Classification of intrapartum cesarean sections: a prospective national study in Norway (Nor-Why-Cesarean study)

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Abstract

Objective: To validate an intrapartum Cesarean Section Classification System (ICSCS). **Design:** Nationwide prospective observational study. **Setting:** Twenty-five Norwegian maternity units **Population or Sample:** Singleton cephalic pregnancies with spontaneous or induced labour at [?] 37 weeks gestation delivering February-August 2017. **Methods:**. After training of all collaborators, Cesarean section (CS) after spontaneous or induced labour were classified based on fetal status, dynamic progress in labour, use of oxytocin, frequency of contractions and linked to denominator data collected and centralized by the Norwegian Medical Birth Registry. **Main Outcome Measures:** Cohens kappa as measure of agreement for correct application of the classification. Prevalence of the different groups using the ICSCS within the Ten Group Classification System (Robson groups). **Results:** Of 49 trained experts, 40 (82%) had a $\varkappa > 0.6$ indicating good or very good level of agreement when the classification was applied. A total of 1425 CS were classified: CS classified as fetal indication (no oxytocin) was more common in induced (Group 2a, 4a, 5b) compared to spontaneous labours (Group 1, 3, 5a). CS classified as dystocia related to inefficient uterine action and poor response to oxytocin occurred more often in induced as compared to spontaneous labours. The prevalence of CS classified as dystocia with efficient uterine action (malposition or cephalopelvic disproportion) was low in all Robson groups. **Conclusions:** The ICSCS was successfully validated in a national study. It may become a valuable objective tool for analyzing the management of labour and explaining differences in the prevalence of CS between different groups of women.

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Funding: Norwegian Medical Association.

Keywords: Cesarean section, classification, induction of labour, dystocia, fetal distress, Ten-Group-Classification System

Introduction

The increasing CS rate is a subject of debate within perinatal care.[1, 2] In order to monitor CS rates at national and institutional levels WHO, FIGO and EBCOG in addition to many national professional societies have endorsed the Ten-Group-Classification System (TGCS) as the most appropriate tool for clinical audit.[3-6] The TGCS classifies all women into clinically relevant groups each having a specific CS rate. It serves as the initial structure within which epidemiological variables, processes, perinatal events and outcomes can be analysed. The philosophy of the TGCS is based on 'an intention to treat'.[4, 7, 8]However although the TGCS tells you which women have a CS it does not tell you why.

Internationally there is no consensus on classification of indications for CS and none fulfill the criteria of simplicity, usefulness, reproducibility and robustness.[9] Indications for pre-labour CS need to be considered differently from those performed after spontaneous or induced labour and therefore deserve a separate classification.[10] Most indications used are very detailed, often subjective and multiple and frequently overlap. This may result in long lists of possible indications which has limited use on a day-to-day basis to understand, change and improve care. Using a high level classification system of CS initially prior to more detailed and subjective indications both in prelabour CS and after spontaneous or induced labour may provide the solution.

In 2014-15 a national quality improvement initiative, focusing on the appropriate and safe use of oxytocin in labour took place at delivery units in Norway. During this project, Norwegian maternity health caregivers became aware of a new high level intrapartum CS classification system (ICSCS) (Fig.1), incorporating information on the fetal condition, the dynamic progress of labour, the use or not of oxytocin to accelerate or induce labour and the frequency of contractions. [10-12] This new ICSCS gives a unique insight into the study and management of dystocia and the use of oxytocin. The authors emphasize that the classification is designed to be used irrespective of how you manage labour and must not be misinterpreted as clinical guidance on how to manage labour. Specifically the division of dystocic labours into those with efficient (progress [?]1 cm/h) or inefficient (progress <1 cm/h) uterine action is not an imperative for clinical management, but a pragmatic cut-off to differentiate between the different dynamics of labour.

This classification has been used in The National Maternity Hospital, Dublin since 2005 [13] but had never been formally tested outside that hospital. Following national discussion and agreement, a prospective study was initiated in Norway to test the practicalities and possible benefits of using this new ICSCS in spontaneous and induced labour.

Material and methods

Part 1- Education and training

This was a prospective observational study which took place in Norway from 15th February to 15th August 2017. All delivery units with more than 500 deliveries were invited to participate. To ensure an equally distributed recruitment throughout the whole country, three smaller units located in Northern Norway were invited as well. All but one of the 26 invited units chose to participate in the study. One participating unit did not complete the entire study period due to a lack of local resource although they supported the concept of the project.

The first part of the study consisted of teaching and certification of local collaborators. All participating units appointed 1-3 local collaborators who met for a one-day seminar. At this meeting the philosophy and scientific methodology of the ICSCS was presented. Based on a totally inclusive and mutually exclusive classification one out of seven subcategories could be chosen to classify the intrapartum CS (Fig.1, Supplement 1). For the purpose of classification, the fetal status, the dynamics of labour, the use of oxytocin (either for acceleration or for induction) combined with and frequency of uterine contractions (cardiotocograph) was required. The participants in the study discussed the ICSCS in small groups based on a set of ten cases, followed by a joint presentation reviewing the cases using the study form. The seminar finished with a certification test for all the participants including the classification of ten cases of intrapartum CS, not known to the collaborators beforehand. The level of agreement for each collaborator against the correct classification was estimated by Cohen´s kappa test.

Part 2- Prospective data collection

The second part of the study was the prospective data collection. The classification can be used for all women either in spontaneous or induced labour. However the inclusion criteria for the Nor-Why-Cesarean study were singleton pregnancies with a gestational age of more than 36+6 weeks. Exclusion criteria were multiple pregnancies, deliveries at a gestational age $<$ 37 weeks and all pre-labour CSs. For the purpose of the current study, we also excluded all breech deliveries (Group 6 and 7), thus focusing on women in the TGCS groups 1, 2a, 3, 4a and 5a, b, respectively (Fig. 2).

After delivery, the study form of ICSCS, designed in cooperation with the Medical Birth Registry (Supplement 2) was completed by the certified local project collaborators. Guidance for classification, case examples and information about the project was available through access to a cloud-saved project folder. Email contact with the author of the classification (MR) was available for assistance in the confirmation of classification of any cases where there was disagreement. The study forms were sent to the Medical Birth Registry, scanned and read electronically, and data converted into a statistical file format. Data collected in the study was then linked case by case through the unique personal identification number with data routinely collected to the

registry from the electronic obstetric patient record.

The proportion of different subcategories in the ICSCS is presented as mean and 95% confidence interval of the mean. Non-overlapping confidence intervals indicate a significant difference between different proportions.

The project took place under the umbrella of the Medical Birth Registry of Norway. Collection of perinatal data to the registry is mandatory without the necessity of written informed consent from the pregnant women. The study was approved by the research ethics committee (REK Nord 2018/1682-3).

Results

Part 1

A total of 49 senior clinicians (11 midwifes, 6 non-consultants and 32 consultants) went through the certification process for use of the ICSCS. The strength of agreement compared with the correct classification for the set of 10 cases was good or very good for 40/49 (82%). There were significant interprofessional differences with consultants performing better than midwifes and non-consultants (Fig. 3). However, importantly there was general agreement and understanding afterwards when the classification of the cases was presented and explained.

Part 2

The 25 delivery units participating in the study, accounted for 82.1% of the deliveries in Norway (Tab. 1, Fig. 2).

The characteristic of the birth population from participating and non-participating units revealed minor, but statistically significant differences in maternal age, pre-pregnancy BMI, parity, start of labour, gestational age at delivery, and transfer to the neonatal intensive care unit (Tab. 1). The categorization of the entire birth population according to the TGCS (which is standard practice in (Norway) is shown in Tab. 2, and of those the groups 1, 2a, 3, 4a and 5 were included in the study. Of eligible women, 8.7% had missing data due to missing study forms (Fig. 2).

The CSs were classified according to the classification and within the study group shown in Figure 4 (Supplement 3). In both nulliparous and parous women (without a previous CS), induction of labour (Group 2a and 4a) compared to spontaneous onset of labour (Group 1 and 3) was associated with a significant higher proportion classified as CS for fetal indication (no oxytocin), dystocia-inefficient uterine action-oxytocin-poor response and dystocia-inefficient uterine action- oxytocin-inability to treat fetal intolerance (Fig. 4, Supplement 3). In women with a previous CS, induction of labour (Group 5b) compared to spontaneous start of labour (Group 5a) was associated with a higher proportion of CS classified as dystocia-inefficient uterine action-oxytocin-poor response and dystocia-inefficient uterine action-inability to treat-fetal intolerance. The prevalence of CS classified as dystocia-efficient uterine action (CPD or malposition) was generally low in all groups. In dystocic labour in women with a previous CS (Group 5) there was a greater prevalence of CS classified as dystocia-inefficient uterine action-no oxytocin compared to the remaining study population (Groups 1-4) (Fig. 4, Supplement 3).

Discussion

Main findings

In this prospective national Norwegian study, we successfully taught midwives and obstetricians to use the ICSCS. [10-12] All clinicians participating in the study found it useful. Intrapartum CS classification patterns corresponded to clinical experience associated with parity, spontaneous and induced labour and labour after a previous CS. Dystocia with inefficient uterine action (progress less than 1cm/hour) either due to fetal intolerance or poor response was the most common cause of intrapartum CS in particular if labour was induced (TGCS group 2a and 5b, Fig. 4).

Our study is the first to successfully apply this ICSCS outside the National Maternity Hospital, Dublin and also at a national level on a birth population analysed by the TGCS.

Interpretation

The simple hierarchical classification system used in the study (Figure 1, Supplement 1) classifies intrapartum CS by the condition of the fetus, rate of progress during labour and the use of oxytocin in an inclusive and mutually exclusive manner.[10, 12] This is in contrast to a systematic review of indication-based classifications[9] which identified only two out of twelve studies using a mutually exclusive system [14, 15]. Generally, this review found low reproducibility in classification (disagreement in 45% of the cases [range 8%-83%]). The studies utilizing a mutually exclusive classification [14, 15] incorporated some elements of the TGCS into their indication system (previous CS and breech), but did not differentiate between suspected fetal distress according to use or non-use of oxytocin and whether the suspected fetal distress was a primary factor or only occurred as a result of treatment of dystocia. Both types of suspected fetal distress were accounted for appropriately in the current study.

Detailed indications for intrapartum CS in Norway have been previously reported based on the mandatory data collection in the Medical Birth Registry of Norway.[16-18] Interestingly an analysis of the period 1967-84, classified 31 indications into seven high level groups (mechanical, uterine, presentation, asphyxia, other fetal, maternal, acute placental). More than one category though was present in 35% of all CS.[16]

A comparison of Scotland, Sweden, USA and Norway during the time period 1980-90, chose the first relevant in a hierarchy of five indications (previous CS, breech presentation, dystocia, fetal distress, or other) as the primary indication and were classified accordingly. The number of CS with multiple indications was not reported. [17]

A nationwide study in 1998-99 reported indications for CS using a pre-determined set of 31 indications with up to four choices per case.[18] In all three studies the classification systems were also totally inclusive, but not mutually exclusive. Both the arbitrary hierarchy [17] and the subjectivity related to combinations among a set of indications [16, 18] make a comparison impossible. Moreover, there was no division of CS into those performed before and during labour and features characterizing women according to the TGCS (breech presentation, previous CS) were partly mixed with indications. [16-18]

A Slovenian study applied a modified version of the ICSCS used in the current study on deliveries in the TGCS group 1. [19]They found intrapartum CS classified as Dystocia-Efficient uterine action - CPD to be more prevalent as compared to Norway (3.1% vs. 0.2%). [19] Different clinical approaches to vaginal operative delivery could explain this: instrumental delivery was performed four times more frequently in Norway compared to Slovenia.[20]

In a Swedish registry-based study on women in TGCS Group 1 and 2a for the period 1999-2010 multiple indications accounted for 14% of all intrapartum CS and an indication was missing in as many as 18% of deliveries. [21]

Other studies, based on either national or multicenter data did not apply indications within the TGCS and their subgroups,[22, 23] making it impossible to differentiate pre-labour CS from those performed intrapartum. Multiple indications per CS were also common and while they might provide a more complete explanation of the clinical situation, they are not useful for classification, comparison and learning from each other.

Strengths and limitations

A strength of the study is the prospective and national design, and uniform data collection using the Norwegian Medical Birth Registry. Standard obstetric practice was based on the Norwegian national guidelines. [24] After education and training, the reproducibility of the ICSCS was tested for midwifes and doctors before data collection was started; all achieved good or very good levels of agreement. In contrast to other indication systems, all births were first classified according to the TGCS [7] and then subsequently classified using the ICSCS.

A fundamental measure of quality care is knowing your results, including the ability to interpret them.[25] We agree with the authors of the system that this enables a much better clinical interpretation of the CS

rate as the incidence and risk benefit ratio of the indications varies according to the different groups. For example staff refraining from using oxytocin in women with a previous CS was reflected in a higher incidence of dystocia-inefficient uterine action-no oxytocin in women with a previous CS (Group 5) compared to the remaining groups (1-4).

Non-participation of some units (18% of the birth population), some missing project forms and population differences between participating and non-participating units are relative weaknesses but did not affect the purpose of the study.

There was a strong consensus within the project group about the benefits of the ICSCS within the TGCS system as part of a recommended audit and feedback. [26] However without a suitable electronic patient record (EPR) and perinatal database implementation on a routine basis nationally was not felt to be possible at the present time. Unfortunately the process of introducing changes into different EPRs (there are currently 3 maternity EPRs in Norway) and subsequent approval by the Medical Birth Registry are challenging and time-consuming. During the training initially it was difficult for some participants to grasp the concept that this classification system is completely independent and applicable irrespective of the guidelines used in the management of labour. The study did reveal though that, despite national guidelines, the CS rate according to the TGCS and the high level classification system used in this study did produce different results between participating units (data not shown). This initiated a discussion about relevant differences in local obstetric practice based on an objective and reproducible classification of CS (Suppl. 2). Performed either as a comparison between units or as a longitudinal assessment at one unit it may highlight areas for improvement in perinatal care or confirmation of appropriate care. For example, the prevalence of the fetal indication (no oxytocin) group should be relatively similar within the same groups of women (based on the TGCS and similar epidemiological case mix) and identical guidelines for fetal monitoring. Existing differences should then be related to other perinatal outcome measures and could reveal either an over- or under-use of CS for fetal indication. This type of quality assessment as a result of using the classification was positively embraced by all participants.

Conclusion

High level classification of intrapartum CS using totally inclusive but also mutually exclusive objective criteria is useful for interpretation of clinical practice. Detailed and more subjective clinical indications are more useful used within the ICSCS and within the overarching structure of the TGCS.

We successfully tested a ICSCS in a prospective nationwide study. The system can be easily taught, and we recommend including it as part of routine perinatal data collection. It may become a valuable objective tool for analyzing and improving the management of labour.

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Contribution to authorship: JK initiated the project and national data collection, performed the data analysis, and drafted the manuscript. MR gave support in teaching the ICSCS to the collaborators from participating units and participated in the interpretation of data and revision of the manuscript. Apart from their role as local project collaborators FM, JR and CT participated in data interpretation and revision of the manuscript.

Details of ethics approval: The study was approved by the Research Ethics Committee (REK Nord 2018/1682-3). Data collection to the Medical Birth Registry of Norway is mandatory and does not require consent form the women.

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References:

1. Blustein J, Liu J. Time to consider the risks of caesarean delivery for long term child health. BMJ. 2015 Jun 10;350:h2410.

2. Visser GHA, Ayres-de-Campos D, Barnea ER, de Bernis L, Di Renzo GC, Vidarte MFE, et al. FIGO position paper: how to stop the caesarean section epidemic. Lancet. 2018 Oct 13;392(10155):1286-7.

3. Betran AP, Torloni MR, Zhang JJ, Gulmezoglu AM, Section WHOWGoC. WHO Statement on Caesarean Section Rates. BJOG. 2016 Apr;123(5):667-70.

4. Robson MS. Classification of caesarean sections. Fetal and Maternal Medicine Review. 2001;12(1):23-39.

5. Mothers FWGOCICO, Infants During L, Delivery. Best practice advice on the 10-Group Classification System for cesarean deliveries. Int J Gynaecol Obstet. 2016 Nov;135(2):232-3.

6. European B, College Of O, Gynaecology E. EBCOG position statement on caesarean section in Europe. Eur J Obstet Gynecol Reprod Biol. 2017 Dec;219:129.

7. Robson M. The Ten Group Classification System (TGCS) - a common starting point for more detailed analysis. BJOG. 2015 Apr;122(5):701.

8. Robson M. A global reference for CS at health facilities? Yes, but there is work to do. BJOG. 2016 Feb;123(3):437.

9. Torloni MR, Betran AP, Souza JP, Widmer M, Allen T, Gulmezoglu M, et al. Classifications for cesarean section: a systematic review. PLoS One. 2011 Jan 20;6(1):e14566.

10. Robson M, Hartigan L, Murphy M. Methods of achieving and maintaining an appropriate caesarean section rate. Best practice & research. 2013 Apr;27(2):297-308.

11. Murphy M, Butler M, Coughlan B, Brennan D, O'Herlihy C, Robson M. Elevated amniotic fluid lactate predicts labor disorders and cesarean delivery in nulliparous women at term. Am J Obstet Gynecol. 2015 Nov;213(5):673 e1-8.

12. Ravikumar N, Murphy C, Rath A, Robson M, Keane D. Classification of caesarean sections in spontaneously labouring, single cephalic, nulliparous women at greater then 36 weeks (SCNT). Am J Obstet Gynecol. 2005;193(6):S128.

13. National Maternity Hospital, Holles Street: Annual report 2005 [cited; Available from: https://www.lenus.ie/handle/10147/45338

14. Anderson GM, Lomas J. Determinants of the increasing cesarean birth rate. Ontario data 1979 to 1982. N Engl J Med. 1984 Oct 4;311(14):887-92.

15. Gregory KD, Henry OA, Gellens AJ, Hobel CJ, Platt LD. Repeat cesareans: how many are elective? Obstet Gynecol. 1994 Oct;84(4):574-8.

16. Borthen I, Lossius P, Skjaerven R, Bergsjo P. Changes in frequency and indications for cesarean section in Norway 1967-1984. Acta Obstet Gynecol Scand. 1989;68(7):589-93.

17. Notzon FC, Cnattingius S, Bergsjo P, Cole S, Taffel S, Irgens L, et al. Cesarean section delivery in the 1980s: international comparison by indication. Am J Obstet Gynecol. 1994 Feb;170(2):495-504.

18. Kolas T, Hofoss D, Daltveit AK, Nilsen ST, Henriksen T, Hager R, et al. Indications for cesarean deliveries in Norway. Am J Obstet Gynecol. 2003 Apr;188(4):864-70.

19. Korenc M, Stern K, Verdenik I, Lucovnik M. Classification of Primary Caesarean Sections in Labor and its Usefulness for Analysis of Slovenian Perinatal Data. Zdr Varst. 2019 Mar;58(2):78-83.

20. Zeitlin J, Alexander S, Barros H, Blondel B, Delnord M, Durox M, et al. European Perinatal Health Report; 2015.

21. Poignant M, Hjelmstedt A, Ekeus C. Indications for operative delivery between 1999-2010 and induction of labor and epidural analgesia on the risk of operative delivery–a population based Swedish register study. Sex Reprod Healthc. 2012 Dec;3(4):129-34.

22. Frohlich M, Koga C, Buhrer C, Mori C, Yamamoto M, Sakurai K, et al. Differences in rate and medical indication of caesarean section between Germany and Japan. Pediatr Int. 2020 Sep;62(9):1086-93.

23. Boyle A, Reddy UM, Landy HJ, Huang CC, Driggers RW, Laughon SK. Primary cesarean delivery in the United States. Obstet Gynecol. 2013 Jul;122(1):33-40.

24. Norsk gynekologisk forening Veileder i fødselshjelp. ePub. ISBN 978-82-692382-2-8.

25. Robson MS. Known knowns, unknown unknowns and everything in-between - the Ten Group Classification System (TGCS). BJOG. 2021 Aug;128(9):1454-5.

26. Boatin AA, Cullinane F, Torloni MR, Betran AP. Audit and feedback using the Robson classification to reduce caesarean section rates: a systematic review. BJOG. 2018 Jan;125(1):36-42.

Tables

Table 1: Maternal and neonatal characteristics of the birth population of Norway during the study period (singleton term deliveries)

	Participating units	Non-participating units	Total	*p*
Maternal age (years)	31.0±4.8	30.2±4.8	30.8 ±4.8	<0.001
Maternal pre-pregnancy BMI	24.3±4.8	24.1±4.4	24.3±4.8	0.01
Parity				
0	9554 (41.9%)	1813 (36.6%)	11367 (41.0%)	<0.001
1+	3139 (58.1%)	13225 (63.4%)	16364 (59.0%)	
Gestational age at delivery (days)	280.6	281.0	280.7	0.002
Start of labour				
Spontaneous	16272 (71.4%)	3731 (75.3%)	20003 (72.1%)	<0.001
Induced	5152 (22.6%)	950 (19.2%)	6102 (22.0%)	
Pre-labour cesarean delivery	1355 (5.9%)	271 (5.5%)	1626 (5.9%)	

	Participating units	Non-participating units	Total	*p*
Mode of delivery				
Spontaneous vaginal	17069 (74.9%)	3858 (77.9%)	20927 (75.5%)	<0.001
Operative vaginal	2443 (10.7%)	432 (8.7%)	2875 (10.4%)	
Cesarean	3267 (14.3%)	662 (13.4)	3929 (14.2%)	
Birthweight (g)	3583±483	3589±464	3584±479	0.38
5 min Apgar score < 7	260 (1.1%)	51 (1.0%)	311 (1.1%)	0.55
Transfer to NICU	1740 (7.6%)	254 (5.1%)	1994 (7.2%)	<0.001

Table 2: The total birth population of all participating units according to the Ten-Groups-Classification System. Study population marked with grey color.

Group	N	Size of the group	CS rate wit
Total	3605/22595	100%	
1: Para 0, singleton, cephalic, >37 weeks, spontaneous	471/5961	28.4%	7.9%
2a: Para 0, singleton, cephalic, >37 weeks, induced	498/2153	10.3%	23.1%
2b: Para 0, singleton, cephalic, >37 weeks, CS before labour	157/157	0.7%	100%
3: Para 1+, no previous CS, singleton, cephalic, >37 weeks, spontaneous	102/7620	36.4%	1.3%
4a: Para 1+, no previous CS, singleton, cephalic, >37 weeks, induced	93/2009	9.6%	4.6%
4b: Para 1+, singleton, cephalic, >37 weeks, CS before labour	202/202	0.9%	100%
5a: Para 1+, previous CS, singleton, cephalic, >37 weeks, spontaneous	179/926	4.4%	19.3%
5b: Para 1+, previous CS, singleton, cephalic, >37 weeks, induced	155/465	2.4%	33.3%
5c: Para 1+, previous CS, singleton, cephalic, >37 weeks, CS before labour	600/600	2.6%	100%
6: Para 0, singleton, breech	348/468	2.1%	74.4%
7: Para 1+, singleton breech	197/342	1.5%	57.6%
8: All women with multiple pregnancies	203/480	2.1%	42.3%
9: All women with tranverse lie	48/48	0.2%	100%
10: Singleton, cephalic, <37 weeks	352/1164	5.2%	30.2%

Figures

Figure 1: The classification system for intrapartum Cesarean section based on categorization into seven subcategories (textboxes with gray background)

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Inefficient uterine action: progress in cervical dilatation during labor < 1 cm/hour

Efficient uterine action: progress in cervical dilatation during labor [?] 1 cm/hour

Figure 2 : Flowchart of recruitment and study population according to the Ten group classification system (TGCS)

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`image2.emf` available at https://authorea.com/users/655544/articles/661282-classification-of-intrapartum-cesarean-sections-a-prospective-national-study-in-norway-nor-why-cesarean-study

Figure 3: Level of agreement with the correct classification of intrapartum cesarean deliveries by type of obstetric caregiver. Data expressed as Cohens kappa, based on a test with ten cases.

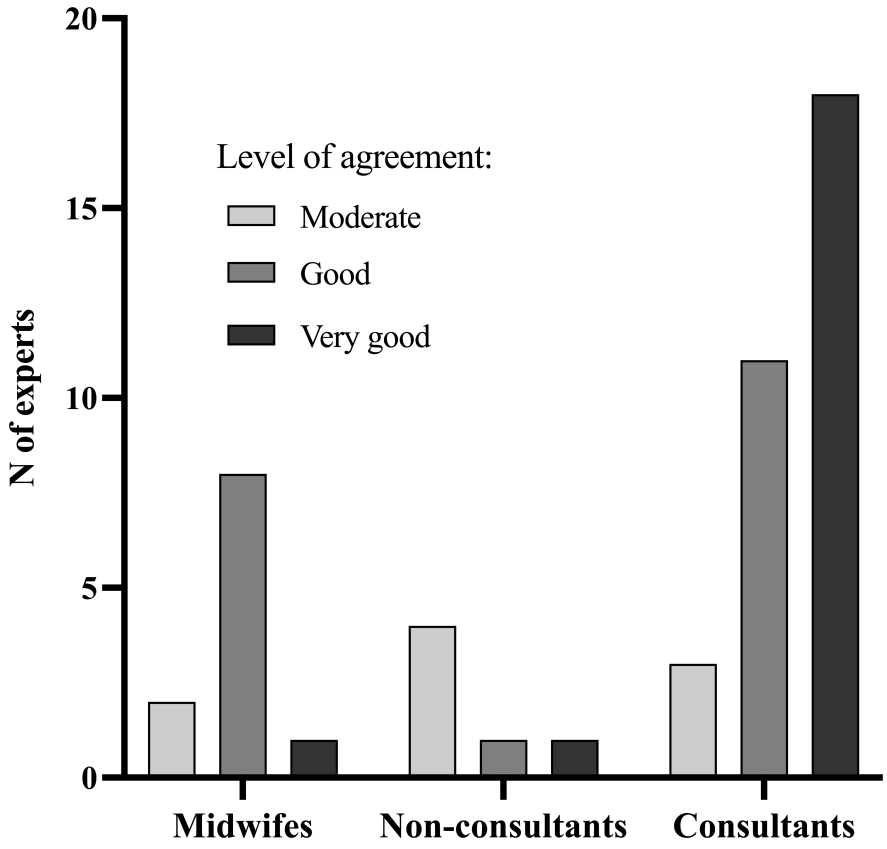
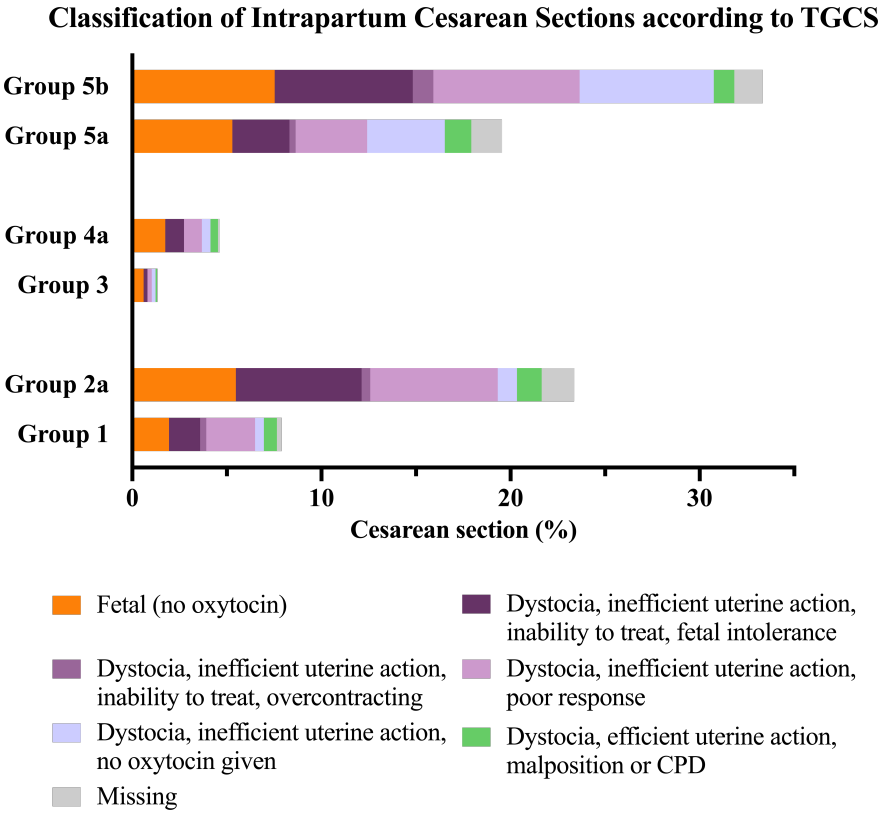


Figure 4: Classification of intrapartum CS according to the TGCS



Supplementary files

Supplement 1: Guidance document for classification of intrapartum CS

Supplement 2: Study form filled out by the local collaborators (pdf file)

Supplement 3: Classification of intrapartum CS according to the TGCS, data presented in a table.