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Implementation of the WHO manual for Robson classification: an example from Sri Lanka using a local database for developing quality improvement recommendations

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ABSTRACT

Objectives This study aimed at describing the use of a prospective database on hospital deliveries for analysing caesarean section (CS) practices according to the WHO manual for Robson classification, and for developing recommendations for improving the quality of care (QoC).

Design Observational study.

Setting University Obstetric Unit at De Soysa Hospital for Women, the largest maternity unit in Sri Lanka.

Data collection and analysis For each childbirth, 150 variables were routinely collected in a standardised form and entered into a database. Data were routinely monitored for ensuring quality. Information on deliveries occurring from July 2015 to June 2017 were analysed according the WHO Robson classification manual. Findings were discussed internally to develop quality improvement recommendations.

Results 7504 women delivered in the hospital during the study period and at least one maternal or fetal pathological condition was reported in 2845 (37.9%). The CS rate was 30.0%, with 11.9% CS being performed prelabour. According to the Robson classification, Group 3 and Group 1 were the most represented groups (27.0% and 23.1% of population, respectively). The major contributors to the CS rate were group 5 (29.6%), group 1 (14.0%), group 2a (13.3%) and group 10 (11.5%). The most commonly reported indications for CS included abnormal cardiotocography/suspected fetal distress, past CS and failed progress of labour or failed induction. These suggested the need for further discussion on CS practices. Overall, 18 recommendations were agreed on. Besides updating protocols and hands-on training, activities agreed on included monitoring and supervision, criterion-based audits, risk management meetings and appropriate information for patients, and recommendations to further improve the quality of data.

Conclusions This study provides an example on how the WHO manual for Robson classification can be used in an action-oriented manner for developing recommendations for improving the QoC, and the quality of data collected.

Strengths and limitations of this study

- Despite being a single-centre study, this is the first study from a setting with limited resources reporting on the use of a prospective individual-patient database for analysing practices on caesarean section.
- This is also the first report on the use of the WHO implementation manual for Robson classification in a project aiming at quality improvement. The paper describes how the WHO manual can be used in an action-oriented manner for developing recommendations for improving the quality of maternal healthcare, and the quality of data collected.
- This pilot experience can be of interest to both researchers and policy makers, providing a model on how different types of variables can inform the Robson classification, and how findings from the Robson classification can be used proactively for decision making.

INTRODUCTION

Improving the appropriate use of caesarean section (CS) is a major global concern.[1 2] While global CS rates at the population level are rising, major disparities exist among countries, with both underuse and overuse of this procedure.[1 2] Although there is no debate about the need to increase access to safe CS, there is also common agreement that CS should be performed only for medically indicated reasons.[1 2]

Interventions to reduce unnecessary CS have shown little success.[2] In the last few years, WHO has endorsed the use of the Robson classification system,[3] and a manual for supporting its implementation was published in 2017.[4] The WHO Robson classification manual guides the implementation

of the Robson classification and provides practical tools for analysing CS practice in a standardised, reliable, consistent and action-oriented manner.[4] However, there is still little published experience on the practical utilisation of the WHO Robson classification manual,[4] and no concrete experience has been reported so far on how to use the manual in an action-oriented manner.

A rising trend in the national CS rate has been reported in Sri Lanka (33.2% in 2015), with large heterogeneity among different facilities[5 6] and widespread diffusion of inappropriate indications for CS.[7] Nevertheless, few studies have analysed CS practices in a standardised manner[7 8] and no study used findings of such analyses for developing recommendations to improve the quality of maternal healthcare and the quality of data collected.

Since year 2015 we implemented a prospective individual patient database at the De Soysa Hospital for Women, Colombo, the largest maternity hospital in Sri Lanka. For each case of delivery, about 150 variables were collected and routinely entered in an electronic database.[9] The objective of this study was to describe the use of the information provided by this database to analyse CS practices according to the WHO Robson classification manual[4] in an action-oriented manner, with the aim of developing recommendations for improving the quality of maternal hospital care.

Box 1 The 10 groups of the Robson classification[4]

Group 1: Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour
Group 2: Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who had labour induced or were delivered by caesarean section (CS) before labour
2a Labour induced
2b Prelabour CS
Group 3: Multiparous women without a previous CS, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour
Group 4: Multiparous women without a previous CS, with a single cephalic pregnancy, ≥37 weeks gestation who had labour induced or were delivered by CS before labour
4a Labour induced
4b Prelabour CS
Group 5: All multiparous women with at least one previous CS, with a single cephalic pregnancy, ≥37 weeks gestation
Group 6: All nulliparous women with a single breech pregnancy
Group 7: All multiparous women with a single breech pregnancy including women with previous CS(s)
Group 8: All women with multiple pregnancies including women with previous CS(s)
Group 9: All women with a single pregnancy with a transverse or oblique lie, including women with previous CS(s)
Group 10: All women with a single cephalic pregnancy <37 weeks gestation, including women with previous CS(s)

METHODS

Study design

The study was designed as an observational study aimed at analysing practices related to CS, and at developing recommendations for improving the quality of hospital care. The results section of this paper reports the findings of the Robson analysis[4] and how such findings were internally discussed and used.

Population and setting

The study was conducted at the University Obstetric Unit of De Soysa Hospital for Women, the largest maternity unit in Sri Lanka. Detailed methods of data collection have been previously reported.[9] Briefly, 150 variables (ie, maternal sociodemographic characteristics, risk factors, process indicators, maternal and neonatal outcomes) were collected for each individual birth using a standardised two-page form, and entered in real time in an electronic database. Data quality assurance procedures included detailed case definitions, standard operating procedures, regular random checks and 137 automatic validation rules aiming at minimising data entry errors.[9]

The present paper reports findings relevant to CS practices on births occurring from July 2015 to June 2017. Missing cases for the variables of interest were overall ≤0.7%, except for trial of labour in previous CS, where missing variables were 1.2% (online supplementary table 1).

Data analysis

Data were analysed according to the recommendations of the WHO Robson classification manual[4] and synthesised according to the standardised reporting tables provided by the manual (online supplementary tables 2–4).[4] According to the WHO methodology,[4] the analysis should follow the following key steps. First, each case of birth was classified into one of the Robson groups (box 1), using six key variables (parity, previous CS, onset of labour, number of fetuses, gestational age, fetal lie presentation). Second, data were assessed for: (1) Quality. (2) Type of population. (3) CS rates. As recommended in the WHO Manual,[4] relevant additional information provided by the local data collection system[9] was used as complementary information to allow an in-depth interpretation of CS practices. Specifically, the following types of variables collected by the local individual-patient database were used: maternal age, gestational age, maternal pathological conditions (eg, diabetes, hypertensive disorders and others), fetal pathological conditions, CS indications. For each step, findings were compared with the suggested two sources of interpretation in the WHO manual:[4] (1) The reference ranges and interpretation by Michael Robson.[3 10] (2) The findings of the WHO Multicountry Survey (MCS) on Maternal and Newborn Health (provided by the WHO manual as an additional example for comparison (this is a population characterised by a combination of relatively low CS rates and good outcomes of labour and childbirth)).

Before starting the data analysis, the information in the database was cleaned. Specifically, the open-text categories called 'other' under 'indication for CS' (which already included 18 predefined categories)[9] were thoroughly checked by two experienced obstetricians and

classified, as more appropriate, in one of the predefined categories, or in a new category.

Data use for developing recommendation for improving the quality of care

The findings of the analysis were presented during two dedicated workshops with key hospital staff of different levels (ie, senior obstetricians, neonatologists, registrars, nurses, midwives and other staff). The meetings were led by local staff (HS, RM), in dialogue with the WHO Collaborating Centre, Trieste, Italy.

The workshops had the following objectives: discussing hospital practices related to CS, identifying possible gaps in quality of care (QoC) provided, identifying possible gaps in data quality and/or in data collection procedures, selecting priorities for action, developing and agreeing on recommendations for improving the QoC related to CS and, if needed, the quality of data. Secondary objectives included improving the knowledge of the Robson classification and of the WHO manual,[4] supporting a culture of quality improvement (QI), and fostering teamwork.

During the workshops data were presented and discussed using the standardised reporting tables suggested by the WHO manual (online supplementary tables 2–4), which included the following subsequent evaluations: (1) Robson classification. (2) Data quality. (3) Type of population. (4) CS rates. Additionally, the other characteristics of the population identified as informative for the discussion of CS practices (ie, maternal age, gestational age, maternal and fetal pathological conditions, indications for CS) were tabulated and discussed. The sources of comparison provided by the WHO manual were also made explicit in the tables. Relevant international literature[1 10–13] was made available to further interpret data.

A predefined template for identifying possible QI recommendations was distributed to each participant at the beginning of the workshops (online supplementary table 5). It was emphasised that the proposed actions had to be SMART (Specific, Measurable, Achievable, Realistic, Time-bound).[14] An action-oriented, non-blaming, problem-solving, proactive and participatory attitude was used for building ownership and commitment to changes among participants, and for allowing a wide involvement of all types of staff.

Proposed recommendations were discussed and agreed on in plenary until consensus was reached. Recommendations are presented in the results section.

Patient and public involvement

Patient or public were not directly involved in the study. However, the selection of the variables to be included in the database was informed by patient experience, as reported in literature.[1 9] The development of recommendations for improving the QoC took into account the importance of promoting patient-centred care.

Ethical considerations

Confidentiality was maintained by de-identifying all files before database entry. Human subjects were not directly involved in the study.

RESULTS

The following paragraphs report on the results of the Robson analysis as for the WHO manual,[4] and on the related data discussion and development of a list of actions for improving the quality of hospital practices, agreed on during the workshops.

Characteristics of the population

A total of 7504 women delivered in the hospital during the study period. Detailed characteristics of the population, with a specific focus on the variables relevant to the analysis of CS practices and the Robson classification are reported in online supplementary table 6. Overall CS rate in the study population was 30.0%, with about a third (11.9%) of the total CS performed prelabour. Induction of labour (IOL) occurred in 24.6% of cases. Preterm deliveries (before 37 weeks) were observed in 9.4% of cases, with 0.5% of the total newborns being extremely preterm (less than 28 weeks) and 1.3% being very preterm (28 weeks to before 32 weeks completed). At least one maternal or fetal pathological condition, potentially contributing to the decision for CS or IOL, was reported in 2845 (37.9%) women. Gestational diabetes was the most frequent condition (13.4%), followed by hypertensive disorders of pregnancy (6.7%) and intrauterine growth restriction (6.7%). Overall, 5.9% of the total sample was obese according to the body mass index (BMI) cut-offs suggested for the Asian population (BMI >27.5).[15 16]

Overall the discussion on these general characteristics of the population focused on the following observations: high rate of CS; relatively high rate of IOL; high prevalence of risk factors (which may be explained by the hospital being a tertiary level centre).

Analysis by Robson classification

Table 1 presents the Robson classification (adapted by adding information on groups 2a and 2b, 4a and 4b also). Group 3 (multiparous without previous CS, single cephalic at term, in spontaneous labour) and group 1 (nulliparous, single cephalic at term, in spontaneous labour) were the most represented groups (27.0% and 23.1%, respectively). Group 2a (nulliparous, single cephalic at term, with IOL) was the third most represented group (12.8%).

The major contributors to CS were as follows: Group 5 (multiparous with at least one previous CS, single cephalic at term) 29.6%; group 1 (nulliparous without previous CS, single cephalic at term, in spontaneous labour) 14.0%; group 2a (nulliparous, single cephalic at term, with IOL) 13.3% and group 10 (single cephalic, preterm, including previous CS) 11.5%.

Table 1 The Robson classification report table

Setting name: *De Soysa Hospital, Colombo, Sri Lanka*				Period: July 2015 to June 2017		
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Group	Number of CS in group	Number of women in group	Group size* (%)	Group CS rate† (%)	Absolute group contribution to overall CS rate‡ (%)	Relative contribution of group to overall CS rate§ (%)
1	314	1740	23.2	18.0	4.2	14.0
2	458	1116	14.9	41.0	6.1	20.3
2a	300	958	12.8	31.3	4.0	13.3
2b	158	158	2.1	100	2.1	7.0
3	105	2030	27.1	5.2	1.4	4.7
4	130	771	10.3	16.9	1.7	5.8
4a	81	722	9.6	11.2	1.1	3.6
4b	49	49	0.7	100	0.7	2.2
5	666	814	10.9	81.8	8.9	29.6
6	114	139	1.9	82.0	1.5	5.1
7	90	115	1.5	78.3	1.2	4.0
8	63	84	1.1	75.0	0.8	2.8
9	47	65	0.9	72.3	0.6	2.1
10	258	588	7.8	43.9	3.4	11.5
Total	**Total number of CS=2251**	**Total number of women delivered=7504**	**100%**	**Overall CS rate**	**Overall CS rate**	**100%**

Unclassifiable: 42 cases (0.6%) (Number unclassifiable cases/(Total Number women delivered classified+unclassified) × 100)
*Group size (%)=n of women in the group/total n women delivered in the hospital × 100.
†Group CS rate (%)=n of CS in the group/total n of women in the group × 100.
‡Absolute contribution (%)=n of CS in the group/total n of women delivered in the hospital × 100.
§Relative contribution (%)=n of CS in the group/total n of CS in the hospital × 100.
CS, caesarean section.

Unclassifiable cases accounted for only 42 (0.6%) of total cases. The most prevalent reason was the missing variable previous CS, which was missing in 36 unclassifiable cases (85.7%).

Overall the discussion on table 1 focused on the following points: data showed a relatively high rate of IOL (groups 2a and 4a); the rate of missing cases (0.6%) was perceived as reassuring, although it was felt that all efforts had to be made to avoid missing information under the variable 'previous CS'.

Tables 2–4 summarise findings and their interpretation, related to the data quality, the type of population and the CS rates. Findings different from the Robson comparison and/or from the MCS reference population are highlighted in grey in the tables.

Total number of deliveries and size of group 9 (single pregnancy, transverse or oblique lie, including previous CS), when compared with the Robson interpretation and the MCS example, suggested no major problems in data quality (table 2). The CS rate in group 9 (72.3%) suggested possible misclassification of a few number of cases (about 15 cases). It was felt that the most likely explanation for this finding could have been that women, presenting initially with an oblique/transverse lie, but having a spontaneous version or a successful external cephalic version after admission, were eventually erroneously classified as abnormal lie.

Table 3 synthesises the assessment of the type of population. Overall, findings in steps 1, 4 and 5 were in line with both the Robson references and the MCS example and did not result in major discussion. Findings in steps 2, 3 and 6–9 (highlighted in grey in the table) were somehow different from both the Robson and MCS comparisons, and were interpreted based also on the additional information provided by the local database (column 5 in table 3). Different possible explanations for these findings were identified, including possible misclassifications, case selection (tertiary referral centre), inappropriate care or others (table 3). Specifically, the following were the key findings of the analysis.

In steps 2 and 9, the size of group 3 (multiparous without previous CS, single cephalic at term, in spontaneous labour) plus group 4 (multiparous without previous CS, single cephalic at term with IOL or CS before labour) was larger than the Robson comparison (37.3% vs about 30%) while the ratio of the size of group 6 (nulliparous, single breech) *versus* group 7 (multiparous, single breech, including previous CS) was lower (1.2) than the Robson

Table 2 Assessment of the quality of data

Steps for interpretation	Interpretation by Robson	Example: MCS population	Our findings	Additional information from the database used to interpret data	Final interpretation
STEP 1. Total number of CS and total number of women delivered	Should be identical to the numbers provided by official register	NA	Total CS=2251 Total deliveries=7504	–	There are no missing/incorrect data
STEP 2. Size of group 9 (should be less than 1%)	<1%	0.4%	0.9%	–	No significant misclassification for this group according to references by Robson
STEP 3. CS in group 9 (should be 100% by convention)	100%	88.6%	72.3%	–	Misclassification

CS, caesarean section; MCS, Multicountry Survey; NA, data not available.

comparison (ratio of 1.2 instead of 2). On both steps, the observed values were similar to the MCS example. It was felt that these findings could be explained by the relatively high prevalence of multiparous women in the study population (55%).

In step 3, the small size of group 5 (multiparous with at least one previous CS, single cephalic at term) when compared with the overall CS rate (30.0%) suggested relatively low CS rate in the previous years, or a recently increased rate, or misclassification (wrong classification especially in group 3 where the CS rate is unusually high at 5.2%).

In step 6, group 10 (single cephalic, preterm, including previous CS) was slightly larger than the Robson comparison (7.8% vs 5%), most likely due to the hospital being a tertiary care, or to possible misclassification (eg, breech presentation misclassified as cephalic).

In step 7, the ratio of the size of group 1 (nulliparous, single cephalic at term, in spontaneous labour) *versus* group 2 (nulliparous single cephalic, at term with IOL or CS before labour) was lower than the Robson comparison (1.5 vs 2), possibly due to the observed relatively high rate of IOL in nulliparous women (group 2a 12.8%, see table 1) when compared with existing literature.[11 17 18]

The assessment of CS rates (see table 4) was complemented by an analysis of the indications for CS using data extracted from the individual-patient database (online supplementary tables 7 and 8). Overall, it was found that the main indications for CS were (online supplementary table 7): abnormal cardiotocography (CTG) or suspected fetal distress (27.1%); past CS (23.9%), failure to progress or failed IOL (11.6%); breech/abnormal presentation (8.2%). The following indications, accounting for a total of 147 (6.5%) cases, were identified as potentially inappropriate (in grey in online supplementary table 7): prelabour diagnosis of cephalopelvic disproportion (CPD) (2.5%), history of subfertility/bad obstetric history (2.1%), CS for maternal request (1.9%).

When indications to CS were analysed by Robson groups, some indications were observed at a suspected high or low rate compared with the expected, suggesting potentially inappropriate management. Specifically, abnormal CTG/suspected fetal distress were over-represented as an indication to CS, particularly in Robson groups 1 to 4, suggesting possible gaps in the use/interpretation of CTG (in dark grey in online supplementary table 8). On the other hand, dystocia was reported as an indication for CS in less than 8% of total cases (in light grey in online supplementary table 8), a rate much lower than that observed in the UK and USA, where dystocia is an indication for about 20% of CS.[19–21] Internal discussion identified the following possible explanations for this specific finding: difficulty by data collectors in classifying dystocia; missing information in the medical file; peculiar characteristics of the Sri Lanka population enrolled—such as lower BMI, maternal age and parity; better management of labour compared with reported statistics, or other reasons affecting dystocia rate in the

Table 3 Assessment of the type of population

Steps for interpretation	Interpretation by Robson	Example: MCS population	Our findings	Additional information from the database used to interpret data	Final interpretation
STEP 1. Size of group 1+group 2	35%–42%	38.1%	38.1%	–	Rate in line with both references by Robson and the MCS reference population.
STEP 2. Size of groups 3+4	30%	46.5%	37.3%	Multiparous in our population 55.0%	Rate higher than Robson references but lower than MCS examples. This may be explained by a high prevalence of multiparous women in our population.
STEP 3. Size of group 5	Half of total CS rate	7.2%	10.9%	–	Lower than half of total CS. This, as suggested by the WHO manual, may be due to relatively low CS rate in the previous years, or to a recently increased CS rate or to misclassification.
STEP 4. Size of groups 6+7	3%–4%	2.7%	3.4%	–	Rate in line with both Robson references and MCS examples.
STEP 5. Size of group 8	1.5%–2%	0.9%	1.1%	–	Rate in line with MCS examples.
STEP 6. Size of group 10	<5%	4.2%	7.8%	Divisions by gestational age in our preterm population	Higher than both comparisons. This may be explained by the hospital being a tertiary care referral centre, or by misclassification.
STEP 7. Ratio of the size of group one versus group 2	Ratio 2 or higher	Ratio 3.3	Ratio 1.5	Indication of IOL	Lower than the comparisons. This associates with a large size of group 2a, suggesting a high incidence of IOL. This may be explained by: (1) Case selection (tertiary care referral centre). (2) Inappropriate indication to IOL (deserving further investigation).
STEP 8. Ratio of size of group 3 versus group 4	> 2:1	Ratio 6.3	Ratio 2.6	Indication of IOL	Rate in line with both Robson references, lower than MCS. This may be explained by: (1) Misclassification of augmentation as IOL. (2) Case selection (tertiary care referral centre). (3) Inappropriate indication to IOL (deserving further investigation).
STEP 9. Ratio of size of group 6 versus group 7	Usually 2:1	Ratio 0.8	Ratio 1.2	Multiparous in our population 55.0%	Rate in line with MCS, but lower than Robson references. This may be explained by: (1) High number of multiparous women in our population.

CS, caesarean section; IOL, induction of labour; MCS, Multicountry Survey; MCS reference population: was the population of the WHO MCS with relatively low CS rates and, at the same time, with good outcomes of labour and childbirth.

Table 4 Assessment of the CS rates

Steps for interpretation	Interpretation by Robson	Example: MCS population	Our findings	Additional information from the database used to interpret data	Final interpretation
STEP 1. CS rate in group 1	Under 10% are achievable	9.8%	18.0%	► Abnormal CTG was the indication in 49.4% of cases. ► Potentially inappropriate CS indications to CS in 15%.	CS rate higher than Robson and MCS. This may be explained by inappropriate indications (abnormal CTG/suspected fetal distress) and/or inappropriate care.
STEP 2. CS rate in group 2	Consistently around 20%–35%	39.9%	41.0%	► Abnormal CTG was the indication in 58.3% of group 2a and 30.4% in group 2b. ► Potentially inappropriate CS indications in 25% in 2b.	CS rate higher than Robson and MCS. This may be possibly due to inappropriate indications to CS in IOL and pre-labour CS.
STEP 3. CS rate in group 3	Not higher than 3.0%.	3.0%	5.2%	► Abnormal CTG was the indication in 57.1%.	CS rate higher than Robson and MCS. This may be explained by misclassification (group 5 misclassified as group 3) or, most probably, by inappropriate indication to CS (CTG misinterpretation).
STEP 4. CS rate for group 4	It rarely should be higher than 15%	23.7%	16.8%	► Abnormal CTG was the indication in 60.5% in group 4a and 18.4% in group 4b. ► Failed induction was an indication in 25.9% of group 4a.	CS rate higher than Robson. Size of group 4b suggests low prelabour CS in this group, while the rate of CS in group 4a was high mainly due to CTG abnormalities and failed IOL. This may be explained by misclassification (group 5 misclassified as group 4) or, most probably, by inappropriate indication to CS (CTG misinterpretation).
STEP 5. CS rate in group 5	Rates of 50%–60% are considered appropriate	74.4%	81.8%	► past CS was the indication in 70.1%. ► Rate of prelabour CS was 62.5%.	CS rate higher than Robson and MCS. Low rate of IOL in this group. The vast majority are CS for past section. This may be explained by the group size or a policy of scheduling prelabour CS (low offer of trial of labour). Also, women's preference, based on previous information, for repeating CS may have a role.
STEP 6. CS rate for group 8	Usually around 60%	57.7%	80.9%	► Multiple pregnancy was the indication in 58.7%. ► Elective CS rate in multiple pregnancies was 37.8%.	CS rate higher than Robson and MCS. Possible tendency to perform elective CS in multiple pregnancies
STEP 7. CS in group 10	Usually around 30%	25.1%	41.1%	► Maternal/fetal pathological conditions were the indication in 48.1%.	CS rate higher than Robson and MCS. This may be explained by a high-risk population.

Continued

Table 4 Continued

Steps for interpretation	Interpretation by Robson	Example: MCS population	Our findings	Additional information from the database used to interpret data	Final interpretation
STEP 8. Relative contribution of groups 1, 2 and 5 to the overall CS rate	Normally contribute to 2/3 (66%) of all CS performed in most hospitals	Contributed to 63.7% of all CS	63.9%	–	In line with both Robson and MCS reference.
STEP 9. Absolute contribution of group 5 to overall CS rate	NA	Responsible for 28.9% of all CS	Absolute contribution: 8.87% Relative contribution: 29.59%		Absolute contribution lower than MCS (Robson comparison not provided in the WHO manual). Relative contribution in line with MCS (the value provided in the WHO manual as MCS example refers to the relative contribution).

CS, caesarean section; CTG, cardiotocography; IOL, induction of labour; MCS, Multicountry Survey; MCS reference population: was the population of the WHO MCS with relatively low CS rates and, at the same time, with good outcomes of labour and childbirth; NA, data not available.

UK and USA statistics. Misclassifications were identified in 1.9% of the total indications to CS (highlighted with an asterisk in online supplementary table 8).

Table 4 reports the interpretation of assessment of CS rate. Overall, findings in steps 8 and 9 were in line with both Robson references and MCS examples, and did not result in major discussion. Findings from all other steps (in grey in table 4) were somehow different from either the Robson comparison or the MCS example. Details on data interpretation are provided, step by step, in table 4.

Developing QI recommendations

Table 5 reports the key findings of the analysis, the possible explanations, and the agreed recommendations that emerged from the hospital staff discussion. Overall, 18 recommendations were developed, and three were identified as priorities for action (highlighted with an asterisk in table 5). Some recommendations, such as the need to train staff on fetal monitoring, emerged from different key findings and as such were identified as a priority for action. Most recommendations aimed at improving the implementation of evidenced-based indications for CS and IOL. Besides updating protocols and hands-on training, activities agreed included monitoring and supervision, criterion-based audits, risk management meetings and appropriate information for patients. Recommendations to further improve the quality of data were also agreed on (recommendations 17 and 18).

DISCUSSION

This study reports experience from a lower middle-income country, where information accumulated in an individual patient database was used locally for conducting an in-depth analysis of CS practices according to the WHO manual for Robson classification,[4] and for developing recommendations to improve QoC.

With respect to previous literature, this study has three main aspects of novelty, which can be of interest for both researchers and policy makers. First, this is the first study conducted in a lower middle-income country, reporting on the use of a prospective individual patient database to analyse practices on CS. Such databases are generally lacking in low-resource settings. Furthermore, the availability of accurate data is relatively limited even in high-income countries, where most hospital administrative data sets lack key information such as maternal risk factors. These are needed for evaluating the case mix and for interpreting the observed CS rates. To our knowledge, even the few studies in high-income countries, which used individual patient databases for the Robson classification,[22–24] had access to much less information than in this study in Sri Lanka, where a large number of variables were collected prospectively.[9] The availability of many variables, including CS indications by Robson groups, was invaluable for an in-depth understanding of CS practices.

Second and most important, the paper provides a model on how findings of the Robson analysis can be used for

Table 5 Process of development of quality improvement recommendations

Key findings from the analysis	Possible explanations that emerged from hospital staff discussion	Agreed recommendations for quality improvement
1. High intrapartum CS rate in group 1, with potentially inappropriate indications (main current indication was CTG abnormality)	1. Possible inappropriate interpretation of fetal monitoring 2. Possible inappropriate use of oxytocin 3. Possible inappropriate indications to CS	1. Develop a training plan for strengthening capacities of staff in CTG interpretation* 2. Hands-on trainings on instrumental delivery 3. Supportive supervision and monitor overtime staff skills in CTG interpretation and instrumental delivery 4. Adoption of Robson classification of CS indications (22) 5. Criterion-based audits of CS indications 6. Regular risk management meetings with emphasis on diagnosis of fetal distress
2. High rate of IOL and high rates of CS in women undergoing IOL (high contribution of group 2a to total CS rate and high CS rate in group 4a)	1. Possible inappropriate indications for IOL 2. Possible inappropriate use of prostaglandin/oxytocin 3. Possible Inappropriate CTG interpretation 4. Possible misdiagnosis of failed IOL	7. Consultant meeting to update IOL protocols (agreeing on criteria for failed IOL according to recent evidence)* 8. Criterion-based audits on IOL 9. Monitor IOL indications, complications and abnormal CTG associated with use of prostaglandins or oxytocin
3. High prevalence of prelabour CS (group 2b) with more frequent CS indications: abnormal CTG, potentially inappropriate indications (25%), presence of maternal/fetal pathological conditions	1. Inappropriate indications for prelabour CS	10. Update protocols on indications for prelabour CS 11. Criterion-based audits on indications for prelabour CS 12. Review cases of CS for abnormal CTG during staff training
4. High CS rate in groups 3 and 4a (multiparous). More frequent indication is abnormal CTG 5. Very high CS rate in group 5, majority are elective. Past CS is the main indication	1. Rate of CS in multiparous women suggests suboptimal care in this group of women 2. Inappropriate interpretation of CTG 3. Low offer of TOLAC	Recommendations #1,2,3 13. Criterion-based audits of offers and unsuccessful cases of TOL 14. Use of patient education leaflets to inform women of TOL benefits and establishment of a nurse-led TOLAC counselling service* 15. Monitoring the prevalence of TOLAC
6. Breech is the fourth most common indication for CS	1. Refusal by mothers to accept ECV due to preconceived prejudices	16. Develop an information leaflet on the value of ECV
7. Low rate of CS for dystocia with half of CS done in second stage 8. Low CS rate in group 9	1. Possible problems in data quality 2. Possible misclassification of a few number of cases	Recommendation #2,4 17. Training for data collectors and hospital staff on definitions used for the Robson's classification according to the WHO manual, stressing also the definition of dystocia 18. Add few internal validation rules in the database (previous CS, breech, dystocia) and strengthen monitoring on these variables.

Continued

Table 5 Continued

Key findings from the analysis	Possible explanations that emerged from hospital staff discussion	Agreed recommendations for quality improvement
9. High contribution to CS rate from group 10. Majority of the indications for maternal/fetal pathological conditions	1. Iatrogenic indications of IOL/CS in the late preterm period	Recommendation #7 (update protocols of IOL and elective CS criteria in late preterm and SGA) Recommendation #5 (criterion-based audits on cases of IOL and elective CS)

CS, caesarean section; CTG, cardiotocography; ECV, external cephalic version; IOL, induction of labour; SGA, small for gestational age; TOL, trial of labour; TOLAC, trial of labour after caesarean.

internal discussion and for QI purposes. Existing literature has reported heterogeneity of practices related to CS and substandard practices have been identified even in 'developed countries' such as Australia, France, Italy and others.[25–27] However, the majority of published studies using the Robson classification focused on the analysis, rather than on the development of recommendations to improve CS practices. A recent systematic review[16 28] cited only six studies that used the Robson classification in a clinical audit cycle to reduce CS rates. We were able to identify only one study, conducted in Canada, where the local Society of Obstetricians and Gynaecologists has formally supported the use of the Robson classification,[29] measuring the effect of the Robson analysis on the CS rate with a before and after design.[30]

Third, this is the first report on the use of the WHO implementation manual for Robson classification,[4] where all steps suggested therein were followed. The paper documents an example of how the manual can be used in an action-oriented manner.

As for additional findings, this study underscored the lack of specific reference standards for the Robson classification. Interestingly, in several instances the findings of this analysis were within the range of the values provided by the Robson guideline, but not of those provided by the MCS population, or vice versa. This is not surprising, given the fact that as stressed in the WHO manual, none of these two comparisons could be taken as an absolute standard.[4] The WHO manual underlines that neither Robson nor MCS references 'have been validated against outcomes and should not be taken as a recommendation' and 'it is up to the hospital itself to decide what is appropriate care, based on its results and other available evidence'.[4] Being specific for Sri Lanka, this study may help researchers and policy makers in future to further interpret data from a similar setting. Meanwhile, more research should be conducted to identify the gold standard for Robson analysis.

This study did not aim to compare in detail the findings of the Robson analysis to the international literature, but rather to describe the whole process of how data were internally used to develop recommendations to improve hospital practices. However, few points on key clinical findings can be further discussed here. In most Robson groups, the very high rate of CS performed for abnormal CTG/suspected fetal distress was a reason of concern. Although a similar rate of around 25% had been reported in USA[23] the contribution of abnormal CTG in Sri Lanka may highlight a problem unique to countries in economic transition. In these settings, with increasing investment in health infrastructure, CTG machines are becoming increasingly available and, due also to their wide usage in high-income countries, practitioners and policy makers often see them as essential for the provision of quality obstetric care. However, the introduction of these technologies has not always been complemented by adequate capacity development. Currently, Sri Lanka does not have mandatory training for staff in CTG interpretation.

Further, currently there is a lack of facilities for ancillary tests such as fetal scalp blood sampling and cord blood pH levels, which are important adjuncts in verifying decisions made based on CTG interpretation. Recently, there have been calls to optimise technical skills of staff on CTG interpretation, by delivering adequate training.[31] Results of this study suggest that improving the quality of CTG interpretation could be an important step towards reducing CS rates and increasing appropriateness of care.

The high rate of IOL in our population (24.6%), when compared with existing literature,[14 32 33] is also a matter of concern that needs further investigation. IOL should be performed only with a clear medical indication (ie, when expected benefits outweigh its potential harms).[32] Recent data from high-income settings show that IOL does not result in increased CS rates,[34 35] while our findings suggest that the high rate of IOL may have contributed to the relatively high rate of CS (groups 2a and 4a contributed to 16.9% of the total number of CS, and the two key indications to CS in these groups were abnormal CTG and failed induction, table 1 and online supplementary table 8). Sri Lanka has the highest rate of IOL in Asia[32 33] and a better understanding of practices related to IOL may contribute to the current local debate on how to improve quality of maternal care. As recommended by Robson[36] the Robson classification 'provides a common starting point for further analyses for all labour and delivery events and outcomes'; it draws attention to specific groups, where further analysis can be performed to understand the reasons behind the initial observation. We plan to further analyse and report IOL practices in a future paper.

A relevant proportion of CS (6.5%) was performed electively for potentially inappropriate indications (ie, prelabour diagnosis of CPD, history of subfertility, maternal request). However, this is a frequent finding in the literature, as documented in studies from USA, Germany, China, Brazil, Argentina, India, Pakistan and other countries.[37–44] One of the recommendations agreed on in this experience was the implementation of regular auditing of cases of CS without absolute indications, aimed at promoting good practices.

We acknowledge some limitations of this study. The analysis highlighted cases of possible misclassification and missing variables resulting in cases being unclassifiable. However, this was a rare finding (respectively, 0.5% and 0.6% of total cases, see table 1 and online supplementary table 8). Data quality was the object of internal discussion, and actions to improve it were within the list of recommendations developed.

Despite not all recommendations developed fitting into the remit of SMART,[17] the process still provided the opportunity to discuss clinical practice using objective data in a constructive, participatory manner, and resulted in a concrete list of actions. Activities agreed on aligned with evidenced-based recommendations on effective interventions for improved health worker performance,[45] also taking into account previous experience of the team.[46–50]

This was a pilot study in one single facility and it will be important to replicate similar experiences in other settings to evaluate generalisability of findings. We believe that the commitment of local staff, a favourable local leadership and a constructive dialogue with an external partner providing independent technical support, were the three essential favourable elements in succeeding in performing the analysis and most importantly, in using data proactively.

The study does not report perinatal outcomes such as perinatal mortality rates. We have planned to wait some more to collect a larger sample to be able to have adequate power to analyse and discuss hard (but relatively rare) outcomes such as perinatal mortality.

Within the project time lines, it was not possible to follow-up the impact of the recommendations developed. Future longer-term studies will be needed to monitor implementation.

CONCLUSIONS

This study provides an example from a setting with limited resources where information from an individual patient database were used locally for conducting an in-depth analysis of CS practices, following the WHO manual.[4] Further, it was used for developing recommendations to improve the quality of hospital care. Future studies may further explore other aspects of maternal care, such as practices related to IOL—and monitor over time outcomes of the recommendations developed.

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