hospitals are included in the database. The 2002 NIS contains patient-level clinical and resource-use information on more than 7.8 million discharges from 995 hospitals in 35 states; these data, appropriately weighted, can be used to estimate the total number of inpatient hospital discharges in the United States. The Centers for Disease Control and Prevention (CDC) classified the project as non-human subject research because the information in the administrative dataset is stripped of all personal identifiers.

All NIS hospitalizations of women, aged 15-44 years, that listed concurrent pregnancy and injury discharge diagnoses were included in this study. Pregnancy diagnoses were identified by the following International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes: N630-

N676, V22-V24, or V27-V28. Hospitalizations for molar and ectopic pregnancies were excluded from all analyses to focus on normal intrauterine pregnancies. Deliveries were identified by ICD-9-CM codes documenting a live birth, a stillbirth, or a delivery-related procedure such as Cesarean section.

Injury diagnoses were considered to be any of the ICD-9-CM injury diagnosis codes from 800 to 999.99 or an external-cause-of-injury code (E-code) in any of the 15 diagnosis fields available on each record. The ICD-9-CM diagnosis codes describe the type of injury and the ICD-9-CM E-codes describe the mechanism of injury. We excluded records with an injury ICD-9-CM diagnosis of late effects of injuries (905-909), trauma complications (felt to be nonprimary event, 958), allergic reactions (995.1-.4, 995.6-.7, 995.86, 995.89), and complications of medical and surgical care (996-999). We classified the remaining injuries by their first-listed ICD-9-CM injury diagnosis code: fractures, dislocations, sprains, and strains (800-849); intracranial injuries (850-854); internal injuries to the thorax, abdomen, and pelvis (860-869); open wounds (870-897); injury to blood vessels (900-904); superficial injuries, contusions, and crushing injuries (910-929); foreign body injuries (930-939); burns (940-949); nerve and spinal cord injuries (950-957); other unspecified injuries (959); poisonings (960-979); toxic effects of nonmedicinal substances (980-989); and other specified injuries (990-995). "Other unspecified injuries" refers to injuries that are not described. "Other specified injuries" refers to injuries that are described but are not classifiable in the aforementioned groups.

We classified mechanisms of injury on the basis of the CDC-recommended framework of E-code groupings, which include cut/pierce, fall, firearm, motor vehicle traffic (MVT), natural/environment, overexertion, poisoning, struck by/against, other specified mechanism, and other unspecified mechanism.¹³ If more than one injury mechanism was listed for a given hospitalization, we classified it according to the first listed mechanism. We excluded records with only adverse ef-

fects or late effects E-codes, because we wanted to focus on hospitalizations for acute, noniatrogenic injuries. We used the CDC-recommended framework to describe the intent of injury (unintentional, self-inflicted, assault, undetermined).¹³ We used the Barell matrix to determine the body region of injury.¹⁴

Because blood vessel, nerve, and spinal cord injuries may be complications of hospital care, two obstetricians (D.J.J. and S.F.M.) independently reviewed hospitalization records indicating such injuries. When the reviewers disagreed (on a small number of records), the reviewers discussed and came to a consensus regarding the record. We excluded those that both reviewers agreed were complications of hospital care.

Injury severity was measured by the Injury Severity Score (ISS), an anatomically based scoring system used for trauma patients.¹⁵ Scores range from 1 to 75. We used ICDMAP-90 software (Johns Hopkins University, Baltimore, MD), which assigns the ISS based on ICD-9-CM injury diagnosis codes in the hospitalization data. The injury severity categories we used were nonsevere (ISS: 1-8), severe (ISS: 9-75), and unspecified body region and severity. Hospitalizations with injury diagnoses that ascribe injuries to an unspecified body region could not be given an ISS, because ISS is anatomically based.

The NIS does not contain any unique patient identifying information; we therefore used hospitalizations rather than patients as our unit of analysis. We categorized the injury hospitalizations as either "nondelivery" or "delivery," on the basis of whether a delivery occurred during the hospitalization. We then compared the two hospitalization categories by the patient's age, payor, median household income in the patient's ZIP code, and the teaching status and location of the hospital. We also assessed for differences between the two hospitalization categories in injury characteristics, including type, mechanism, intent, severity and affected body region. Unless otherwise noted, all hospitalization frequencies presented in the text and tables were weighted to reflect national esti-

TABLE 1

Comparison of patient and hospital characteristics of nondelivery and delivery injury hospitalizations involving pregnant women, National Inpatient Sample, 2002

| Characteristics | Nondelivery (n = 10,581) | | Delivery (n = 6401) | | P value |
|---------------------------------------|-----------------------------|------|------------------------|------|---------|
| | No. | % | No. | % | |
| Patient's age, years | | | | | |
| 15-24 | 5292 | 50.0 | 2663 | 41.6 | .0001 |
| 25-34 | 4129 | 39.0 | 2866 | 44.8 | |
| 35-44 | 1161 | 11.0 | 873 | 13.6 | |
| Payor | | | | | |
| Medicare | 151 | 1.4 | 26 | 0.4 | .0000 |
| Medicaid | 4472 | 42.4 | 2948 | 46.2 | |
| Private | 4187 | 39.7 | 2928 | 45.9 | |
| Other | 1741 | 16.5 | 483 | 7.6 | |
| Average income, patient's ZIP code | | | | | |
| \$1-\$24,999 | 751 | 7.3 | 467 | 7.5 | .1196 |
| \$25,000-\$34,999 | 2152 | 20.8 | 1028 | 16.5 | |
| \$35,000-\$44,999 | 2870 | 27.7 | 1719 | 27.5 | |
| ≥\$45,000 | 4579 | 44.2 | 3029 | 48.5 | |
| US region of hospital | | | | | |
| Northeast | 2105 | 19.9 | 771 | 12.1 | .0009 |
| Midwest | 2554 | 24.1 | 1366 | 21.3 | |
| South | 3481 | 32.9 | 3183 | 49.7 | |
| West | 2441 | 23.1 | 1081 | 16.9 | |
| Location, teaching status of hospital | | | | | |
| Rural | 1132 | 10.7 | 815 | 12.7 | .5229 |
| Urban, nonteaching | 3114 | 29.4 | 1798 | 28.1 | |
| Urban, teaching | 6335 | 59.9 | 3789 | 59.2 | |
| Patient's length of stay, days | | | | | |
| 0 | 899 | 8.5 | 34 | 0.5 | .0000 |
| 1 | 4255 | 40.2 | 416 | 6.5 | |
| 2 | 2211 | 20.9 | 2241 | 35.0 | |
| 3 | 1101 | 10.4 | 1871 | 29.2 | |
| 4 | 701 | 6.6 | 890 | 13.9 | |
| ≥5 | 1415 | 13.4 | 950 | 14.8 | |

Numbers are weighted to reflect national estimates. Some totals do not add up to the total sample size, because of rounding or because of missing information.

mates. We performed χ^2 tests and logistic regression using SAS, version 9.1 (SAS Institute, Cary, NC) and STATA, version 8.0 (StataCorp, College Station, TX), and accounted for the complex sampling design of HCUP NIS in all our analyses.

RESULTS

There were 4,572,447 pregnancy-associated hospitalizations of women aged 15-44 in 2002, an estimated 90.4% (n = 4,134,404) were delivery-related hospitalizations and 9.6% (n = 438,043) were not delivery-related. Injury hospitaliza-

tions accounted for 0.4% (n = 19,333) of all pregnancy-associated hospitalizations. We observed that 99.2% of injury hospitalizations of pregnant women in Vermont lacked a documented injury diagnosis and had an unspecified injury mechanism. These Vermont hospitalizations (n = 2351) were excluded, because data elements required for our analysis were missing. There were 16,982 (unweighted n = 3532) injury hospitalizations remaining for subsequent analyses; of these, 62.3% (n = 10,581, unweighted n = 2190) were nondelivery hospitalizations and 37.7% (n = 6401, unweighted n = 1342) were hospitalizations associated with a delivery.

The characteristics of the population are described in Table 1. Nearly half (46.8%) of all injury hospitalizations during pregnancy involved a woman younger than 25 years old. Medicaid (43.7%) was the most common primary expected payor of the injury hospitalizations. The average length of stay was 2.7 days for nondelivery injury hospitalizations and 4.0 for delivery injury hospitalizations.

The most common injury type for both groups of hospitalizations was fractures, dislocations, sprains, and strains. The second most common injury type was poisoning for nondelivery hospitalizations and superficial injuries, contusions and crushing injuries for delivery hospitalizations.

Injury mechanisms were identified in 89.5% of nondelivery injury hospitalizations and 72.9% of delivery injury hospitalizations (Table 2). For nondelivery hospitalizations, MVT was the most common mechanism and falls was the second most common; for delivery hospitalizations, falls was the most common mechanism, followed by MVT (Table 2). The majority of injuries for both groups of hospitalizations were unintentional, although self-inflicted injuries and assault injuries were more common in nondelivery hospitalizations than in delivery hospitalizations (Table 2).

Variables found to be significantly associated with delivery were included in a full logistic model. These variables included patient's age, payor, median household income for the patient's ZIP

TABLE 2
Comparison of injury characteristics of nondelivery and delivery hospitalizations involving pregnant women

| Characteristics | Nondelivery (n = 10,581) | | Delivery (n = 6401) | | P value |
|--------------------------------------|-----------------------------|------|------------------------|------|---------|
| | No. | % | No. | % | |
| Mechanism of injury | | | | | |
| Cut/pierce | 255 | 2.4 | 44 | 0.7 | .0000 |
| Drowning/submersion | 5 | 0.1 | 0 | 0.0 | |
| Fall | 2150 | 20.3 | 2002 | 31.3 | |
| Fire/burn | 87 | 0.8 | 43 | 0.7 | |
| Firearm | 80 | 0.8 | 29 | 0.5 | |
| Machinery | 11 | 0.1 | 8 | 0.1 | |
| Motor vehicle traffic | 3544 | 33.5 | 935 | 14.6 | |
| Pedal cyclist | 6 | 0.1 | 0 | 0.0 | |
| Pedestrian | 14 | 0.1 | 5 | 0.1 | |
| Transport | 115 | 1.1 | 33 | 0.5 | |
| Natural/environment | 143 | 1.4 | 97 | 1.5 | |
| Overexertion | 150 | 1.4 | 297 | 4.6 | |
| Poisoning | 1415 | 13.4 | 244 | 3.8 | |
| Struck by/against | 677 | 6.4 | 167 | 2.6 | |
| Suffocation | 19 | 0.2 | 5 | 0.1 | |
| Other specified mechanism | 544 | 5.1 | 448 | 7.0 | |
| Other unspecified mechanism | 329 | 3.1 | 322 | 5.0 | |
| Missing | 1037 | 9.8 | 1722 | 26.9 | |
| Intent of injury | | | | | |
| Unintentional | 7105 | 67.2 | 4296 | 67.1 | .0000 |
| Self-inflicted | 1210 | 11.4 | 24 | 0.4 | |
| Assault | 1081 | 10.2 | 350 | 5.5 | |
| Undetermined | 149 | 1.4 | 9 | 0.2 | |
| Missing | 1037 | 9.8 | 1722 | 26.9 | |
| Injury severity score (ISS) | | | | | |
| Nonsevere (ISS: 1-8) | 4010 | 37.9 | 2836 | 44.3 | .0000 |
| Severe (ISS: 9-75) | 593 | 5.6 | 201 | 3.1 | |
| Unspecified body region and severity | 3538 | 33.4 | 1269 | 19.8 | |
| Missing | 2441 | 23.1 | 2097 | 32.8 | |
| Affected body region | | | | | |
| Head and neck | 1210 | 11.4 | 409 | 6.4 | .0000 |
| Spine and back | 437 | 4.1 | 434 | 6.8 | |
| Torso | 2300 | 21.7 | 1489 | 23.3 | |
| Extremities | 1978 | 18.7 | 1083 | 16.9 | |
| Unclassifiable by site | 2215 | 20.9 | 890 | 13.9 | |
| Missing | 2441 | 23.1 | 2097 | 32.8 | |

Numbers are weighted to reflect national estimates.

code, hospital region, length of stay, certain injury types and mechanisms, intent of injury, injury severity, and affected body region.

Overexertion was the only specified injury mechanism to significantly increase the odds of a hospitalization ending in delivery (odds ratio OR 4.55, confidence interval 95% CI 2.21-9.39); MVT had significantly lower adjusted odds of including a delivery during the injury hospitalization (OR 0.36, 95% CI 0.23-0.58) (Table 3).

Compared with unintentional injuries, self-inflicted (OR 0.01, 95% CI 0.00-0.07) and assault (OR 0.22, 95% CI 0.11-0.41) injuries both had significantly lower odds of being a delivery injury hospitalization (Table 3). Severity was unrelated to delivery status (Table 3).

COMMENT

Using NIS data, we found that there were more than 16,900 injury hospitalizations of pregnant women nationwide in 2002. The rate of injury hospitalizations of pregnant women was 4.1 per 1000 deliveries, substantially higher than that reported by El-Kady et al (2.1 per 1000 deliveries in California) and also higher than we hypothesized.² The reason is likely our use of a broader criterion for "injury," one that included all acute noniatrogenic injuries, such as poisonings and injuries that fall under the "Other" ICD-9-CM injury category. Because we included these additional injury types, the leading injury types that we identified also differed from those identified in prior studies.^{2,3} For example, we found poisonings to be the second most common injury type in nondelivery hospitalizations, rather than superficial injuries, contusions and crushing injuries as previously suggested.³

The prevalence of poisonings during pregnancy highlights an opportunity for public health interventions and health-care systems to prevent injury hospitalizations. The majority (68.6%) of poisonings in the nondelivery group was self-inflicted. With the incidence of depression during pregnancy being as high as the postpartum incidence (14.5%),

TABLE 3
Adjusted odds ratios that a delivery occurred during injury hospitalization of pregnant women, by various injury characteristics

| Characteristic | Delivery hospitalization | |
|--------------------------------------|--------------------------|------------|
| | OR _{adj} | 95% CI |
| Mechanism of injury | | |
| Cut/pierce | 0.62 | 0.22-1.73 |
| Fall | 0.89 | 0.56-1.41 |
| Motor vehicle traffic | 0.36 [‡] | 0.23-0.58 |
| Overexertion | 4.55 [‡] | 2.21-9.39 |
| Poisoning | 3.88 | 0.70-21.47 |
| Struck by/against | 0.58 | 0.32-1.04 |
| Other unspecified mechanism | 2.07 [†] | 1.18-3.66 |
| Intent of injury | | |
| Unintentional | 1.00 | Reference |
| Self-inflicted | 0.01 [‡] | 0.00-0.07 |
| Assault | 0.22 [‡] | 0.11-0.41 |
| Undetermined | 0.05 [†] | 0.01-0.36 |
| Injury severity score (ISS) | | |
| Nonsevere (ISS: 1-8) | 1.00 | Reference |
| Severe (ISS: 9-75) | 0.95 | 0.54-1.66 |
| Unspecified body region and severity | 0.60 | 0.25-1.47 |
| Affected body region | | |
| Head and neck | 1.43 | 0.87-2.35 |
| Spine and back | 1.61 | 0.95-2.71 |
| Torso | 1.00 | Reference |
| Extremities | 0.96 | 0.67-1.38 |
| Unclassifiable by site | 1.00 | 0.52-1.93 |

Odds ratios are adjusted (OR_{adj}) for age, payor, median household income for patient's ZIP code, hospital region, length of stay, injury type, injury mechanisms, intent of injury, injury severity, and body region affected.

[†] $P \leq .05$.

[‡] $P \leq .001$.

the number of self-inflicted poisonings points to a need for providers to conduct prenatal mental health screening in addition to postpartum mental health screening.¹⁶ Providers should also be educating their patients about proper medicinal drug usage during pregnancy to prevent unintentional poisonings. Further studies are needed to better characterize the poisonings that occur during pregnancy and to determine which screenings or interventions are effective in decreasing the number of poisoning hospitalizations.

Our estimate that 38% of injury hospitalizations during pregnancy included delivery is also higher than estimates of prior studies, that 19-24% of pregnant trauma patients deliver during the injury hospitalization.^{2,17} We expected our estimate to be lower because our data could include multiple injury hospitalizations per pregnancy, which would lower an estimate of deliveries per injury-related pregnancy hospitalization relative to that for deliveries per pregnant patient hospitalized. Even though our higher estimate may be the result of

our using a more nationally representative multistate dataset as well as a broader definition of injury, it is nevertheless cause for concern, because the pregnancy outcomes have been shown to be worse for women who delivery during an injury hospitalization than for those who do not.^{2,3}

To better anticipate the course of an injured pregnant patient's hospitalization, health care providers need to know which injury mechanisms are associated with a delivery hospitalization. We hypothesized that we would find at least one injury mechanism to be associated with delivery. In fact, overexertion was the only reported injury mechanism that significantly increased the odds the injury hospitalization would end in delivery. Overexertion, as described by the National Center for Health Statistics, refers to excessive physical exercise, strenuous movement during activity, and overexertion from lifting, pulling, or pushing. Overexertion during pregnancy, particularly in the last trimester, is a potential problem, because the increased weight experienced by pregnant women in conjunction with hormonal changes can lead to increased joint laxity and hypermobility, which can place them at increased risk for injury.¹⁸ Although providers should continue to encourage physical activity by women with uncomplicated pregnancies, our results reinforce the need for providers to encourage their pregnant patients to follow the American College of Obstetricians and Gynecologists' recommendations concerning exercise during pregnancy.¹⁹

Our study was limited by a lack of data on gestational age, parity, race/ethnicity, or injury risk behaviors. Our study was also limited by its reliance on hospital discharge data, whose accuracy depends on the quality and consistency of coding by hospitals participating in HCUP NIS. For example, we excluded certain Vermont hospitalization records, because of possible miscoding, and therefore we may have underestimated the number of injury-related hospitalizations during pregnancy that occurred in 2002. Although the HCUP database has a higher injury mechanism reporting rate than in other publicly available databases, there

still were some injury hospitalizations records that did not document the type or cause of injury.²⁰ Missing injury type and mechanism data led to limited information on injury severity and intent. Also, although we used the first listed injury code to describe the nature of a patient's injury, this code may not necessarily reflect the patient's most severe injury, nor the primary reason for hospital admission.

Our results showed that pregnant women are hospitalized for injuries more often than previously thought. To decrease the number of such hospitalizations, providers need to broaden the injury prevention messages they give to pregnant patients during prenatal care visits. Pregnant women should receive at least the same injury prevention interventions and messages as nonpregnant women do during routine medical visits (eg, about seatbelt use). Care providers should also not let a patient's pregnant state deter them from screening that patient for depression or substance abuse, an issue alluded to in prior research.^{21,22} Care providers should also proactively provide their pregnant patients with information on proper medication usage and appropriate activity levels during pregnancy. ■

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