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Hospital Costs Associated with Stillbirth Delivery

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Abstract

Objectives—Fetal deaths account for nearly one percent of all births in the United States. The cost of hospital care associated with fetal deaths may be substantial. However, there is very limited data on the economic burden of fetal death.

Methods—We conducted a retrospective medical chart review of stillbirths at three large hospitals in Michigan over a ten-year period and identified medical complications, hospital costs, and length of stay for these deliveries. Mothers with stillbirth were matched with mothers of the same age who delivered a live-born infant at the same hospital during the same year.

Results—Our final sample was comprised of 533 stillbirths and 1053 matched live births. Average hospital cost for stillbirth was \$7495 (± 7015) and the average length of stay was 2.8 days (± 2.8). Having a serious maternal medical complication was associated with higher costs and longer length of stay among women with stillbirth. Early stillbirths between 20–28 weeks gestational age, epidural/spinal/general anesthesia, and cesarean delivery were also associated with longer length of stay. Average hospital costs for women with stillbirth were more than \$750 higher than women with live births but length of stay was not significantly different between the two.

Conclusions—This study suggests that stillbirths were associated with substantial maternal hospital costs. Future research examining the economic impact of stillbirths beyond labor and delivery such as increased costs associated with additional testing and care in subsequent pregnancies will help better understand the overall economic impact of stillbirths.

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Keywords

fetal death; hospital costs; length of stay; obstetrics; stillbirth

Introduction

Stillbirths (fetal death at 20 weeks of gestation or more) total about 26,000 per year in the United States, accounting for nearly 1% of all deliveries.[1] While the cost of hospitalization and length of stay associated with live births in the United States is well-established, there is only limited data about these measures for deliveries of stillborn infants. [2–5] Yet the overall economic impact of stillbirths may be substantial. In addition to the direct costs of labor and delivery, a loss may precipitate need for additional testing and care in subsequent pregnancies, adverse mental or physical health outcomes of the parents and associated health care costs, lost parental productivity, and lost lifetime productivity of the newborn. Recognizing that stillbirth deliveries have not only emotional but economic consequences may increase support for efforts to prevent fetal deaths.

To fill this important gap in the literature, this paper evaluated hospital costs and length of stay associated with labor and delivery of stillbirths and compared cost and length of stay of stillbirths with matched live birth deliveries. We also examined how maternal demographics, mode of delivery, medical interventions, and maternal complications may affect hospital costs or length of stay in stillbirth deliveries. This evaluation makes a useful first step towards elucidating the direct economic cost of stillbirth delivery in the U.S. and hopefully will help inform the broader discussion on the economic impact of stillbirths.

Methods

Data Sources

We abstracted paper charts and computerized medical records for stillbirth deliveries between 1996 and 2006 at three large academic hospitals in southeastern Michigan. Two hospitals were urban and one suburban. Together, the three hospitals account for approximately 12,000 deliveries per year. The study was approved by the Institutional Review Boards at the University of Michigan and Wayne State University as these boards had oversight for research at the three participating hospitals. We identified stillbirths as fetal deaths at or greater than 20 weeks gestational age, and excluded cases in which a multiple pregnancy resulted in both a live and stillborn infant (n=11) since it was not clear whether the hospital stay should be counted in the stillborn or live born category. At two hospitals we collected available data on every stillbirth in 1996–2006. We did not have enough resources to collect all stillbirths at the largest of the three hospitals, so in this case we deliberately oversampled non-African-American women from the 10 year period (the patient population was heavily African-American). This allowed us to evaluate potential differences in care by race and ethnicity which was important since few U.S. studies have looked specifically at care of African-American women with stillbirth even though this population faces twice the risk of stillbirth compared to Caucasian women.[1]

For each mother with stillbirth, we identified two control mothers with a live birth and matched on year of delivery, hospital, and maternal age. In the few cases where an exact match was not available, we selected a control from the next delivery year or, if still not available, a control who was one year older than the case. Our initial data set included 535 stillbirths from the three hospitals. We removed 2 stillbirths with outlier costs. Both had extremely high hospital costs (\$880,000 and \$240,000) due to critical illness in the mother and when these outliers were included, they had a significant impact on the results. For example, including the outliers increased the regression coefficient corresponding to hospital cost by almost 300% with a 4-fold rise in its standard error. After this exclusion, we had a final analytic sample size of 533 stillbirths.

Of the 1066 matched live births, billing data were not available for 11 of them and 2 had extremely low hospital costs (less than \$200 for labor and delivery). We deemed the latter two live births as having data errors and hence excluded them from the analysis. This left us with a final analytic sample of 1053 matched live births as controls. No cases or controls were included in the analysis more than once.

Data collection for stillbirths included demographics, information about medical and obstetrical histories, prenatal data, labor and delivery methods and complications, cause of death, length of stay, and hospital charges. For controls, we collected demographic information (including maternal age, race, and insurance), length of stay, and hospital charges. Research assistants were trained in obstetrical chart abstraction until they achieved 90% concordance with other trained abstractors. Charts were abstracted by a single research assistant and approximately 75% of charts were randomly re-abstracted or reviewed by the primary investigator for accuracy. Data were double-entered and was analyzed with Stata SE 10.1 (College Station, TX).

Statistical Analysis

Total hospital charges attributed to the mother during her hospitalization for labor and delivery were included. For stillbirths, this included charges for any fetal testing or monitoring. For live births, any hospital charges for infant care were billed separately to the infant and not included in our maternal cost data. Charges were converted to costs using the hospital-year specific cost-to-charge ratios published in the historical impact files from the Centers for Medicare & Medicaid Services.[6] All cost estimates were adjusted to 2010 United States dollars using the medical care component of the Consumer Price Index for all urban consumers.[7] Physician fees were not included.

The unit of analysis was pregnancy (if twins were stillborn or a mother had two live births, this is counted as one pregnancy and one hospitalization). We set level of significance at 0.05. Because the hospital cost data were fairly normally distributed, a linear regression model was used for analyzing hospital costs. The hospital length of stay, on the other hand, is a variable representing count data with a strong positive skew (more than 80% of deliveries had a length of stay of 3 days or less). Therefore, it was analyzed using a Poisson regression model and the results were reported using incidence rate ratios.

To compare stillbirth and live birth deliveries, we used data on the cases with their matched controls. For the hospital cost outcome, clustering within the matching stratum was accounted for by using a stratum-specific random effect in a linear mixed model framework. For length of stay, we utilized a generalized linear mixed model framework for analysis with length of stay modeled as a Poisson distribution and a random effect for matching stratum to account for clustering. In addition to stillbirth (versus live birth), we added type of insurance (private versus public/no insurance) and maternal race (Caucasian, African-American, Asian/Other) as additional independent variables in these regression models.

Overall, the case-control matching accounted for 7% of overall variation in hospital cost which is significant variation, indicating that a clustered analysis was appropriate. We had little missing data for the analysis: 4% had missing hospital cost and less than 0.1% were missing data for length of stay.

Although our primary analysis included stillbirths with no minimum birth weight, we recognize that some U.S. states have minimum weight requirements for stillbirths which vary between 350–500 grams, depending on state.[8] For this reason we repeated the multivariable analysis by excluding all stillbirths less than 500 grams birth weight and their matched controls. There was no meaningful difference in our findings. We also tested whether having the stillbirth diagnosed in the antepartum period (prior to active labor) versus intrapartum affected cost and length of stay outcomes, as prolonged time to delivery might be associated with more maternal complications; however, there was no difference in outcomes between the antepartum and intrapartum groups.

We performed a sensitivity analysis by re-running the above models after deleting successively the subset of pregnancy events resulting in multiple births (livebirth or stillbirth) as well as cases with serious medical complications. The serious complications for live births were identified from billing data whereas those for the stillbirth cases were obtained either from billing data or from chart review.

Within stillbirths, we examined the association of various pregnancy and delivery characteristics including serious maternal complications and type of analgesia with hospital costs and length of stay. We compared hospital costs and length of stay between early stillbirths (20–27 5/7 weeks gestation) and late stillbirths (28 weeks and more gestation) since cause of death may vary based on gestation and also since the international definition of stillbirth typically is limited to losses at or beyond 28 weeks gestational age.[9, 10]

Results

Stillbirths

Characteristics of the stillbirth deliveries are described in Table 1. Maternal age ranged from 17 to 42. Half of the women had public insurance (263 women) or no insurance (5 women) and the rest (260 women) had private insurance. About two-thirds of women were identified as African-American, and a third Caucasian. Most women were single. Average gestational age at the time of delivery was 30 weeks, and gestational age had a bimodal distribution with peaks around 22 and 38 weeks (Figure 1) Among the 533 mothers with stillbirth, 44%

had early losses between 20 and 27 6/7 weeks gestational age and 56% had a late loss at 28 weeks or later. For 23% of the women, the stillbirth was their first pregnancy and 37% of women had no living children. In 76% of cases, stillbirths were clearly documented prior to active labor and thus were classified as “antepartum”. Most cases of intrapartum losses were situations where we simply could not prove definitely that the stillbirth occurred before active labor. These included cases where women were diagnosed with fetal demise and already in labor at the time of admission, mothers admitted with PPRM at a gestational age incompatible with life, or cases in which the timing of active labor was not documented.

Of women with stillbirth, forty-three (8%) had a cesarean delivery. Most (92%) had some type of pain medications during labor and delivery, with the bulk receiving oral or intravenous pain relief (data not shown in table). Augmentation was used during labor and delivery in 79% of these cases. Thirty one women (6%) with stillbirth had at least one of the following serious maternal complications: disseminated intravascular coagulation (n=9), need for a blood transfusion (n=14), shock or hypotension (n=3), respiratory failure requiring intubation (n=6), renal failure (n=8), diabetic ketoacidosis (n=4), sepsis (n=5), uterine rupture (n=2), unplanned hysterectomy (n=2), or maternal death (n=1). Overall, 17 (55%) women had just one single serious complication, 9 (29%) had 2 serious complications, 2 (6.5%) had three complications, 2 (6.5%) had four complications, and 1 (3%) had 5 complications. In this study, the only two serious complications frequently identified in tandem were disseminated intravascular coagulation and need for a blood transfusion. For women with stillbirths, mean ($\pm$ standard deviation) hospital costs were \$7495 ($\pm$ 7015). Range was \$659–\$77,080 and median cost was \$5977. Mean length of stay was 2.8 days ($\pm$ 2.8) with a range from less than 24 hours to 29 days.

Results from multivariate regression analyses for women with stillbirth are reported in Tables 2 and 3. We found no statistically significant difference in either hospital costs or length of stay between primigravida women and multigravida women, for women with or without prenatal care, or for mothers who had augmentation or induction of labor and those who did not. There was no significant difference in hospital cost for early versus late stillbirths either but average length of stay was 22% shorter for late stillbirths (IRR: 0.78, 95% CI: 0.70–0.87, $p<0.001$). Similarly, women who delivered via cesarean section had similar hospital costs but an almost one-third longer hospital stay on average (IRR: 1.30, 95% CI: 1.07–1.57, $p<0.01$) compared to women with vaginal delivery. Women who had epidural or spinal anesthesia also had no difference in hospital costs but longer length of stay (IRR: 1.17, 95% CI: 1.03–1.33, $p<0.05$). Having a serious medical complication was associated with significantly higher hospital costs (regression coefficient: 8919, 95% CI: 6678–11160, $p<0.001$) and also more than twice the length of stay (IRR: 2.15, CI: 1.84–2.53, $p<0.001$).

Live Births versus Stillbirths

As noted, live births controls were matched to stillbirths based on hospital of delivery, maternal age, and year of delivery so these variables were not significantly different from stillbirth deliveries. Live birth mothers were significantly more likely than stillbirth mothers to have private insurance (60% versus 49%, $p<0.001$) and were slightly more likely to be

Caucasian though this was not significant (30% versus 26%, $p=0.072$). For women with live birth, mean and standard deviation for hospital costs were \$6600 (± 4208). Range was \$269–\$64,010 and median cost was \$5802. Mean length of stay for live births was 2.6 days (± 2.3 days) with range from less than 24 hours to 45 days.

We conducted multivariable regression analysis which not only accounted for the matching between hospital, maternal age, and delivery year but also included maternal race and insurance type as potential confounders. Compared to women with stillbirth, women with live birth had significantly lower delivery costs (regression coefficient: $-\$757$, 95% CI: $-\$1312$ to $-\$201$, $p<0.01$). However, none of the covariates was significant.

Poisson regression model controlling for insurance type and race found no significant difference in hospital length of stay between mothers with live births and those with stillbirths (IRR=0.95, 95% CI: 0.89–1.013, $p=0.102$). However, African-American mothers were shown to have a 13% longer length of stay (IRR: 1.13, CI: 1.05–1.22, $p<0.05$) compared with Caucasian mothers.

We then performed a sensitivity analysis by excluding cases with multiple births. (Table 4) This did not have significant impacts on the hospital costs or LOS. We further tested the model by also excluding mothers who had known serious maternal medical complications (31 stillbirths and 24 live births). While women with stillbirth still had significantly lower costs than women with live births, the difference between cases and controls was smaller (regression coefficient: $-\$424$, 95% CI: $-\$836$ to $-\$12$, $p<0.05$). Length of stay continued to show no significant differences between mothers with live birth and stillbirth.

Discussion

To our knowledge, detailed economic impacts associated with stillbirth delivery have not been previously reported or compared directly with the maternal hospital costs of a live birth. Our study demonstrated that stillbirths with serious maternal complication had both higher hospital costs and longer lengths of stay. Women with early stillbirths before 28 weeks gestation, those who received epidural or spinal anesthesia and women with cesarean delivery also had longer hospital stays.

We were surprised to find that delivering a stillborn infant is associated with higher hospital costs than delivery of a live-born infant. This is an unexpected result which suggests the impact of stillbirth may be greater than previously recognized. However, this result should be interpreted with caution because our data on live births had quite limited measures of maternal risk factors. We speculated that the higher delivery costs associated with stillbirth could be related to serious maternal complications and excluding mothers with these conditions did narrow the difference between groups although stillbirth costs remained significantly higher.

Stillbirth is also linked with a host of maternal medical conditions including hypertension, diabetes, and other autoimmune disorders which may by themselves contribute to more complicated and more expensive medical stays. Higher maternal costs among stillbirths may also be due to the fact that diagnostic tests run to determine cause of death for the stillbirth

fetus are billed to the mother's stay while any diagnostic testing needed for a live-born infant after delivery is billed to the baby's account. Either way, these are charges related to stillbirth delivery.

Our estimates of hospital costs and length of stay for live births fall in the range of previously reported values.[3, 4] Our live birth numbers are higher than some estimates which likely reflects the fact that our sample includes a decade of deliveries, an older-than-average maternal population, and a higher-risk population overall since most of our cohort was selected from a socioeconomically-depressed population in urban, inner-city hospitals. [3–5]

Our information on serious maternal comorbidities was abstracted from written maternal medical charts; in many cases we lacked laboratory or imaging studies which could have provided information on additional medical complications so it is difficult to compare our results to prior studies of obstetrical morbidity based on International Classification of Diseases codes (ICD-9) and which used different inclusion criteria[11] Data on serious maternal medical complications for live births were limited to cases identified in billing data so total numbers are likely underestimated.

Our clinical experience has been that women with stillbirth are usually eager to leave the hospital as soon as possible after delivery for emotional reasons, and a Swedish study noted women report leaving earlier after stillbirth so it was surprising to find in our analysis that length of stay was as long as for women with live births.[12] However, since this cohort had numerous pregnancy comorbidities, the mothers may have needed to stay longer for medical reasons than they might otherwise have chosen.

The cost of stillbirths has been largely neglected likely because there are no infant care costs and much of the economic impact may be hidden or deferred. Indeed, there are substantial costs associated with stillbirths in addition to the hospital costs of labor and delivery. For example, in some situations, patients with a stillbirth may need extensive postpartum medical evaluation to determine the risk for fetal death recurrence. Since there is higher risk for poor outcomes in subsequent pregnancies, additional antepartum testing also may be needed in the next gestation; while the effectiveness of some screening is medically uncertain, the cost for additional laboratory studies, fetal monitoring, and prenatal visits may be substantial.[13, 14] With stillbirth there is lost economic productivity of the child but this is rarely discussed or counted. Finally, bereaved parents have significantly higher risks for depression, anxiety, and post-traumatic stress disorder which can lead to devastating emotional impacts on parents.[15–19] Unfortunately, no studies have quantified the costs of treatment for these mental health outcomes or for the lost parental productivity due to these complications. Future research evaluating these costs will help understand the life-long economic impact of stillbirth.

Like all studies, limitations of this project must be considered. First, the study is a retrospective analysis of hospital records and is limited by the availability and accuracy of those records. Abstraction from hand-written records of physicians and nurses from paper charts also posed challenges because contents were not always legible or complete. Second,

since the study did not abstract full medical charts for control patients with live births due to resource and funding constraints, we were substantially limited in what confounders we could include in the comparisons of live births and stillbirths. Additional research is needed to further evaluate the role of these comorbidities. Third, hospital costs in general do not include physician fees which may account for about 35% of total costs for labor and delivery so total costs for both stillbirths and live births can be assumed to be higher than reported here.[20] We did not include infant hospital costs in our analysis which can be significant for live birth infants who are preterm or growth-restricted but which obviously do not exist for stillbirths. We could not classify every stillbirth as antepartum versus intrapartum due to missing data; however, our finding that 76% of cases could clearly be documented as antepartum is similar to a recent JAMA study which showed 83% of stillbirths were antepartum.[21] Finally, the study was limited to three academic hospitals in Michigan with a high percentage of African-American patients so results may not be generalizable to other areas of the United States.

However, we believe these limitations are balanced by having a diverse and large population of stillbirths over a long period of time, targeting hospitals with a high volume of births, and the availability of detailed information available from full chart review which may not be available in computerized records. In addition, our research included a large African-American population which few studies have done, despite the much higher risk for stillbirths in this group.

In summary, our study demonstrated that stillbirths have significant hospital costs associated with labor and delivery and calls for additional research to identify and itemize other costs that may be associated with stillbirths (e.g., antepartum and postpartum complications related to mental and physical health and parent productivity). Research detailing the specific components of the costs for stillbirth would also be useful to help evaluate the cost-effectiveness of stillbirth prevention efforts and medical management of labor and delivery.

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Figure 1.

Gestational Age of Stillbirths (n=531)*

*In two cases gestational age known to be above 20 weeks but exact dates unknown.

Table 1

Maternal Demographics and Pregnancy Characteristics, n (%)

	Stillbirths (n=533)	Livebirths* (n=1053)
Mean maternal age (SD)	28 years (+/- 7)	27 years (+/-7)
Insurance^{†††}		
-Private	260 (49%)	625 (60%)
-Public or None	268 (51%)	414 (40%)
Race		
-Caucasian	158 (30%)	254 (26%)
-African-American	343 (66%)	707 (71%)
-Asian	21 (4%)	30 (3%)
Hospital		
-Hospital #1	118 (22%)	230 (22%)
-Hospital #2	195 (37%)	384 (36%)
-Hospital #3	220 (41%)	439 (42%)
Marital Status		
-Married	205 (39%)	---
-Single	325 (61%)	---
Mean Gestational Age (SD)	30 weeks (+/-7)	---
Late Loss (28+ weeks)	297 (56%)	---
First Pregnancy	121 (23%)	---
No Prenatal Care	38 (7%)	---
Use of Augmentation in Labor	423 (79%)	---
Type of Delivery		
-Vaginal	490 (92%)	---
-Cesarean	43 (8%)	---
Serious Maternal Complication **	31 (6%)	---

* Data not available for live births

** Includes disseminated intravascular coagulation, need for a blood transfusion, shock or hypotension, respiratory failure requiring intubation, renal failure, diabetic ketoacidosis, sepsis, uterine rupture, unplanned hysterectomy, or maternal death

[†] p<0.05

^{††} p<0.01

^{†††} p<0.001

Table 2

Variables Impacting Stillbirth Hospital Costs, Multivariable Analysis *

Variable (Reference)	Regression Coefficient	95% Confidence Interval
First Pregnancy	48	–1366 to 1464
No Prenatal Care	–169	–2369 to 2031
Anesthesia (epidural/spinal/general)	474	–856 to 1803
Late Stillbirth (vs.<28wks)	393	–762 to 1549
Cesarean Delivery	1400	–854 to 3655
Augmentation/induction of Labor	–1216	–2698 to 266
Serious Maternal Complication ** †††	10,065	7692 to 12,440

* Model also controlled for maternal demographics (age, race, insurance, and hospital of delivery)

† p<0.05

†† p<0.01

††† p<0.001

** Includes disseminated intravascular coagulation, need for a blood transfusion, shock or hypotension, respiratory failure requiring intubation, renal failure, diabetic ketoacidosis, sepsis, uterine rupture, unplanned hysterectomy, or maternal death

Table 3

Variables Impacting Stillbirth Hospital Length of Stay, Multivariable Analysis *

Variable (Reference)	Incident Rate Ratio	95% Confidence Interval
First Pregnancy	0.93	0.81 to 1.08
No Prenatal Care	0.94	0.76 to 1.17
Anesthesia (epidural/spinal/general) [†]	1.17	1.03 to 1.33
Late Stillbirth (vs.<28wks) ^{†††}	0.77	0.69 to 0.86
Cesarean Delivery ^{†††}	1.41	1.17 to 1.69
Augmentation/induction of Labor	0.90	0.78 to 1.03
Serious Maternal Complication ^{** †††}	2.30	1.95 to 2.71

* Model also controlled for maternal demographics (age, race, insurance, and hospital of delivery)

[†] p<0.05

^{††} p<0.01

^{†††} p<0.001

^{**} Includes disseminated intravascular coagulation, need for a blood transfusion, shock or hypotension, respiratory failure requiring intubation, renal failure, diabetic ketoacidosis, sepsis, uterine rupture, unplanned hysterectomy, or maternal death

Table 4

Comparison of Hospital Costs for Live Births versus Stillbirths

Model	Regression Coefficient	95% Confidence Interval
Full model * † ‡	-\$757	-\$1312 to -\$201
Excluding mothers with multiple births †	-\$739	-\$1299 to -\$178
Excluding mothers with multiple births and mothers with serious medical complications ** †	-\$424	-\$836 to -\$12

* Full model controlled for maternal demographics (age, race, insurance, and hospital of delivery)

† p<0.05

‡ p<0.01

‡ ‡ p<0.001

** Includes disseminated intravascular coagulation, need for a blood transfusion, shock or hypotension, respiratory failure requiring intubation, renal failure, diabetic ketoacidosis, sepsis, uterine rupture, unplanned hysterectomy, or maternal death