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Trauma during pregnancy: An analysis of maternal and fetal outcomes in a large population

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Objective: This study was undertaken to determine the occurrence rates, outcomes, risk factors, and timing of obstetric delivery for trauma sustained during pregnancy.

Study design: This is a retrospective cohort study of women hospitalized for trauma in California (1991-1999). International Classification of Disease, ninth revision, Clinical Modification codes, and external causation codes for injury were identified. Maternal and fetal/neonatal outcomes were analyzed for women delivering at the trauma hospitalization (group 1), and women sustaining trauma prenatally (group 2), compared with nontrauma controls. Injury severity scores and injury types were used to stratify risk in relation to outcome. Statistical comparisons are expressed as odds ratios (ORs) with 95% CIs.

Results: A total of 10,316 deliveries fulfilling study criteria were identified in 4,833,286 total deliveries. Fractures, dislocations, sprains, and strains were the most common type of injury. Group 1 was associated with the worst outcomes: maternal death OR 69 (95% CI 42-115), fetal death OR 4.7 (95% CI 3.4-6.4), uterine rupture OR 43 (95% CI 19-97), and placental abruption OR 9.2 (95% CI 7.8-11). Group 2 also resulted in increased risks at delivery: placental abruption OR 1.6 (95% CI 1.3-1.9), preterm labor OR 2.7 (95% CI 2.5-2.9), maternal death OR 4.4 (95% CI 1.4-14). As injury severity scores increased, outcomes worsened, yet were statistically nonpredictive. The type of injury most commonly leading to maternal death was internal injury. The risk of fetal, neonatal, and infant death was strongly influenced by gestational age at the time of delivery.

Conclusion: Women delivering at the trauma hospitalization (group 1) had the worst outcomes, regardless of the severity of the injury. Group 2 women (prenatal injury) had an increased risk of adverse outcomes at delivery, and therefore should be monitored closely during the subsequent course of the pregnancy. This study highlights the need to optimize education in trauma prevention during pregnancy.

Traumatic injuries in pregnancy are a major cause of maternal and neonatal morbidity and mortality.[1-13] In fact, trauma is the leading cause of nonobstetric maternal mortality in the United States. Motor vehicle accidents alone in the United States result in 1300 to 3900 fetal losses per year.[1,2] Trauma is not a rare event, prior

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studies suggest that 6% to 7% of all pregnancies may be affected by some sort of traumatic injury.[3,4] Consequently, clinicians may encounter a wide range of trauma in their practice. Trauma, severe or nonsevere, has been associated with an increased risk of spontaneous abortion, premature labor, preterm premature rupture of the membranes, uterine rupture, placental abruption, fetal distress, maternal death, and stillbirth.[5] Even minor injuries have been associated with adverse pregnancy outcomes.[6]

Most published studies of trauma in pregnancy analyze outcomes and make management recommendations that are based predominantly on small numbers of case series at single institutions. Because few population-based studies have been published, it has been difficult to formulate recommendations for preventative measures in the public health arena.[7] The ability to predict adverse outcomes for both the mother and fetus is an important goal in pregnancies affected by trauma in order to improve outcomes.

In our study, we sought to analyze the occurrence rates, risk factors, and maternal and fetal outcomes of women hospitalized for trauma during pregnancy in a large population. We also analyzed clinical outcomes stratified by the timing of trauma in relation to delivery, by different types and mechanisms of injuries, and by the severity of injury.

Methods

A computerized database of hospital discharge records linked to birth and death certificates in the state of California has been used for this study (Vital Statistics-Patient Discharge Database, [VS/PDD]), and is compiled from hospitals reporting to the California Office of Statewide Health Planning and Development. Linkage of maternal and neonatal/infant hospital discharge records with birth and death records has been shown to be successful in 98% of cases.[14] This study was approved by the Office of Statewide Health Planning and Development and by the institutional review board at the University of California at Davis.

Codes using the International Classification of Diseases, ninth revision, Clinical Modification (ICD-9-CM) were used to identify hospitalizations for trauma and injury classifications. Injury classifications included: Fractures/dislocations/sprains/strains (800-849), intracranial injuries (850-854), internal injuries to thorax, abdomen and pelvis (860-869), open wounds (870-897), injury to blood vessels (900-904), superficial injuries/contusions/crushing injuries (910-929), burns (940-949), and nerve and spinal cord injuries (950-957). External causation codes (E-codes) were used to identify mechanisms of injury, including: motor vehicle accidents (E810-E825), falls (E880-E889), drowning (E 910), suicide attempts (E950-E959), assaults (E960-E969), fires (E890-E899), and use of guns (E922, E955, E965, E985).

Maternal outcome measures included: preterm labor (644.0, 644.2), premature rupture of membranes (658.2), placental abruption (641.2), cesarean hysterectomy (68.3, 68.4, 68.6, 68.8), uterine rupture before and during labor (665.0, 665.1), blood transfusion (99.0), cesarean section, and maternal death. Fetal/neonatal/infant outcomes included: premature delivery (before 37 weeks), low birth weight (under 2500 g), fetal distress (656.3, 768.2, 768.3, 768.4), birth asphyxia (768.5, 768.6, 768.7, 768.9), respiratory distress syndrome (769), fetal, neonatal, and infant death. Demographic characteristics analyzed included maternal age, race, education, insurance type, parity, and start of prenatal care.

Outcomes were analyzed for women who delivered at the time of trauma hospitalization (group 1), and for women who were hospitalized for trauma up to 9 months preceding the obstetric delivery hospitalization (group 2). Maternal and neonatal outcomes of trauma during pregnancy were compared with uninjured pregnant women. Pregnant women who sustained fetal loss before 20 weeks' gestation were not captured in the VS/PDD.

The severity of the injury sustained in pregnancy has been previously assessed using the injury severity score (ISS).[8] ISS is an anatomic scoring system used for trauma patients. Six body regions are assigned scores and the highest 3 scores are squared and summed to produce the ISS. [9] Scores less than 9 were categorized as nonsevere, and scores 9 or greater were categorized as severe injuries. IS scores were assigned using ICDMAP-90 Software (Tri Analytics Inc, Bel Air, Md). Any record with an ICD-9-CM code ranging from 800 to 969 was assigned an ISS. Records indicated as injury using an ICD-9-CM with an ISS of 0 were considered noninjured. An ISS of 99, denoting the software's inability to score the injury, was excluded from the study. Women were considered injured if they had 1 of the above ICD-9-CM codes for injury and an ISS greater than 0. IS scores were used to stratify risk in relation to maternal and fetal outcomes.

Descriptive statistics were calculated based on the entire number of deliveries that occurred between 1991 and 1999. As demographic variables have been shown to affect the outcomes of interest (ie, maternal age, race, parity, education, insurance, prenatal care, and gestational age), we used logistic regression to obtain risk-adjusted odds ratios (ORs) with 95% CIs, to assess the associations between injuries during pregnancy for maternal, fetal, neonatal, and infant death. As a woman may have had multiple deliveries during the study period, we randomly picked 1 of her deliveries to obtain the risk-adjustment model. Poisson regression was performed for relative risk estimation. All relative risks calculated by Poisson regression equaled or approximated

Table I Occurrence rates and mechanism of injury

	Injury at delivery (group 1)		Prenatal injury (group 2)	
ICD-9-CM injury classifications	N	Per 1000 deliveries	N	Per 1000 deliveries
Any of the following injuries and ISS>0	2,494	0.52	7,822	1.62
Fractures, dislocations, sprains, and strains	1,037	0.21	3,781	0.81
Intracranial injuries	69	0.01	757	0.16
Internal injuries to thorax, abdomen, and pelvis	241	0.05	606	0.14
Open wounds	282	0.06	2,017	0.42
Injury to blood vessels	108	0.02	105	0.02
Superficial injuries, contusions, and crushing injuries	799	0.17	2,975	0.63
Burns	120	0.02	174	0.04
Nerve and spinal cord injuries	120	0.02	189	0.04
Total injuries	2,776		10,604	
Mechanisms of injury:				
Motor vehicle crashes	405	0.08	3,218	0.67
Falls	439	0.09	1,460	0.30
Suicide attempts	11	0.00	242	0.05
Assaults	112	0.02	1,195	0.25
Fires	13	0.00	42	0.01
Guns	20	0.00	297	0.06

the calculated ORs. As for the risk-adjusted analysis, we did not use the entire population of deliveries, but rather a subset that ensured that each mother occurred at most once in our analysis, logistic regression was deemed the appropriate route of analysis. All analyses were performed in SAS (Cary, NC).

Results

A total of 4,833,286 obstetric deliveries were identified in VS/PDD database from 1991-1999. We observed that 10,316 (0.2 %) deliveries met study criteria with at least 1 ICD-9-CM code for trauma and an ISS of 0. Of those, 2,494 deliveries occurred at the time of trauma hospitalization associated with 2,776 injuries (group 1, occurrence 0.52 per 1,000 deliveries) and 7,822 women were hospitalized for trauma during the prenatal period associated with 10,604 injuries (group 2, occurrence 1.62 per 1,000 deliveries). Table I shows the occurrence rates for trauma types and mechanism of injury. For both groups of women the most common form of injury were fractures/dislocations/sprains and strains, (group 1 occurrence rate 0.21 per 1,000 deliveries, group 2, 0.78 for 1,000 deliveries), followed by superficial injuries/contusions/crushing injuries (group 1, 0.17 per 1,000; group 2, 0.62 for 1,000).

Falls were the most common mechanism of injury for women delivering at the trauma hospitalization (group 1), followed by motor vehicle accidents. Motor vehicle accidents lead to the majority of admissions for women admitted during the prenatal period, (group 2), followed by falls. Assaults were the third most common mechanism of injury for both groups of women.

As shown in Table II, demographic variables affected the timing and the probability of sustaining injury. Group 1 had a larger number of older women age 30 to 41+, whereas group 2 had a higher number of women under 20, and 21 to 25 compared with the control group. Both groups had a higher number of multiparous women, parity 3 or higher, and a larger number of non-Hispanic white and African American women. Both had higher rates of no prenatal care and were less likely to initiate prenatal care in the first trimester. There were more women delivering between 28 to 36 weeks in both groups of women, with a larger increase in premature deliveries in the group delivering at the admission for trauma (group 1).

The effect of injuries on maternal and fetal/neonatal outcomes is shown in Table III. For any type of injury that occurred in group 1, both the maternal and fetal/neonatal outcomes were significantly worse compared with the control group and group 2. For women in group 1, the risk of placental abruption was 9-fold higher, risk of uterine rupture 42-fold higher, and the risk of maternal death was 69-fold higher compared with the control group. For the neonates of women in group 1, adverse fetal outcomes included a 2-fold increase in premature delivery, a 4.6-fold increase in fetal death, and a 3-fold increase risk of neonatal death.

Table II Demographics

Characteristic	Category	Uninjured (N)	%	Injury at delivery (group 1) Any injury (N)	%	*P*-value	Injury prenatally (group 2) Any injury (N)	%	*P*-value
Maternal age (y)	20 and under	790,816	16.37	325	13.03	.0001	1,637	20.93	.0001
	21-25	1,217,070	25.20	568	22.77		2,132	27.26	
	26-30	1,332,308	27.58	713	28.59		1,948	24.90	
	30-35	1,001,102	20.72	562	22.53		1,309	16.73	
	35-40	418,146	8.66	276	11.07		676	8.64	
	41+	70,120	1.45	43	1.72		116	1.48	
Race/ethnicity	Non-Hispanic white	1,698,145	35.15	974	39.05	.0001	3,023	38.65	.0001
	African American	348,300	7.21	237	9.50		1,392	17.80	
	Hispanic	2,236,202	46.29	1,032	41.38		2,753	35.20	
	Asian	343,802	7.12	147	5.89		355	4.54	
	Other race	185,219	3.83	88	3.53		271	3.46	
Maternal education	Less than high school	1,625,535	33.65	746	29.91	.0007	2,679	34.25	.0001
	Completed high school	1,404,660	29.08	727	29.15		2,696	34.47	
	Some college, no degree	923,278	19.11	510	20.45		1,542	19.71	
	College	827,521	17.13	470	18.85		794	10.15	
Insurance	MediCal	2,259,227	46.77	1,117	44.79	.6760	4,603	58.85	.0001
	Private insurance	975,733	20.20	505	20.25		1,182	15.11	
	Managed care	1,433,958	29.69	759	30.43		1,842	23.55	
	Self-pay/uninsured	142,437	2.95	71	2.85		157	2.01	
Parity	Nulliparous	1,877,374	38.86	937	37.57	.0006	2,800	35.80	.0001
	1	1,496,055	30.97	748	29.99		2,170	27.74	
	2	811,833	16.81	386	15.48		1,370	17.51	
	3 or higher	640,650	13.26	400	16.04		1,466	18.74	
Prenatal care	None	53,318	1.10	63	2.53	.0001	186	2.38	.0001
	First trimester	3,756,592	77.77	1,877	75.26		5,721	73.14	
	Second trimester	802,857	16.62	409	16.40		1,479	18.91	
	Third trimester	164,835	3.41	77	3.09		304	3.89	
Gestational age	under 28 wks	35,433	0.73	65	2.61	.0001	79	1.01	.0001
	28 to 32 wks	68,169	1.41	110	4.41		156	1.99	
	33 to 36 wks	364,150	7.54	264	10.59		737	9.42	
	37 or more wks	3,963,329	82.05	1,777	71.25		6,005	76.77	

P values compare groups to uninjured women.

Women sustaining trauma prenatally (group 2) had worse outcomes compared with the control group, yet to a much less degree than group 1. Group 2 women sustained a 2.7-fold increase in premature labor, and a 4-fold increased risk of maternal death compared with uninjured control women. In addition, there was a 20% increase in preterm delivery, 56% higher placental abruption rate, a 38% increase in low birth weight, and an increase need for blood transfusions. There was no significant increased risk of fetal or neonatal mortality in group 2. The mean time to hospitalization for delivery from the hospitalization for trauma was 152 days in group 2 cases.

Outcomes stratified by severity of injury using IS scores are shown in Table IV. For group 1, the outcomes were worse for severe injuries (ISS > 10), compared with nonsevere injuries (ISS <10). A nonsevere score, however, still carried significant risk of adverse maternal and fetal/neonatal outcomes. Examples include a 7.7-fold increased risk of abruption, a 16-fold increase in uterine rupture, a 4.9-fold increase in maternal death, and a 2.7-fold increase in fetal death for nonsevere injury. For severe injury, we observed a 23-fold increased risk of abruption, 233-fold risk of uterine rupture, a 555-fold increased risk of maternal death, and a 17-fold increased risk of fetal death.

There were minimal differences in risk for the maternal/fetal outcomes when stratifying for severity of the injury for women admitted for trauma prenatally (group 2). These women still had increased risk of adverse outcomes compared with the control population, as described previously, yet the outcomes did not consistently worsen with increasing severity of injury.

Logistic regression was performed to determine which factors were the most significant contributors to maternal, fetal, neonatal, and infant death. The model included the following variables: maternal age, race,

Table III Outcomes

	Non-injured		Injury at delivery (group 1)					Injury prenatally (group 2)				
Outcomes	N	%	N	%	OR	95% CI	*P* value	OR	N	%	95% CI	*P* value
Maternal												
Preterm labor	256,941	7.06	267	14.40	2.13	(1.87-2.43)	.000	979	18.41	2.70	(2.51-2.89)	.000
PROM	57,941	1.59	45	2.43	1.46	(1.09-1.97)	.013	101	1.90	1.18	(0.97-1.44)	.106
Placental abruption	32,083	0.88	149	8.04	9.22	(7.79-10.91)	.000	82	1.54	1.56	(1.25-1.94)	.000
Induction	76,095	2.09	47	2.54	1.17	(0.88-1.57)	.287	118	2.22	1.07	(0.89-1.28)	.482
Cesarean section	813,914	22.36	726	39.16	2.18	(1.98-2.40)	.000	1361	25.59	1.20	(1.13-1.28)	.000
Maternal death	405	0.01	16	0.86	69.48	(41.83-115.4)	.000	3	0.06	4.43	(1.42-13.82)	.011
Uterine rupture prior labor	267	0.01	6	0.32	42.87	(19.04-96.53)	.000	0	0			
Uterine rupture during labor	2,288	0.06	11	0.59	8.96	(4.94-16.24)	.000	2	0.04	0.60	(0.15-2.41)	.474
Blood transfusion	10,897	0.30	78	4.21	13.86	(11.03-17.41)	.000	30	0.56	1.76	(1.23-2.52)	.002
Cesarean hysterectomy	1,909	0.23	15	2.07	7.83	(4.66-13.15)	.000	3	0.22	0.87	(0.28-2.70)	.808
Infant												
Preterm delivery	356,586	10.64	336	20.12	2.07	(1.84-2.34)	.000	654	13.66	1.20	(1.11-1.31)	.000
Low birth weight	215,876	5.93	269	14.51	1.67	(1.40-2.00)	.000	489	9.20	1.38	(1.23-1.55)	.000
Fetal distress	348,765	9.58	310	16.72	1.84	(1.62-2.10)	.000	611	11.49	1.20	(1.09-1.31)	.000
Asphyxia	17,999	0.49	30	1.62	2.40	(1.59-3.62)	.000	27	0.51	0.97	(0.66-1.44)	.896
RDS	49,495	1.36	102	5.50	2.10	(1.63-2.71)	.000	91	1.71	1.04	(0.82-1.31)	.783
Fetal death	15,037	0.41	60	3.24	4.67	(3.42-6.37)	.000	25	0.47	0.95	(0.63-1.43)	.803
Neonatal death	11,720	0.32	27	1.50	3.11	(1.92-5.04)	.000	22	0.42	0.94	(0.58-0.54)	.818
Infant death	18,640	0.51	31	1.73	2.20	(1.42-3.40)	.001	38	0.72	1.04	(0.72-1.51)	.850

The adjusted odds are controlled for maternal age, parity, race/ethnicity, education, prenatal care, and insurance type.
For all death outcomes, the adjusted odds also controls for gestational age.
PROM, Premature rupture of membrane; *RDS*, respiratory distress syndrome.

education, prenatal care, insurance, parity, severity of injury, gestational age, and type and mechanism of the injury. As shown in Table V, for women in group 1, the injury type associated with the highest risk of maternal death was internal injury, followed by intracranial injury. The risk of maternal death was highest in older women 41+, in women with severe injuries, and women at gestational ages at 32 weeks or less. The most common type of injury causing fetal death was also internal injury, followed by open wounds. Injury to blood vessels was the most common type of injury leading to neonatal and infant death. The largest contributor to the risk of fetal, neonatal and infant death was gestational age, with less than 28 weeks' gestation associated with the highest risk, followed by 28 to 32 weeks. This effect was also observed for group 2.

Comment

Women who delivered at the trauma hospitalization (group 1) had the worst maternal/fetal/neonatal outcomes when compared with all others. In addition, these women had progressively worse outcomes with higher IS scores (≤ 9). Significant maternal and fetal morbidity and mortality occurred; however, even with nonsevere injuries (ISS < 9). Although higher IS scores were associated with worse outcomes, lower scores still had significantly elevated adverse outcomes therefore limiting their predictability in pregnant trauma patients. Women sustaining trauma during pregnancy who deliver at a subsequent hospitalization (group 2) continue to have an increased risk of maternal mortality and significant morbidity at delivery and should be monitored closely during the pregnancy. When injury type was examined, maternal and fetal death was highest with internal injuries to the thorax, abdomen, and pelvis. Gestational age was the strongest predictor of fetal, neonatal, and infant death, and less so the type, mechanism, or severity of the injury.

The use of the large obstetric database in California allowed for population-based estimates of occurrence rates of hospitalizations for trauma during pregnancy (group 1, 0.52 per 1000 deliveries; group 2, 1.62 per 1000). We found that 24% of pregnant trauma patients admitted to the hospital will deliver at the trauma hospitalization, which is consistent with Williams et al.[12]

The leading injury type in both groups of trauma patients was fractures/dislocations/sprains/strains, which is consistent with Shiff et al[6] in a smaller population of patients. Falls, resulting in hospital admission, were the leading mechanism of injury in group 1, leading to the severest injuries and the worst outcomes. Women admitted with the diagnosis of falls during pregnancy

Table IV Outcomes of injury stratified by severity

		Injury at Delivery (group 1)						Injury prenatally (group 2)					
					Adjusted OR						Adjusted OR		
Outcome	Injury severity	N	%	*P*-value	OR	LCL	UCL	N	%	*P*-value	OR	LCL	UCL
Preterm labor	ISS<9	231	14.1	.000	2.08	1.81	2.39	870	19.5	.000	2.90	2.69	3.13
	ISS≥9	36	16.9	.000	2.55	1.78	3.66	109	12.7	.000	1.71	1.39	2.09
PROM	ISS<9	42	2.6	.007	1.53	1.12	2.08	82	1.8	.237	1.14	0.92	1.42
	ISS≥9	3	1.4	.900	0.93	0.30	2.91	19	2.2	.073	1.37	0.87	2.17
Abruption	ISS<9	111	6.8	.000	7.65	6.30	9.29	67	1.5	.001	1.52	1.19	1.94
	ISS≥9	38	17.8	.000	22.89	16.06	32.62	15	1.7	.030	1.76	1.06	2.94
Induction	ISS<9	43	2.6	.250	1.20	0.88	1.62	104	2.3	.253	1.12	0.92	1.36
	ISS≥9	4	1.9	.977	0.98	0.36	2.66	14	1.6	.400	0.80	0.47	1.35
Cesarean section	ISS<9	562	34.2	.000	1.74	1.57	1.93	1151	25.8	.000	1.21	1.13	1.29
	ISS≥9	164	77.0	.000	12.71	9.19	17.57	210	24.4	.032	1.19	1.01	1.39
Maternal death	ISS<9	1	0.1	.112	4.93	0.69	35.17	3	0.1	.004	5.28	1.69	16.48
	ISS≥9	15	7.0	.000	554.7	317.4	969.3	0	0.0	.982	—	—	—
Uterine rupture prior labor	ISS<9	2	0.1	.000	16.34	4.06	65.8	0	0.0	.977	—	—	—
	ISS≥9	4	1.9	.000	233.9	85.8	637.8	0	0.0	.990	—	—	—
Uterine rupture during labor	ISS<9	5	0.3	.001	4.61	1.91	11.10	2	0.0	.629	0.71	0.18	2.84
	ISS≥9	6	2.8	.000	42.14	18.63	95.33	0	0.0	.937	—	—	—
Transfusion	ISS<9	46	2.8	.000	9.12	6.80	12.25	26	0.6	.003	1.82	1.24	2.67
	ISS≥9	32	15.0	.000	54.46	37.21	79.72	4	0.5	.471	1.44	0.54	3.84
Cesarean hysterectomy	ISS<9	8	1.4	.000	5.39	2.66	10.91	2	0.2	.580	0.68	0.17	2.71
	ISS≥9	7	4.3	.000	16.22	7.45	35.27	1	0.5	.483	2.03	0.28	14.55
Preterm delivery	ISS<9	266	17.9	.000	1.81	1.58	2.06	541	13.5	.000	1.19	1.08	1.30
	ISS≥9	70	37.6	.000	4.79	3.54	6.47	113	14.7	.014	1.29	1.05	1.57
Low birth weight	ISS<9	197	12.0	.000	1.44	1.18	1.76	407	9.1	.000	1.39	1.23	1.58
	ISS≥9	72	33.8	.000	3.60	2.34	5.53	82	9.5	.075	1.31	0.97	1.75
Fetal distress	ISS<9	245	14.9	.000	1.61	1.39	1.86	508	11.4	.001	1.19	1.08	1.31
	ISS≥9	65	30.5	.000	4.21	3.06	5.77	103	12.0	.060	1.23	0.99	1.54
Asphyxia	ISS<9	19	1.2	.003	2.05	1.27	3.32	21	0.5	.773	0.94	0.60	1.46
	ISS≥9	11	5.2	.000	4.59	2.02	10.42	6	0.7	.749	1.16	0.48	2.79
RDS	ISS<9	70	4.3	.000	1.82	1.35	2.44	73	1.6	.884	1.02	0.79	1.32
	ISS≥9	32	15.0	.000	3.52	2.09	5.95	18	2.1	.690	1.11	0.66	1.89
Fetal death	ISS<9	25	1.7	.000	2.70	1.76	4.14	22	0.5	.835	1.05	0.68	1.63
	ISS≥9	28	15.1	.000	16.85	9.90	28.68	3	0.4	.319	0.55	0.17	1.78
Neonatal death	ISS<9	16	1.1	.000	2.97	1.70	5.19	15	0.4	.852	0.95	0.55	1.65
	ISS≥9	7	4.4	.011	3.61	1.35	9.67	4	0.5	.856	0.91	0.31	2.67
Infant death	ISS<9	18	1.2	.009	1.98	1.19	3.29	27	0.7	.708	1.08	0.72	1.63
	ISS≥9	8	5.1	.011	3.17	1.31	7.67	6	0.8	.798	0.89	0.37	2.15

LCL, Lower confidence limit; *UCL*, Upper confidence limit.

should be closely monitored. The possibility of assault as the true mechanism of injury should always be investigated in such cases.

The demographic distribution found in our study was consistent with data for injuries in the state of Pennsylvania, described by Weiss[11] showing an increased risk of injury in younger women prenatally.[3,10] However, our study demonstrated that there were a larger number of older, multiparous women sustaining severe injuries who delivered at the trauma hospitalization compared with controls. Both younger (age 20 and under), and older multiparous women (age 35-41+), at gestational ages under 28 weeks sustaining injury, are at highest risk of adverse outcomes, and preventative measures should be targeted at these women early in the pregnancy. Because these women are less likely to initiate early prenatal care, preventive measures may be challenging.

In our study, women sustaining trauma prenatally (group 2) had increased morbidities, including higher rate of abruption, premature delivery, and low birth weight at delivery, over noninjured control women. These results may support the theory that subclinical chronic abruptions secondary to trauma may lead to placental insufficiency and low birth weight infants.[12]

Table V Mortality analysis using logistic regression (group 1)

Factor	Maternal			Fetal			Neonatal			Infant		
Age (y)	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
20 and	0.66	(0.4-0.99)	.043	0.74	(0.7-0.8)	.000	0.91	(0.9-0.96)	.001	1.08	(1.03-1.13)	.001
21-25	0.79	(0.6-1)	.172	0.96	(0.9-1.0)	.138	0.99	(0.95-1.0)	.806	1.05	(1.01-1.09)	.013
30-35	1.51	(1.1-2.1)	.011	1.15	(1.1-1.2)	.000	1.10	(1.1-1.2)	.000	1.05	(1.01-1.09)	.023
35-40	1.61	(1.1-2.4)	.018	1.37	(1.9-1.6)	.000	1.24	(1.2-1.3)	.000	1.15	(1.1-1.2)	.000
41+	2.86	(1.6-5.1)	.000	1.97	(1.8-2.2)	.000	1.71	(1.6-1.9)	.000	1.61	(1.47-1.8)	.000
Parity												
1	0.63	(0.5-0.9)	.002	0.75	(0.7-0.8)	.000	0.84	(0.81-0.9)	.000	0.96	(0.93-1.0)	.029
2	0.82	(0.6-1.2)	.250	0.85	(0.8-0.9)	.000	0.93	(0.9-0.98)	.003	1.06	(1.0-1.1)	.013
3+	0.85	(0.6-1.2)	.382	1.01	(0.9-1.1)	.806	1.09	(1.0-1.1)	.002	1.27	(1.2-1.33)	.000
Injury												
ISS<9	2.18	(0.21-23)	.516	0.32	(0.14-0.7)	.008	0.69	(0.3-1.5)	.330	0.63	(0.31-1.3)	.204
ISS≥9	14.6	(1.5-143)	.022	0.47	(0.13-1.7)	.237	0.71	(0.2-2.3)	.568	0.58	(0.2-1.8)	.336
Wks												
<28	10.9	(6.9-17.1)	.000	134.6	(128-140)	.000	305.8	(294-318)	.000	181.1	(175-187)	.000
28-32	10.1	(7.1-14.4)	.000	28.0	(27-29)	.000	32.4	(31-34)	.000	20.9	(20-21.7)	.000
33-36	4.0	(3.1-5.2)	.000	5.8	(5.5-6.0)	.000	6.2	(5.9-6.4)	.000	4.35	(4.2-4.5)	.000
Injury type												
Fractures	0.6	(0.11-4.0)	.650	1.81	(0.8-4.1)	.158	1.87	(0.9-4.0)	.107	1.77	(0.87-3.6)	.115
Intracranial	11.1	(1.6-76)	.014	1.97	(0.5-7.9)	.340	7.43	(2.3-24.3)	.001	4.87	(1.5-15.5)	.007
Internal	15.0	(1.9-117)	.010	6.67	(2.7-16.7)	.000	2.06	(0.8-5.0)	.112	2.46	(1.1-5.7)	.036
Open	2.1	(0.32-14)	.434	4.81	(2.1-11.3)	.000	3.27	(1.4-7.4)	.005	3.55	(1.7-7.6)	.001
Blood	3.1	(0.25-39)	.377	2.22	(0.3-18.2)	.459	9.75	(2.3-41.8)	.002	9.59	(2.5-37.3)	.001
Superficial	0.14	(0.0-4.09)	.255	1.05	(0.4-2.6)	.920	1.20	(0.5-2.8)	.672	1.16	(0.53-2.5)	.715
Burns	0.00	—	—	—	—	—	1.87	(0.2-19.4)	.602	1.50	(0.15-15)	.727
Nerve and Mechanism	0.00	—	—	7.2	(0.9-55.3)	.059	0.67	(0.03-13)	.788	0.49	(0.03-8.8)	.625
MVA	3.1	(0.41-23)	.271	5.4	(2.9-9.8)	.000	3.65	(2.0-6.6)	.000	3.43	(1.96-6.0)	.000
Falls	0.0	—	—	4.2	(2.0-8.7)	.000	2.03	(0.9-4.4)	.075	2.05	(1.01-4.12)	.045
Assaults	5.63	(0.36-89)	.219	6.4	(2.6-15.8)	.000	3.32	(1.2-9.1)	.020	2.60	(1.0-6.7)	.051

MVA, Motor vehicle accident.

We believe that women admitted to the hospital for trauma and delivered at a subsequent hospitalization should be closely monitored during the remainder of their pregnancies.

Our study concludes that IS scores are not predictive of outcomes, and that adverse outcomes can occur with the assignment of a nonsevere score.[8] We did find, however, that for women delivering at the trauma hospitalization, as the ISS increased, a proportional increase in maternal and fetal morbidity and mortality was seen. ISS was not predictive in the group of women sustaining trauma prenatally. We agree with Schiff et al[8] that an obstetric scoring system should be developed to assess outcomes in traumatized pregnant women.

Many studies have attempted to identify or predict fetal outcome after injury using factors such as IS scores and maternal coagulation defects.[8,10,13] Our study has found that fetal outcome is highly dependent on gestational age and less so on the injury type, mechanism, or severity of the injury. The group under 28 weeks' gestation had the highest risk of fetal/neonatal/ infant death most likely related to compounded complications of prematurity and injury. Stillbirth was highest for the group under 28 weeks' gestation; this may denote poor fetal tolerance to maternal physiologic stress of trauma.

This is a retrospective, population-based study, analyzing women with a discharge diagnosis of trauma during pregnancy, and cannot be generalized to women sustaining minor trauma not requiring hospitalization, or to women with pregnancy loss before 20 weeks' gestation. In addition, our study does have some limitations that were based on a retrospective study design and the use of computer coded data, which are subject to some degree of error. However, our results are similar to other published work and the large number of cases accessible in this population-based data set minimizes the effects of a small error rate.

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