Incidence of second-stage (fully dilated) cesarean sections and how best to represent it: A multicenter analysis

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Abstract
Objective: To gather multicenter data on the incidence of second-stage cesarean sections and suggest alternative methods by which the data can be represented.
Methods: Retrospective, observational study over a 12-month study period. Numbers of term, singleton live births were collated from each of six maternity units. Data were separated by mode of delivery—unassisted vaginal birth, assisted (instrumental) vaginal delivery and elective, first-stage, and second-stage cesarean sections. Second-stage cesarean sections were expressed as a proportion of all deliveries, of all laboring women (i.e. excluding elective cesarean sections), and all women who reach full dilatation (i.e. excluding elective and first-stage cesarean sections).
Results: Of the 28,867 deliveries included in the analysis, 493 of these were second-stage cesarean sections. This represented an incidence of 1.7% of all deliveries, 2.0% of all women in labor, and 2.5% of all women who reach full dilatation.
Conclusion: Second-stage cesarean sections continue to be common. Safe delivery of a deeply impacted fetal vertex is essential in modern obstetric practice.

1 | INTRODUCTION
Cesarean sections performed at full dilatation (FDCS) are becoming increasingly common in obstetric practice. Delivery of a deeply impacted fetal vertex can often be the most challenging type of delivery for the obstetrician and is associated with an increased risk of maternal complications such as uterine angle extensions, major obstetric hemorrhage, and damage to adjacent viscera. An unsuccessful instrumental delivery is also more likely to cause neonatal trauma and increases the risk of admission to the neonatal unit. In the long-term, women who have had a successful instrumental delivery are more likely to want and achieve a subsequent pregnancy than women who have had a failed operative vaginal delivery.

Data relating to the incidence of FDCS are sparse and often comprise figures collected from a single maternity unit. Figures are commonly expressed as a proportion of the total number of births within that unit, and though this can be a reliable measure of incidence, it has its drawbacks. Cesarean section rates in general are known to vary greatly between different maternity units, as well as between different nations. As such, units which have high elective (planned) cesarean section rates and/or a high proportion of cesareans performed in the first stage of labor may be falsely represented when measuring their rates of FDCS as a proportion of all deliveries.

The aims of our study are two-fold. The first is to gather multicenter data on the incidence of FDCS. The second is to propose two other methods of representing FDCS data: (1) FDCS as a proportion...
of all laboring women, and (2) FDCS as a proportion of all women who reach full dilatation. The first index excludes all women who undergo elective cesarean sections whereas the second index includes only women who reach full dilatation (i.e., it excludes both elective cesarean sections and cesarean sections performed in the first stage of labor).

2 | MATERIALS AND METHODS

The present study was a retrospective, observational study of six maternity units located within a busy, multi-ethnic, urban region of Greater London. Data were collected from each of these units over a 12-month study period (April 2017-March 2018 inclusive). Each maternity unit comprised a labor ward and an on-site midwifery-led unit. Each labor ward was staffed 24 h a day by two resident on-call obstetricians with at least one of them having a minimum of 5 years of obstetric experience. Facilities within each unit included a dedicated obstetric theater and recovery, staffed with anesthetists, scrub team, and midwives.

Data collection was performed using a predefined proforma (Figure 1). Each maternity unit was asked to self-report the number and mode of delivery of all live births within the study period. Multiple pregnancy, non-cephalic presentation, and neonates delivered at <37 completed weeks of gestation were excluded from the analysis. Number of hours per week that a consultant was present on the labor ward, midwife: birth ratio, and proportion of women receiving one-to-one midwifery care in labor were also obtained from each maternity unit. Midwifery-led units reported numbers of successful deliveries within the study period as well as number of women transferred to their associated labor wards. Each data set that was received was verified by an independent observer to eliminate the impact of reporting bias. This was an epidemiologic study and as such, patient clinical data were not used, therefore research ethics approval was not sought.

Centralized analysis of the data was performed with three indices calculated for each maternity unit.

- Fully dilated cesarean sections as a proportion of:

1. All births

\[
\text{FDCS} = \frac{\text{Total number of deliveries}}{\text{Total number of births}} \times 100 \%
\]

2. All laboring women

\[
\text{FDCS} = \frac{\text{UVB + AVD + first stage caesarean sections + FDCS}}{\text{UVB + AVD + FDCS}} \times 100 \%
\]

3. All women who reach full dilatation

\[
\text{FDCS} = \frac{\text{UVB + AVD + FDCS}}{\text{UVB + AVD + FDCS}} \times 100 \%
\]

where UVB represents unassisted vaginal birth and AVD represents assisted vaginal delivery.

3 | RESULTS

A total of 28,867 deliveries between the six maternity units (Unit 1-6) over the 12-month study period met the inclusion criteria (Table 1). The total number of deliveries in each unit varied between 3145 and 5705 births.

Consultant presence on the labor ward varied between 98 and 156 h/week. All maternity units had a midwife: birth ratio of 1:30 and the proportion of women receiving one-to-one midwifery care in labor was 96%-99% (Table 2). The proportion of deliveries conducted on each of the midwifery-led units ranged between 19% and 10% and the proportion of intrapartum transfers of women from the midwifery-led unit to the labor ward ranged between 10% and 19%.

Unassisted vaginal births constituted 15,469 (53.6%) of the total number of deliveries. Successful assisted vaginal (instrumental) deliveries constituted 4171 (14.4%) of births and included those deliveries performed both in the labor ward delivery room and the labor ward theatre.

The total number of cesarean sections performed in the region was 9227, giving an overall cesarean section rate of 32%. Elective cesarean sections accounted for 3797 of these deliveries (mean 13.2%, range 9.9%-19.3%). Cesarean sections performed in the first stage of labor accounted for 4937 deliveries (mean 17.1%, range 12.7%-27.6%).

There was a total of 493 second-stage cesarean sections performed between all units. This constituted an overall mean incidence of 1.7% of all births. When adjusting the statistic to include only women who had gone through labor, i.e., excluding elective cesarean sections, the overall mean incidence of FDCS was 2.0% (range 0.90%-2.48%). Of the women who reached full dilatation, 2.5% of them underwent an FDCS (range 1.04%-3.00%).

Subgroup analysis of each maternity unit (Figure 2) revealed that Maternity Unit 5 had an FDCS rate of 0.77% of all births. This was found to be a significant outlier with regard to incidence (Grubbs’ test z score 1.93; Critical z score 1.89; α = 0.05). Of the remaining five maternity units, there was very little variation between their rates of FDCS and the adjusted mean incidence (excluding unit 5) was calculated to be 1.9% of all births (range 1.72%-2.17%, standard deviation 0.19%).
Concurrently, when adjusting the statistic to include only laboring women and women who reach full dilatation, Unit 5 was also deemed to be an outlier. Exclusion of Maternity Unit 5 revealed an adjusted mean FDCS incidence of 2.3% of all laboring women and 2.8% of all women who reach full dilatation.

### DISCUSSION

Cesarean sections performed in the second stage of labor continue to be prevalent in modern obstetric practice. As such, safe delivery of a deeply impacted fetal vertex should continue to form an important part of the obstetrician's skill set. The overall incidence of FDCS among our population was generally consistent with figures obtained from other recent publications.7,11

This study highlights the observation that cesarean section rates can vary greatly between different maternity units,8 and this can subsequently affect how data on FDCS are interpreted. We found that the proportion of elective cesarean sections performed in each unit varied between 10% and 19%, whereas first-stage cesarean section rates varied between 13% and 27%. The overall cesarean section rate between units in the region ranged from 27% to 40% of all deliveries. This observation lends itself to the original suggestion of this study that representing the incidence of FDCS should take into account these variations.

When representing the incidence of FDCS as a proportion of laboring women or women who reached full dilatation, the impact of variations in elective and first-stage cesarean section rates can be mitigated. Taking Unit 6 as an example, its high elective cesarean section rate resulted in a seemingly lower incidence of FDCS as a proportion of all women when compared with the other maternity units. When adjusted to reflect all laboring women, however, this figure was much more in keeping with the other units. In another example, Maternity Unit 1 performed a greater proportion of cesarean sections in the first stage of labor and therefore it appeared to have a relatively modest FDCS rate when accounting for all laboring women. However, when looking at women who reached full dilatation, the proportion of them who underwent FDCS was proportionally greater, suggesting that management of the second stage in this unit was as effective as in all other units.

Five of the six maternity units included in the study showed only slight, non-significant variation between their FDCS rates. Unit 5 was a notable exception. A much lower rate was observed within this unit and this undoubtedly had an effect on the overall mean (1.7% instead of 1.9% if Unit 5 were excluded from the analysis). Though Unit 5 was statistically shown to be an outlier, the question of why their rates were so low remains. From the data collected, Unit 5 had one of the highest proportions of women delivering on their midwifery-led unit. It also had the lowest proportion of intrapartum transfers from their midwifery-led unit to their labor ward. This may partly explain their lower incidence of FDCS; however, the full reasons for the low incidence observed are likely to involve many other factors.

An in-depth analysis of why Unit 5 had a lower incidence of FDCS goes beyond the scope of this study. Demographic data such as maternal age, parity, and race may also contribute to the difference in incidence. Further research is needed to investigate these factors and understand the reasons behind the lower incidence of FDCS in Unit 5.

### TABLE 1  Number and mode of delivery for each maternity unit included in the study over a 12-month period a

| Unit | Unassisted vaginal births | Assisted vaginal (instrumental) deliveries | Elective cesarean sections | First-stage cesarean sections | Second-stage cesarean sections | Total |
|------|--------------------------|-------------------------------------------|---------------------------|-------------------------------|-------------------------------|-------|
| 1    | 2055 (44.6%)             | 721 (15.7%)                               | 471 (10.2%)               | 1273 (27.6%)                 | 84 (1.82%)                   | 4604  |
| 2    | 2785 (56.3%)             | 564 (11.4%)                               | 598 (12.1%)               | 916 (18.5%)                  | 85 (1.72%)                   | 4948  |
| 3    | 2934 (59.6%)             | 624 (12.7%)                               | 486 (9.9%)                | 772 (15.7%)                  | 107 (2.17%)                  | 4923  |
| 4    | 1703 (54.1%)             | 428 (13.6%)                               | 422 (13.4%)               | 526 (16.7%)                  | 66 (2.10%)                   | 3145  |
| 5    | 3288 (57.6%)             | 881 (15.4%)                               | 750 (13.1%)               | 742 (13.0%)                  | 44 (0.77%)                   | 5705  |
| 6    | 2704 (48.8%)             | 953 (17.2%)                               | 1070 (19.3%)              | 708 (12.7%)                  | 107 (1.93%)                  | 5542  |
| Total| 15 469 (53.6%)           | 4171 (14.4%)                              | 3797 (13.2%)              | 4937 (17.1%)                 | 493 (1.7%)                   | 28 867|

aValues are given as number with percentage of total for each unit in parentheses.

### TABLE 2  Intrapartum care data for each maternity unit a

| Unit | Consultant presence on LW (h/week) | 1:1 midwifery care on LW (%) | Midwife: birth ratio | Number of successful deliveries performed in the MLU (% of all deliveries) | Intrapartum transfers from MLU to LW (% of those starting their labor on MLU) |
|------|-----------------------------------|-----------------------------|----------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| 1    | 120                               | 96                          | 1:30                 | 783 (17%)                                                                 | 172 (18%)                                                                   |
| 2    | 125                               | 99                          | 1:30                 | 495 (10%)                                                                 | 119 (19%)                                                                   |
| 3    | 156                               | 97                          | 1:30                 | 935 (19%)                                                                 | 168 (15%)                                                                   |
| 4    | 98                                | 98                          | 1:30                 | 472 (15%)                                                                 | 94 (17%)                                                                    |
| 5    | 113                               | 97                          | 1:30                 | 1027 (18%)                                                                | 113 (10%)                                                                   |
| 6    | 115                               | 98                          | 1:30                 | 942 (17%)                                                                 | 226 (19%)                                                                   |

Abbreviations: LW, labor ward; MLU, midwifery led unit.

aValues are given as numbers and proportions of deliveries within each midwifery-led unit as well as proportion of intrapartum transfers from each MLU to LW; unless otherwise stated.
as maternal parity, body mass index, and ethnicity did not form part of the study design. It is not known whether there was any variation in the length of passive second stage of labor or whether some units employed greater use of supplemental oxytocin in the second stage of labor. Neither is it known whether there were any differences in practices in determining when and where to perform operative vaginal deliveries and which instruments to use.

In the United Kingdom, reference to clinical guidelines, particularly for the management of the second stage of labor and the use of instruments, aims to standardize the clinical care that women receive irrespective of the maturity unit in which they deliver. However, as alluded to with variations in cesarean section rates, practices between units may also vary with regard to trials of vaginal deliveries.

Experience on the labor ward is often cited as a factor when evaluating fetal and maternal outcomes. Consultant presence on the labor ward varied between each unit (98–156 h/week); however, units with greater consultant presence did not necessarily have lower rates of FDCS (Table 2). It has also been suggested that the use of intrapartum ultrasound during the second stage of labor can enhance the accuracy of assessing fetal position. However, it has not been demonstrated to result in any reduction in the decision to proceed with an instrumental delivery, the choice of instrument used or the odds of a second-stage cesarean section.

The strengths of our analysis were that it was performed over a long study period and involved comparison and collation of data from multiple maternity units. Data gathered from each unit were independently verified, which kept the risk of reporting bias low. We acknowledge that although the geographical region in which the data were collected was large, it primarily represents an urban area. We do not know if similar incidence figures would apply to rural regions. Additionally, when adapting our figures and excluding elective and first-stage cesarean sections we were unaware of the individual indications for each of the cesarean sections and how these indications varied across the maternity units. Similarly, of the 493 second-stage cesarean sections performed, we do not have a breakdown of which of these were conducted after a failed attempt at an instrumental delivery. Further work to detail the processes and decision making involved when performing a trial of operative vaginal delivery and/or an FDCS is needed. This would give clinicians clarity when assessing suitability and safety for vaginal birth and give the women under their care the most informed option on how they choose to deliver.

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CONFLICTS OF INTEREST
The authors have no conflicts of interest.

AUTHOR CONTRIBUTIONS
AR, GL, and CC were involved in the conceptualization, study design, and data analysis. The manuscript was written, revised, and approved by AR, GL, and CC.
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