Does a Cesarean section delivery always cost more than a vaginal delivery?

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Abstract

There is evidence that average total charges per episode of child birth depend on maternal plus child length of stay, neonatal intensive care unit (NICU) utilization, maternal race and mode of delivery. In particular, when maternal and child records are linked, this study suggests that when adjusted for maternal characteristics, the cost of vaginal deliveries followed by NICU utilization may be higher than the cost of Cesarean sections and NICU utilization.

Objective Cesarean section, one of the most frequently performed surgical procedures on women, is rising globally and in the USA. Much of the current Cesarean section literature focuses on reporting geographic and hospital-specific variations, but little has been published about the clinical and demographic characteristics of the patients, and even less about the economic consequences of a Cesarean section delivery compared with a vaginal delivery [e.g. the total hospital charges and length of neonatal intensive care unit-NICU-stay] of a birth episode. To examine these relationships further, three urban Baltimore hospitals volunteered in 2004 to participate in a retrospective chart review that linked mother and child hospital records.

Methods 1172 mother–child records were randomly selected and data regarding maternal co-morbidities, age, infant weight along with transfer to neonatal intensive care units, and economic data were extracted from the mother and child charts.

Conclusion Average total charges for vaginal deliveries [maternal plus total baby charges that includes NICU utilization (X = $17 624.38)] may be higher than average total charges for Cesarean sections [maternal plus total baby charges that includes NICU utilization (X = $13 805.47)]. Specifically, maternal race – being African American – was indirectly associated with overall charges through its association with mode of delivery and NICU utilization patterns. The presence of maternal co-morbidities – Herpes Simplex Virus, hypertension and diabetes – most probably influenced babies' hospital stay charges as well as NICU charges when transferred to NICU following both vaginal and Cesarean section deliveries. Thus, prenatal care targeting co-morbidities management may reduce the odds of a newborn's transfer to NICU thus avoiding greater lengths of stay, medical care and charges. Recommendations for obstetrical practices as well as health care policy on their charges should not assume that Cesarean section deliveries are always costlier than vaginal deliveries.

Introduction

Cesarean section, one of the most frequently performed surgical procedures on women, is rising globally and in the USA. This trend is predicted to continue despite increasing efforts to curb it through performance improvement initiatives, including patient-preference management [1–3].

Over the past few decades Cesarean section has received much attention because of differences in obstetrician philosophies, practice patterns and patient preference [4–10]. While advances in

anaesthesia and surgical procedures have decreased complications and mortality risks for mothers and babies, the controversy surrounding the appropriateness of a Cesarean section delivery – often fuelled by considerations about the risks associated with a major surgical procedure and the escalating costs of health care delivery – continues to be debated [11–14]. These considerations, which are generic to all health care systems, suggest a need for a greater understanding of the clinical, demographic, and economic variables and factors associated with Cesarean section as compared with vaginal delivery [15,16].

Since 1988, the Maryland Hospital Association has analysed Maryland Cesarean section rates annually to assess factors associated with the appropriateness of this procedure. A 1989 report by the Public Citizens Research Group indicated that Cesarean section rates in Maryland were among the highest in the USA [17]. In response to this report a number of initiatives were undertaken to better understand the reasons for these trends, and to monitor them in each Maryland hospital [18]. Finally, a gubernatorial task force was created in 1996 to craft recommendations for appropriate decision making related to both primary and repeat Cesarean sections in Maryland [19]. The 6-year decline in the rates of Cesarean section procedures in Maryland was followed by a steep 5-year increase mirroring the overall US trend (Fig. 1).

Much of the current Cesarean section literature focuses on reporting geographic and hospital-specific variations, but little has been published about the clinical and demographic characteristics of the patients, and even less about the economic consequences of a Cesarean section delivery compared with a vaginal delivery [e.g. the total hospital charges and length of neonatal intensive care unit-neonatal intensive care unit (NICU)-stay] of a birth episode.

To examine these relationships, three urban Baltimore hospitals volunteered in 2004 to participate in a pilot project to test the feasibility of linking mother and child hospital records in retrospective fashion. This study compares epidemiological (e.g. mother's age, race, fetal birth weight), clinical (e.g. maternal co-morbidities, including hypertension, diabetes mellitus, Human-immunodeficiency Virus, Herpes Simplex Virus and syphilis), along with resource utilization characteristics (e.g. admission into and length of stay (LOS) in the NICU as well as NICU charges) between Cesarean section versus vaginal delivery. The project was coordinated by LogicQual Research Institute, a research subsidiary of the Maryland Hospital Association and a non-profit organization that led many of the previous studies of Cesarean sections in Maryland [1,18].

Materials and methods

The sample

The three hospitals were recruited because of their urban focus and high volume obstetrical practice. Hospital nursing staff was trained to conduct the chart review.

The power analysis is based on the national NICU transfer rate for both types of deliveries of 9% and a discrepancy effect size of 10%. Thus, with a sample size of 400 from each hospital, the study had a power of 80% to yield statistically significant results. The criterion for significance (alpha) was set at 0.05 (2-tailed). A total of 1201 mother–child cases were obtained from the three participating hospitals and, of these, 1172 (97.6%) had complete data and therefore constituted the study sample (Fig. 2).

Analytical approach

This study focused on the identification of the true cost (measured as charges) of newborn delivery and NICU utilization by vaginal versus Cesarean section delivery. The main outcome of interest is the overall total charge per episode of a newborn, and the study variables are: total charges (maternal + baby charges), total LOS (maternal + baby LOS), age group (15–17 years, 18–24 years, 25–34 years and 35–44 years), mode of delivery (vaginal vs. Cesarean section), race (white vs. non-white), prenatal care, baby weight (≤2500 g and >2500 g), and maternal co-morbidities (hypertension, diabetes mellitus, Human-immunodeficiency Virus, Herpes Simplex Virus and syphilis). Separate box plots of the vaginal and Cesarean section data suggest a strong presence of outliers in the data set, and these were removed using 3-standard deviations as a cut-off point (Fig. 3). A univariate analysis was performed using total charges to classify the vaginal and Cesarean section data set

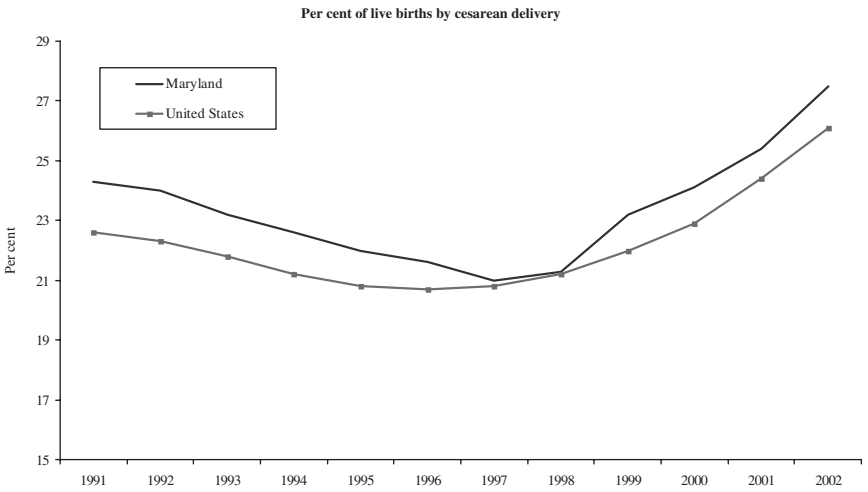

Figure 1 Cesarean section rates in Maryland and USA 1991–2002. Source: National Vital Statistics Reports.

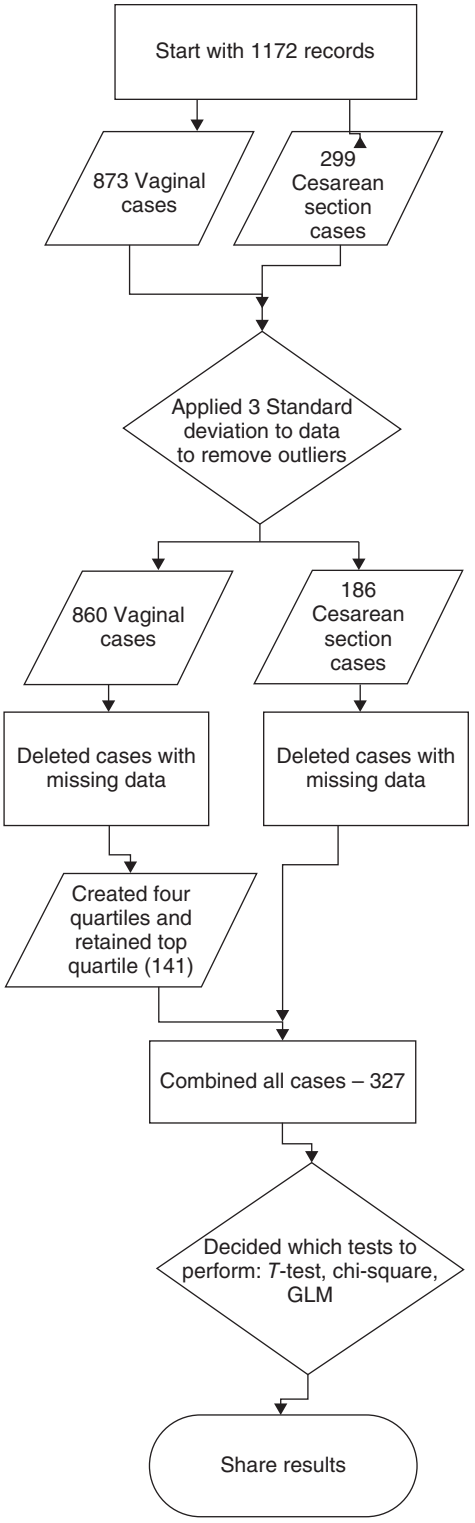

Figure 2 Steps in the analytical approach.

Figure 3 Box plot of mean total charges by mode of delivery.

into four quartiles. The top quartile within the vaginal data set was retained as it represents the group with the highest total charges.

Six box plots were used to assess the distribution of total charges of the top quartile in the vaginal data set, each of the four quartiles in the Cesarean section data set as well as the whole of Cesarean section data set. The plots indicate the average total charges for women in the vaginal data is higher than those of all Cesarean section deliveries. Hence, all of the Cesarean section data (186 cases) and the top quartile vaginal data (141 cases) were combined into one data set (186 + 141 = 327 cases). All analyses were conducted on this combined data set.

The *T*-test method was used to determine the difference in total charges and total LOS between Cesarean section and vaginal delivery. Both simple linear regression (SLR) and multiple linear regression (MLR) models were conducted using total charges as the dependent variable and age group, LOS, baby weight, mode of delivery, race, hypertension, diabetes mellitus, Human-immunodeficiency Virus, Herpes Simplex Virus and syphilis as the explanatory variables. Since there are four age groups, three new dummy variables were created and nested models were used to test these dummy variables as well as the co-morbidity variables jointly for their effects. In order to account for possible confounding among the explanatory variables, the effect of interactions of each explanatory variable was assessed. All terms with $P > 0.05$ were subsequently dropped from the ensuing model. The adopted model was compared with the results of a stepwise procedure and results are similar between the two approaches. Relationships between the explanatory variables were further assessed using the chi-square test.

All analyses were conducted using SAS and STATA software.

Results

The study population of 327 mothers with newborns consisted of 141 (43.1%) who underwent vaginal and 186 (56.9%) who underwent Cesarean section deliveries. There were 263 non-whites and 64 whites that make up the study. The mean total charges for deliveries via Cesarean section and vaginal deliveries were $13 805.47, and $17 624.38 respectively. The difference between the charges was statistically significant at $P < 0.05$. The mean

Table 1 Study enrollees by race, NICU utilization and baby weight

	Mode of delivery	
	Vaginal	Cesarean section
n	141	186
Mean total charges*	17 624	13 805
Mean total length of stay	10.7	9.6
Race (%)		
White	19.2	19.9
Non-white	80.8	80.1
NICU (%)*		
No	58.9	78.0
Yes	41.1	22.0
Baby weight (%)*		
Abnormal (<2500 g)	28.4	15.0
Normal (≥2500 g)	71.6	85.0

*Significant at $P < 0.05$.
NICU, neonatal intensive care unit.

total LOS between vaginal (10.7 days) and Cesarean section (9.6 days) deliveries was however, not significantly different (see Table 1).

As expected [20], there is a strong association between mode of delivery and NICU utilization. Babies delivered vaginally had a 41% NICU utilization rate compared with about 22% in babies delivered via Cesarean section. The Pearson chi-square statistics is 13.85 and is statistically significant with $P < 0.0001$. A similar association is found between mode of delivery and baby weight. About 28% of babies delivered vaginally had low birth weight (<2500 g) while only 15% of babies delivered via Cesarean section had similar low birth weight. The results were significant at $P < 0.005$.

Results also indicate a strong association between baby weight and NICU utilization. The odds ratio is 20.67 (Confidence Interval: 10.41, 41.05), and babies with low birth weight are much more likely to end up in NICU (81%) than babies with normal birth weight (17%). Hence, on the average, low weight babies had nearly 21 times the odds of being admitted to NICU than the normal weight babies.

The independent variables collected for this study included race, age, maternal co-morbidities, LOS, mode of delivery, and NICU utilization. The analysis shows that neither race, age, nor any of the co-morbidities, are significant independent variables when assessed for total effects on total charges, but race becomes significant after adjusting for other factors (LOS, NICU utilization and mode of delivery). Comparison of total (SLR) and direct (MLR) effects on total charges resulted in markedly different conclusions when other factors are controlled. For example, the effects of baby weight was significant in the SLR, but was no longer significant in the final model. The final MLR model was significant ($P < 0.0000$) and R^2 is 0.8278.

The independent variables retained in the final model are race, LOS, NICU utilization, and mode of delivery. The results indicate that the bulk of the variation associated with the total cost in the above model is explained by total LOS. However, mean total LOS for whites and non-whites are not significantly different and are 9.9, and 10.1 respectively ($P > 0.05$).

Conclusion

The identification of an 'inverse' relationship between the total charges associated with a Cesarean section delivery versus a vaginal delivery is intriguing. While it is routinely believed that a Cesarean section delivery always costs more than a vaginal delivery, this study suggests that the true cost should include baby charges and NICU utilization in addition to the cost of delivery. When supplementing the charges of NICU utilization with the delivery charges, this study challenges the absolute belief that Cesarean section deliveries always cost more than vaginal deliveries. For example, in the study data set, a delivery-cost-only analysis would result in average charges of X = $8587 for vaginal delivery and X = $7795 for Cesarean delivery, both lower and in reverse rank order. However, a secondary analysis of the study's entire database regarding the average charges for a Cesarean section and vaginal deliveries without a transfer to NICU was similar to that reported in the literature. The mean charge for a Cesarean section was $7529 (CL: 6972.3–8085.7) while the charge for a vaginal delivery was $5012.80 (CL: 4799.8–5225.8). The relative constancy of the Cesarean section mean charges between the total sample and the sub-sample and the variation in the vaginal delivery charges continue to raise questions. Indeed, understanding the characteristics of the mother and the baby simultaneously is now of utmost importance and should be considered in discussions surrounding differences in vaginal and Cesarean section delivery charges. Once a vaginal delivery charge may not always be the same vaginal delivery charge.

Clearly, findings from this study could have important policy and practice pattern implications. For example, rather than focusing on Cesarean section rate indicators alone, performance measurement systems might expand the scope of their data gathering to include capturing data on prenatal care, maternal co-morbidities and race. From a policy perspective, decreasing Cesarean section rates may not decrease the financial impact of such a goal on the health care performance system in Maryland and possibly other jurisdictions. Moreover, health care information systems may need to be revised to routinely provide utilization and cost statistics about the delivery episode through linkages between maternal and child records.

Given these observations, we will explore these and other questions in the next phase of this pilot study that will focus on additional maternal and child cofactors and morbidities.

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