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A method to assess obstetric outcomes using the 10-Group Classification System: a quantitative descriptive study

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ABSTRACT

Objectives: Internationally, the 10-Groups Classification System (TGCS) has been used to report cesarean section rates, but analysis of other outcomes are also recommended. We now aim to present the TGCS as a method to assess outcomes of labor and delivery using routine collection of perinatal information.

Design: A methodological study to describe the use of the TGCS

Setting: Stavanger University Hospital (SUH) Norway, National Maternity Hospital Dublin (NMH) Ireland and Slovenian National Perinatal Database (SLO) Slovenia

Participants: 9848 women from Stavanger University Hospital, Norway, 9250 women from National Maternity Hospital Dublin, Ireland and 106 167 women, from Slovenian National Perinatal Database, Slovenia

Main outcome measures: All women were classified according to the TGCS within which cesarean section, oxytocin augmentation, epidural analgesia, operative vaginal deliveries, episiotomy, sphincter rupture, postpartum hemorrhage, blood transfusion, maternal age>35 years, body mass index >30, Apgar score, umbilical cord pH, hypoxic ischemic encephalopathy, antepartum and perinatal deaths were incorporated.

Results: There were significant differences in the sizes of the groups of women and the incidences of events and outcomes within the TGCS between the three perinatal databases.

Conclusions: The TGCS is a standardized objective classification system where events and outcomes of labor and delivery can be incorporated. Obstetric core events and outcomes should be agreed and defined in order to set standards of care. This method provides continuous and available observations from delivery wards, possibly used for further interpretation, questions and international comparisons. The definition of quality may vary in different units and can only be ascertained when all the necessary information is available and considered together.

Key words:

Cesarean section, quality of care, labor outcome, neonatal outcome, the 10-Group Classification System, core outcome

Abbreviations:

SUH, Stavanger University Hospital; NMH, National Maternity Hospital; SLO, Slovenian National Perinatal Database; TGCS, the 10-Group Classification System; WHO, World Health Organization; FIGO, The International Federation of Gynecology and Obstetrics

Strengths and limitations of this study:

- This study proposes the use of an available method which may elaborate potential trends in delivery units and thus guide labor and delivery management
- Events and outcomes of labor are incorporated in the 10-Group Classification System from three different populations in Europe
- The 10-Group Classification System is limited by unclear definitions of some of the outcomes used and encourage the importance of an agreed set of obstetric core outcomes
- The design as a quantitative descriptive study limits the ability to explore causes of the different prevalence's of outcomes and events observed

INTRODUCTION

Safety, consistency and quality in labor and delivery are key priorities for all labor and delivery units. It is difficult to determine what quality in labor and delivery is, but attempts to develop important outcomes are taking place (1-4). An agreed classification system, incorporating key outcomes that are objective, measurable and relevant to clinical practice is required in order to assess consistency and quality of care.

Clinical practice and guidelines do vary internationally and occasionally also nationally. However, agreeing on a standard classification for assessment of quality of care should be less contentious. It is essential that providers and users of maternity care are aware of events and outcomes in their units and in addition having the ability to compare their results objectively over time and to other units. Only then can assessment of the quality of care take place (5, 6). The emphasis on evidence-based medicine should be supported by prospective databases combined with a multidisciplinary quality audit programme. Acceptance and commitment to this philosophy will provide insight about labor and delivery and importantly ensuring that we are providing safe and quality care (7).

The 10-Group Classification System (TGCS) was first described in 2001 and originally popularized as a method to assess cesarean section rates (8). The intention however, was to introduce a generic perinatal classification to assess all perinatal events and outcomes of which cesarean section is only one. The way the ten groups are structured make them relevant to all clinicians and women themselves and can provide a common language and starting point for any discussion on safety, quality of care and perinatal audit (9). The TGCS is endorsed by the World Health Organization (WHO) and the International Federation of Gynecology and Obstetrics (FIGO) and increasingly used by labor and delivery units to report their cesarean section rates (10-18). The WHO and FIGO also recommend that other events and outcomes surrounding labor and delivery are analyzed in relation to cesarean section using this classification.

This paper classifies data from three perinatal databases in different countries and explores the usefulness of the TGCS as a method to assess the quality of care. It also discusses the challenges that occur even using a standard classification system.

METHODS

Data related to pregnancies and deliveries were prospectively collected in Stavanger University Hospital (SUH) Norway 2010-2011, National Maternity Hospital Dublin (NMH) Ireland 2011 and Slovenian National Perinatal Database (SLO) Slovenia 2007-2011. The study population included 9848 women in SUH, 9250 women in NMH and 106 167 women in SLO. All women were classified according to the TGCS (Figure 1). Cesarean section was defined as after spontaneous onset, induction or pre-labor. Pre-pregnancy body mass index was calculated as weight in kilograms/height in meters squared. Episiotomies were either lateral or mediolateral and perineal tears affecting the external or the external and internal sphincter were classified as obstetric anal sphincter injuries. The attending midwife or obstetrician visually estimated blood loss and postpartum hemorrhage > 1000 millilitres were registered at SUH and NMH, and postpartum hemorrhage > 500 millilitres in SLO.

Perinatal deaths included all intrauterine deaths after 22 weeks gestational age and within the first week after delivery. Hypoxic ischemic encephalopathy was classified using the Sarnat or modified Sarnat definition as grade I (mild), grade II (moderate) and grade III (severe). All data are presented as descriptive statistic.

Stavanger University Hospital

Stavanger University Hospital has a catchment population of approximately 320 000 and is the regional maternity unit in the west of Norway. It has a tradition of low obstetrical intervention rates. Women with one previous cesarean were encouraged to deliver vaginally. Information related to pregnancies and deliveries was prospectively collected and recorded in an electronic obstetrical journal system (Natus).

The Regional Committee for Medical and Health Research Ethics classified the study as a quality assurance study of routinely recorded data (REK Vest 2012/1522) and the local committee for data protection (2012/41) approved the project.

National Maternity Hospital

The National Maternity Hospital is a tertiary referral maternity hospital in Dublin, Ireland and one of the largest labor and delivery units in Europe delivering over 9000 women a year. It is well known for its Active Management of Labor philosophy on labor (19). This package of care is based on the prevention of prolonged labor and the physical and emotional sequel that follow. Labor and delivery information is collected prospectively on an obstetrical and

neonatal database. The hospital has traditionally for many years completed an Annual Clinical Report detailing each year's results.

Slovenian National Database

Slovenia is a European Union member state in Central Europe with approximately 2.1 million of inhabitants and 20 000 deliveries per year. Health care in Slovenia is a public service provided through the public health service network. Perinatal care is almost entirely covered by compulsory health insurance, which is publicly funded. Slovenia has had a National Perinatal Information System (NPIS) since 1987 and registration into a computerized database by the attending midwife and doctor is mandatory. Data from all 14 country's maternity unit are collected. To assure quality of data collection, controls are built in the computerized system and audited periodically.

RESULTS

The populations contained 43%, 46% and 48% nulliparous women in SUH, NMH and SLO. The overall cesarean section rates were 13.6%, 21.4% and 17.4% in SUH, NMH and SLO, respectively. The highest rate of cesarean in groups 1 and 2a was observed in SLO. NMH presents the lowest rate of cesarean in group 3 and SUH the lowest rate in group 5. Rupture of the uterus was diagnosed in 0.02% (2/9848) women in SUH, no women in NMH and 0.04% (39/106 167) women in SLO during the study period. The relative sizes of the groups and cesarean section rates are presented in Table 1.

The overall pre-pregnant body mass index > 30 was 9.7%, 12.8%, 8.3% and the frequency of maternal age >35 years was 14.9%, 32.2%, 14.9% in SUH, NMH and SLO, respectively. Maternal characteristics stratified according to the TGCS are presented in Table 2.

The overall use of epidural analgesia varied from 35.0% at SUH and 49.0% at NMH to 2.7% in SLO. The overall operative vaginal delivery rate varied from 12.7%, 11.9% and 3.2% in SUH, NMH and SLO, respectively. The overall induction rates were 20.1%, 24.9% and 23.5% and the frequencies of use of oxytocin were 23.6%, 28.3% and 57.3% in SUH, NMH and SLO. The overall rates of episiotomy were 19.7%, 28.7% and 32.0% and the rates of obstetric anal sphincter injuries were 1.5%, 1.5% and 0.3% in SUH, NMH and SLO, respectively. The overall red cell blood transfusion rate was 2.7%, 1.4% and 0.2% in SUH, NMH and SLO. Labor outcomes stratified according to the TGCS group's 1-5 are presented in Table 3 and 4.

Overall perinatal death in SUH was 4.2 per 1000, in NMH 3.9 per 1000 and 5.0 per 1000 (540/108070) in SLO. Perinatal deaths among groups 1 and 2 together were 1.3‰, 1.4‰ and 1.2‰, among groups 3 and 4 together 0.1‰, 0.8‰ and 1.2‰ and among women with previous cesarean (group 5) 5.5‰, 0‰ and 0.9‰ in SUH, NMH and SLO, respectively. Neonatal outcomes stratified according to the TGCS 1-5 are presented in Table 5.

DISCUSSION

Every labor and delivery unit has a responsibility to record and publish their results. The results also need to be presented in a standardized and structured way, as the management and implications will vary in different groups of women. Any one event or outcome cannot be considered on their own without the understanding of any effects on other events, outcomes or complications. Care during labor and delivery has changed dramatically over the last 30 years (20). In particular, the cesarean section rate has risen and a common classification system might be helpful exploring benefits and risks associated to this intervention.

Limitations

Several challenges were discovered writing this manuscript. When comparing maternal, labor and perinatal outcomes between units and countries, objective variables (blood transfusion rates, perinatal deaths) have advantages over subjective assessed outcomes (postpartum hemorrhage, Apgar score <7 and hypoxic ischemic encephalopathy). In addition, some of our outcomes were differently defined and registered such as postpartum hemorrhage .This issue has been recognized and highlighted as a general problem in clinical trials (3, 4, 28). Standardizing and agreeing on which core outcomes to be used to assess quality would not only increase the usefulness of the information collected but also encourage delivery units to use the same definitions. Due to different databases and registration, we only succeeded in completing Table 1 with data from all the 10 groups. Ensuring quality data from national databases may be challenging and the low rates in SLO particularly of obstetric anal sphincter injuries and transfusion rates should have been validated. Even more important is the need for a structured and standardized collection and registration of defined core outcomes in delivery units and in national registers.

We present the use of the TGCS as a method of which possible patterns within the observed population may uncover. By comparing outcomes and events between standardized

groups of women, hypotheses requiring further attention might be suggested. However, to explore causality further studies are needed.

The 10-Group Classification System

To achieve good data quality, proper registration and standardized definitions of outcomes are essential. The ability to classify all deliveries into one of the ten groups is however a quality indicator which many institutions, countries and perinatal databases struggle to do (5). By presenting data using the TGCS, the ability to demonstrate significant differences in smaller units is limited. However, examining even a small number of cases may be helpful to develop local strategies to improve the quality of care (14). Risk is not only the chance of certain events occurring but also the implications if it did occur.

The TGCS presents a method of risk stratification, which visualizes how the cesarean section rate varies between different units and countries. Interpretation of other outcomes in the different groups may be used as a guidance to assess obstetric quality. Cesarean section rates can only be evaluated if perinatal and maternal outcomes are included (14, 21). Using the TGCS, there are only three possible explanations for differences in the sizes of the groups and the events and outcomes within the groups: data quality, significant differences in important epidemiological variables and differences in clinical practice (9).

To improve management in labor and optimizing care, collection and simple interpretation of data are necessary (1). The data quality must be validated and by working together at multiple levels within the unit, improvements and adverse trends can be detected (2). The TGCS is shown to be consistent in size and the different cesarean section rates in the groups together with the size allow an informative interpretation of a given overall cesarean section rate (Table 1). When other epidemiological information, events, outcomes and processes are analyzed within the different groups as opposed to a proportion of the overall population, they increase in relevance. The TGCS do not adjust for risk factors, but by quantifying patient's populations and different practice patterns it allows a comparison of clinical value and may encourage a more in depth analysis of individual groups or sub-groups. Following are some examples of how our observations may be interpreted.

Focusing on the management of both physical and emotional care of nulliparous women (group 1) is important as this will prevent the cesarean rate from a further increase when these women return for a future delivery (22, 23). SLO has an overall lower cesarean section rate than NMH, but a higher cesarean section rate of 10% in group 1 (Table 1). Table

5 shows that lower cesarean section rates at SUH and NMH do not compromise good perinatal outcome.

A greater than a 2:1 ratio of the size of groups 1 and 2 reflects a low intervention rate in term single cephalic nulliparous women (5). This is influenced by culture, obstetric practice and case mix of the particular population. The ratios in our populations were 3.1, 1.7, and 3.3, SUH, NMH, SLO, respectively. The benefits of labor induction must be weighed against the potential maternal and fetal risks associated with the procedure as well as knowledge of the population and the incidence of antenatal stillbirths (22, 24). Maternity care before and in relation to the management of labor will further influence to which group and following risk the woman belongs to in her next pregnancy (group 3, 4 or 5) (10). The rate of cesarean section in the subsequent pregnancy was 5.3%, 3.8%, 5.1% (SUH, NMH, SLO respectively) in women without a previous cesarean (group 3 and 4 combined) compared to 46.0%, 60.5%, 74.7% (SUH, NMH SLO respectively) in women with a previous cesarean (group 5).

As presented in Table 2, the women delivering at NMH were in all groups older than the women delivering at SUH and in SLO. When comparing cesarean section rates (Table 1), the low rate at NMH in group 1 might reflect a certain type of labor management as high maternal age rather is associated with increased incidence of interventions.

SUH has the lowest cesarean section rate and the lowest use of oxytocin. Compared to NMH and their philosophy of prevention of prolonged labor this may lead to more labors that are prolonged. The package of Active Management of Labor with one to one care and its advantages has always been an issue of much debate (25). The role of oxytocin in labor management is essential, but the optimal dose and timing is yet to be revealed (26). In addition, by using the TGCS, a higher rate of obstetric anal sphincter injuries among women in group 2a and 5 at SUH is detected which should encourage closer investigation. The overall rate of severe postpartum hemorrhage at SUH, is relatively at least, high and in addition proportionally higher transfusion rates (27). This highlights the importance of analyzing both subjective (estimated blood loss) outcomes together with objective (transfusion rates) when evaluating obstetric practice (28, 29).

Compared to SUH and NMH, the operative vaginal delivery rate is lower in SLO. The risk of adverse maternal and neonatal outcomes increases with an operative vaginal delivery but if the alternative is a cesarean at full dilatation, the risk benefit ratio must be carefully considered (30). Occurrence of maternal and neonatal complications is, however, similar to SUH and NMH with the exception of lower sphincter rupture rates in all groups.

Conclusion

We present cesarean section rates, maternal characteristics together with labor and fetal outcomes using the TGCS as a starting point. This is a systematic method of assessing the events and outcomes, which may contribute to the judgment of quality of care in labor and delivery. We encourage other labor and delivery wards to make use of the same classification and then by working together and sharing our knowledge we can learn from each other. The first step in providing quality of care is to be aware of your results.

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Legends:

Table 1 The 10-Group Classification System for Stavanger University Hospital, Norway, National Maternity Hospital Dublin, Ireland, Slovenian National Perinatal Database, Slovenia 2007-2011

Table 2 Maternal characteristics stratified in the 10-Group Classification System groups 1-5

Table 3 Labor outcomes stratified in the 10-Group Classification System groups 1-5

Table 4 Labor outcomes stratified in the 10-Group Classification System groups 1-5

Table 5 Neonatal outcomes stratified in the 10-Group Classification System groups 1-5

Figure 1 The 10-Group Classification System

Table 1 The 10-Group Classification System for Stavanger University Hospital, Norway, National Maternity Hospital Dublin, Ireland, Slovenian National Perinatal Database, Slovenia 2007-2011

	Relative size of the group (%)			CD rate in each group **(%)**			Contribution made to overall CD rate (%)		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Overall				(340/9848)	(1980/9250)	(18454/106167)	CD rate 13.6	CD rate 21.4	CD rate 17.4
Group 1	28.9	25.8	33.2	6.5	7.4	10.0	1.9	1.9	3.3
Group 2	9.3	14.8	10.1	25.7	34.9	30.4	2.4	5.3	3.1
Group 2a	8.6	13.8	9.1	19.6	30.2	23.0	1.7	4.2	2.1
Group 2b	0.5	1.0	1.0	100.0	100.0	100.0	0.5	1.0	1.0
Group 3	37.9	29.8	32.3	1.7	1.1	2.4	0.6	0.3	0.8
Group 4	9.7	9.4	8.8	19.5	12.7	14.9	1.9	1.2	1.3
Group 4a	8.4	8.7	7.9	6.4	5.8	4.2	0.5	0.5	0.3
Group 4b	1.3	0.7	1.0	100.0	100.0	100.0	1.3	0.7	1.0
Group 5	5.5	10.2	4.8	46.0	60.9	74.7	2.5	6.2	3.6
Group 6	1.8	2.4	2.3	79.4	93.2	82.6	1.5	2.2	1.9
Group 7	1.0	1.4	1.1	66.7	85.0	71.7	0.6	1.2	0.8
Group 8	1.7	2.2	1.8	40.8	64.9	54.2	0.7	1.4	1.0
Group 9	0.2	0.4	0.6	100.0	100	92.8	0.2	0.4	0.6
Group 10	4.0	3.7	4.9	31.9	37.6	22.1	1.3	1.4	1.1

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

Table 2: Maternal characteristics stratified in the 10-Group Classification System groups 1-5

	Body mass index > 30 %			Maternal age > 35 years %		
	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	5.3	8.1	5.1	5.2	16.7	6.3
Group 2a	10.3	12.7	11.0	10.7	25.4	8.1
Group 2b	9.8	11.2	11.6	21.7	46.7	23.4
Group 3	6.1	11.4	8.2	18.5	37.3	20.5
Group 4a	12.6	16.1	14.9	23.0	45.9	23.7
Group 4b	16.7	14.3	16.6	32.8	57.1	27.8
Group 5	11.6	19.1	14.8	26.7	46.2	23.8

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

Table 3 Labor outcomes stratified in the 10-Group Classification System groups 1-5

	Episiotomy %			Obstetric anal sphincter injuries %			Duration of labor > 12 hours %			Operative vaginal delivery %		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	35.8	56.8	50.9	2.4	2.5	0.4	11.3	2.8	1.2	23.7	24.6	5.9
Group 2a	40.6	46.1	45.8	3.7	2.2	0.4	9.9	5.8	1.6	31.9	23.4	7.2
Group 2b	-	-	-	-	-	-	-	-	-	-	-	-
Group 3	7.3	8.8	20.4	0.6	1.0	0.2	2.5	0.2	0.1	3.5	2.5	0.7
Group 4a	11.8	12.2	21.8	0.6	0.6	0.2	3.4	0.4	0.2	6.7	4.9	1.3
Group 4b	-	-	-	-	-	-	-	-	-	-	-	-
Group 5	17.9	18.7	12.1	2.4	0.6	0.1	10.1	0.1	0.2	13.8	8.3	1.7

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

-; not applicable

Table 4 Labor outcomes stratified in the 10-Groups Classification System groups 1-5

	Acceleration with Oxytocin %			Epidural in labor %			Postpartum hemorrhage > 1000 milliliters %			Transfusions %		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	33.2	53.2	69.1	43.7	73.7	4.2	4.5	1.0	x	2.6	1.5	0.2
Group 2a	68.3	69.0	79.4	71.8	76.1	5.3	9.9	3.1	x	2.2	3.1	0.2
Group 2b	-	-	-	-	-	-	17.6	1.1	x	2.0	x	0.4
Group 3	6.7	4.0	43.5	19.2	34.9	1.2	2.5	0.5	x	2.8	0.7	0.1
Group 4a	46.9	25.0	68.5	44.7	48.2	2.6	4.1	1.1	x	3.0	1.0	0.3
Group 4b	-	-	-	-	-	-	5.6	4.8	x	1.6	x	0.6
Group 5	12.7	9.0	23.0	39.8	31.7	1.5	5.7	1.6	x	1.8	2.0	0.2

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

-; not applicable

X; missing data

Table 5 Neonatal outcomes stratified in the 10-Group Classification System groups 1-5

	Apgar score <7 at 5 min %			Umbilical cord pH<7.0 %			Antepartum death ‰			Hypoxic-ischemic encephalopathy ‰			Perinatal death ‰		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	0.9	1.1	0.4	0.6	0.5	x	0.7	0	0.5	1.1	3.4	0.8	1.1	0	0.7
Group 2a	2.5	1.6	0.8	0.5	0.3	x	2.4	3.1	3.0	1.1	4.3	1.4	2.4	3.9	3.2
Group 2b	0	x	0.7	0	x	x	0	0	0.9	0	0.1	1.6	0	0	1.9
Group 3	0.4	0.3	0.1	0.2	0	x	0.5	0.4	0.5	0.5	0.4	0.3	0.5	0.4	0.6
Group 4a	0.2	0.9	0.3	0.4	0.9	x	2.4	1.2	3.6	0	0	0.5	2.4	2.3	3.9
Group 4b	0	x	0.8	0	x	x	7.5	0	1.0	0	0.3	0.7	7.5	0	0.1
Group 5	1.3	0.2	0.6	0	0.4	x	5.5	0	0.8	1.8	0	0.6	5.5	0	1.0

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011
X; missing data

Figure 1 The 10-Group Classification System

Group	Description
1	Nulliparous, single cephalic, ≥37 weeks, spontaneous labor
2a	Nulliparous, single cephalic, ≥37 weeks, induced labor
2b	Nulliparous, single cephalic, ≥37 weeks, cesarean before labor
3	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, spontaneous labor
4a	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, induced labor
4b	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, cesarean before labor
5	Previous cesarean, single cephalic ≥37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous cesareans)
8	All multiple pregnancies (including previous cesareans)
9	All abnormal lies (including previous cesareans)
10	All single cephalic, ≤36 weeks (including previous cesareans)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 and 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4, introduction
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 and 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5 and 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not applicable
Bias	9	Describe any efforts to address potential sources of bias	5 and 6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Not applicable
		(*b*) Describe any methods used to examine subgroups and interactions	Not applicable
		(*c*) Explain how missing data were addressed	Excluded
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	Nor applicable

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 and Table 1
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and 2
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	5 (MM)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Table 3,4 and 5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 1-5. Confidence intervals can be calculated, but are not included
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7 and 8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	This method of the expanded use of TGCS is earlier not presented. Limitations (page 7 and 8) and interpretations (page

			8-10) are being discussed.
Generalisability	21	Discuss the generalisability (external validity) of the study results	8 and 10 (conclusion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11 (not applicable)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A method to assess obstetric outcomes using the 10-Group Classification System: a quantitative descriptive study

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ABSTRACT

Objectives: Internationally, the 10-Groups Classification System (TGCS) has been used to report cesarean section rates, but analysis of other outcomes are also recommended. We now aim to present the TGCS as a method to assess outcomes of labor and delivery using routine collection of perinatal information.

Design: A methodological study to describe the use of the TGCS

Setting: Stavanger University Hospital (SUH) Norway, National Maternity Hospital Dublin (NMH) Ireland and Slovenian National Perinatal Database (SLO) Slovenia

Participants: 9848 women from Stavanger University Hospital, Norway, 9250 women from National Maternity Hospital Dublin, Ireland and 106 167 women, from Slovenian National Perinatal Database, Slovenia

Main outcome measures: All women were classified according to the TGCS within which cesarean section, oxytocin augmentation, epidural analgesia, operative vaginal deliveries, episiotomy, sphincter rupture, postpartum hemorrhage, blood transfusion, maternal age>35 years, body mass index >30, Apgar score, umbilical cord pH, hypoxic ischemic encephalopathy, antepartum and perinatal deaths were incorporated.

Results: There were significant differences in the sizes of the groups of women and the incidences of events and outcomes within the TGCS between the three perinatal databases.

Conclusions: The TGCS is a standardized objective classification system where events and outcomes of labor and delivery can be incorporated. Obstetric core events and outcomes should be agreed and defined in order to set standards of care. This method provides continuous and available observations from delivery wards, possibly used for further interpretation, questions and international comparisons. The definition of quality may vary in different units and can only be ascertained when all the necessary information is available and considered together.

Key words:

Cesarean section, quality of care, labor outcome, neonatal outcome, the 10-Group Classification System, core outcome

Abbreviations:

SUH, Stavanger University Hospital; NMH, National Maternity Hospital; SLO, Slovenian National Perinatal Database; TGCS, the 10-Group Classification System; WHO, World Health Organization; FIGO, The International Federation of Gynecology and Obstetrics

Strengths and limitations of this study:

- This study proposes the use of an available method which may elaborate potential trends in delivery units and thus guide labor and delivery management
- Events and outcomes of labor are incorporated in the 10-Group Classification System from three different populations in Europe
- The 10-Group Classification System is limited by unclear definitions of some of the outcomes used and encourage the importance of an agreed set of obstetric core outcomes
- Comparing obstetric outcomes using the 10-Group Classification System do not adjust for risk factors
- The design as a quantitative descriptive study limits the ability to explore causes of the different prevalence's of outcomes and events observed

INTRODUCTION

Safety, consistency and quality in labor and delivery are key priorities for all labor and delivery units. It is difficult to determine what quality in labor and delivery is, but attempts to develop important outcomes are taking place (1-4). An agreed classification system, incorporating key outcomes that are objective, measurable and relevant to clinical practice is required in order to assess consistency and quality of care.

Clinical practice and guidelines do vary internationally and occasionally also nationally. However, agreeing on a standard classification for assessment of quality of care should be less contentious. It is essential that providers and users of maternity care are aware of events and outcomes in their units and in addition having the ability to compare their results objectively over time and to other units. Only then can assessment of the quality of care take place (5, 6). The emphasis on evidence-based medicine should be supported by prospective databases combined with a multidisciplinary quality audit programme. Acceptance and commitment to this philosophy will provide insight about labor and delivery and importantly ensuring that we are providing safe and quality care (7).

The 10-Group Classification System (TGCS) was first described in 2001 and originally popularized as a method to assess cesarean section rates (8). The intention however, was to introduce a generic perinatal classification to assess all perinatal events and outcomes of which cesarean section is only one. The way the ten groups are structured make them relevant to all clinicians and women themselves and can provide a common language and starting point for any discussion on safety, quality of care and perinatal audit (9). The TGCS is endorsed by the World Health Organization (WHO) and the International Federation of Gynecology and Obstetrics (FIGO) and increasingly used by labor and delivery units to report their cesarean section rates (10-18). The WHO and FIGO also recommend that other events and outcomes surrounding labor and delivery are analyzed in relation to cesarean section using this classification.

This paper classifies data from three perinatal databases in different countries and explores the usefulness of the TGCS as a method to assess the quality of care. It also discusses the challenges that occur even using a standard classification system.

METHODS

Data related to pregnancies and deliveries were prospectively collected in Stavanger University Hospital (SUH) Norway 2010-2011, National Maternity Hospital Dublin (NMH) Ireland 2011 and Slovenian National Perinatal Database (SLO) Slovenia 2007-2011. The study population included 9848 women in SUH, 9250 women in NMH and 106 167 women in SLO. All women were classified according to the TGCS (Figure 1). The NMH had a complete TGCS-registration initially. A complete registration was also confirmed at SUS and SLO after cross checking of data. Cesarean section was defined as after spontaneous onset, induction or pre-labor. Pre-pregnancy body mass index was calculated as weight in kilograms/height in meters squared. Episiotomies were either lateral or mediolateral and perineal tears affecting the external or the external and internal sphincter were classified as obstetric anal sphincter injuries. The attending midwife or obstetrician visually estimated blood loss and postpartum hemorrhage > 1000 millilitres were registered at SUH and NMH, and postpartum hemorrhage > 500 millilitres in SLO.

Perinatal deaths included all intrauterine deaths after 22 weeks gestational age and within the first week after delivery. Hypoxic ischemic encephalopathy was classified using the Sarnat or modified Sarnat definition as grade I (mild), grade II (moderate) and grade III (severe). All data are presented as descriptive statistic.

Stavanger University Hospital

Stavanger University Hospital has a catchment population of approximately 320 000 and is the regional maternity unit in the west of Norway. It has a tradition of low obstetrical intervention rates. Women with one previous cesarean were encouraged to deliver vaginally. Information related to pregnancies and deliveries was prospectively collected and recorded in an electronic obstetrical journal system (Natus).

The Regional Committee for Medical and Health Research Ethics classified the study as a quality assurance study of routinely recorded data (REK Vest 2012/1522) and the local committee for data protection (2012/41) approved the project.

National Maternity Hospital

The National Maternity Hospital is a tertiary referral maternity hospital in Dublin, Ireland and one of the largest labor and delivery units in Europe delivering over 9000 women a year. It is well known for its Active Management of Labor philosophy on labor (19). This package of care is based on the prevention of prolonged labor and the physical and emotional sequelae

that follow. Labor and delivery information is collected prospectively on an obstetrical and neonatal database. The hospital has traditionally for many years completed an Annual Clinical Report detailing each year's results.

Slovenian National Database

Slovenia is a European Union member state in Central Europe with approximately 2.1 million of inhabitants and 20 000 deliveries per year. Health care in Slovenia is a public service provided through the public health service network. Perinatal care is almost entirely covered by compulsory health insurance, which is publicly funded. Slovenia has had a National Perinatal Information System (NPIS) since 1987 and registration into a computerized database by the attending midwife and doctor is mandatory. Data from all 14 country's maternity unit are collected. To assure quality of data collection, controls are built in the computerized system and audited periodically.

RESULTS

The populations contained 43%, 46% and 48% nulliparous women in SUH, NMH and SLO. The overall cesarean section rates were 13.6%, 21.4% and 17.4% in SUH, NMH and SLO, respectively. The highest rate of cesarean in groups 1 and 2a was observed in SLO. NMH presents the lowest rate of cesarean in group 3 and SUH the lowest rate in group 5. Rupture of the uterus was diagnosed in 0.02% (2/9848) women in SUH, no women in NMH and 0.04% (39/106 167) women in SLO during the study period. The relative sizes of the groups and cesarean section rates are presented in Table 1.

The overall pre-pregnant body mass index > 30 was 9.7%, 12.8%, 8.3% and the frequency of maternal age >35 years was 14.9%, 32.2%, 14.9% in SUH, NMH and SLO, respectively. Maternal characteristics stratified according to the TGCS are presented in Table 2.

The overall use of epidural analgesia varied from 35.0% at SUH and 49.0% at NMH to 2.7% in SLO. The overall operative vaginal delivery rate varied from 12.7%, 11.9% and 3.2% in SUH, NMH and SLO, respectively. The overall induction rates were 20.1%, 24.9% and 23.5% and the frequencies of use of oxytocin were 23.6%, 28.3% and 57.3% in SUH, NMH and SLO. The overall rates of episiotomy were 19.7%, 28.7% and 32.0% and the rates of obstetric anal sphincter injuries were 1.5%, 1.5% and 0.3% in SUH, NMH and SLO, respectively. The overall red cell blood transfusion rate was 2.7%, 1.4% and 0.2% in SUH,

NMH and SLO. Labor outcomes stratified according to the TGCS group's 1-5 are presented in Table 3 and 4.

Overall perinatal death in SUH was 4.2 per 1000, in NMH 3.9 per 1000 and 5.0 per 1000 (540/108070) in SLO. Perinatal deaths among groups 1 and 2 together were 1.3‰, 1.4‰ and 1.2‰, among groups 3 and 4 together 0.1‰, 0.8‰ and 1.2‰ and among women with previous cesarean (group 5) 5.5‰, 0‰ and 0.9‰ in SUH, NMH and SLO, respectively. Neonatal outcomes stratified according to the TGCS 1-5 are presented in Table 5.

DISCUSSION

Every labor and delivery unit has a responsibility to record and publish their results. The results also need to be presented in a standardized and structured way, as the management and implications will vary in different groups of women. Any one event or outcome cannot be considered on their own without the understanding of any effects on other events, outcomes or complications. Care during labor and delivery has changed dramatically over the last 30 years (20). In particular, the cesarean section rate has risen and a common classification system might be helpful exploring benefits and risks associated to this intervention.

Limitations

Several challenges were discovered writing this manuscript. When comparing maternal, labor and perinatal outcomes between units and countries, objective variables (blood transfusion rates, perinatal deaths) have advantages over subjective assessed outcomes (postpartum hemorrhage, Apgar score <7 and hypoxic ischemic encephalopathy). In addition, some of our outcomes were differently defined and registered such as postpartum hemorrhage .This issue has been recognized and highlighted as a general problem in clinical trials (3, 4, 21). Standardizing and agreeing on which core outcomes to be used to assess quality would not only increase the usefulness of the information collected but also encourage delivery units to use the same definitions. Due to different databases and registration, we only succeeded in completing Table 1 with data from all the 10 groups. Ensuring quality data from national databases may be challenging and the low rates in SLO particularly of obstetric anal sphincter injuries and transfusion rates should have been validated. Even more important is the need for a structured and standardized collection and registration of defined core outcomes in delivery units and in national registers.

We present the use of the TGCS as a method of which possible patterns within the observed population may uncover. This does not include risk adjustment, which limits the ability to compare absolute percentages of the outcomes observed. However, by comparing outcomes and events between standardized groups of women, hypotheses requiring further attention might be suggested. To explore causality further studies are needed.

The 10-Group Classification System

To achieve good data quality, proper registration and standardized definitions of outcomes are essential. The ability to classify all deliveries into one of the ten groups is however a quality indicator which many institutions, countries and perinatal databases struggle to do (5). Stressing this issue is important as the reliability of the data may affect the interpretation if the number of unclassified cases is significant. By presenting data using the TGCS, the ability to demonstrate significant differences in smaller units is limited. However, examining even a small number of cases may be helpful to develop local strategies to improve the quality of care (14). Risk is not only the chance of certain events occurring but also the implications if it did occur.

The TGCS presents a method of risk stratification, which visualizes how the cesarean section rate varies between different units and countries. Interpretation of other outcomes in the different groups may be used as a guidance to assess obstetric quality. Cesarean section rates can only be evaluated if perinatal and maternal outcomes are included (14, 22). Using the TGCS, there are only three possible explanations for differences in the sizes of the groups and the events and outcomes within the groups: data quality, significant differences in important epidemiological variables and differences in clinical practice (9).

To improve management in labor and optimizing care, collection and simple interpretation of data are necessary (1). The data quality must be validated and by working together at multiple levels within the unit, improvements and adverse trends can be detected (2). The TGCS is shown to be consistent in size and the different cesarean section rates in the groups together with the size allow an informative interpretation of a given overall cesarean section rate (Table 1). When other epidemiological information, events, outcomes and processes are analyzed within the different groups as opposed to a proportion of the overall population, they increase in relevance. The TGCS do not adjust for risk factors, but by quantifying patient's populations and different practice patterns it allows a comparison of clinical value and may encourage a more in depth analysis of individual groups or sub-groups. Following are some examples of how our observations may be interpreted.

Focusing on the management of both physical and emotional care of nulliparous women (group 1) is important as this will prevent the cesarean rate from a further increase when these women return for a future delivery (23, 24). SLO has an overall lower cesarean section rate than NMH, but a higher cesarean section rate of 10% in group 1 (Table 1). Table 5 shows that lower cesarean section rates at SUH and NMH do not compromise good perinatal outcome.

A greater than a 2:1 ratio of the size of groups 1 and 2 reflects a low intervention rate in term single cephalic nulliparous women (5). This is influenced by culture, obstetric practice and case mix of the particular population. The ratios in our populations were 3.1, 1.7, and 3.3, SUH, NMH, SLO, respectively. The definition of pre-labor cesarean will additionally define in which group the women are classified (group 1 or group 2b) with an impact of this ratio. Clearly, the benefits of labor induction must be weighed against the potential maternal and fetal risks associated with the procedure, as well as knowledge of the population and the incidence of antenatal stillbirths (23, 25). Maternity care before and in relation to the management of labor will further influence to which group and following risk the woman belongs to in her next pregnancy (group 3, 4 or 5) (10). The rate of cesarean section in the subsequent pregnancy was 5.3%, 3.8%, 5.1% (SUH, NMH, SLO respectively) in women without a previous cesarean (group 3 and 4 combined) compared to 46.0%, 60.5%, 74.7% (SUH, NMH SLO respectively) in women with a previous cesarean (group 5).

As presented in Table 2, the women delivering at NMH were in all groups older than the women delivering at SUH and in SLO. When comparing cesarean section rates (Table 1), the low rate at NMH in group 1 might reflect a certain type of labor management as high maternal age is normally associated with an increased incidence of interventions.

SUH has the lowest overall cesarean section rate and the lowest overall use of oxytocin. However, stratified by the TGCS, the use of oxytocin at SUH was lowest in group 1 only. SUH practice a judicious use of oxytocin that includes a definition of the start of active labor, prolonged labor and thereby indication for oxytocin use, which differ from NMH and SLO (26). Compared to NMH and their philosophy of prevention of prolonged labor this may lead to more labors that are prolonged. The package of Active Management of Labor with one to one care and its advantages practiced at NMH and in SLO, has always been an issue of much debate (27). The role of oxytocin in labor management is important, but the optimal dose and timing is yet to be revealed (26). The different types of labor management probably explain the different rates of oxytocin augmentation and prolonged labors observed (Table 3 and 4).

Furthermore, by using the TGCS, a higher rate of obstetric anal sphincter injuries among women in group 2a and 5 at SUH is evident which deserves closer investigation. The overall rate of severe postpartum hemorrhage at SUH, is relatively at least, high and in addition proportionally higher than the transfusion rates (28). This highlights the importance of analyzing both subjective (estimated blood loss) outcomes together with objective (transfusion rates) when evaluating obstetric practice (21, 29).

Compared to SUH and NMH, the operative vaginal delivery rate is lower in SLO. The risk of adverse maternal and neonatal outcomes increases with an operative vaginal delivery but if the alternative is a cesarean at full dilatation, the risk benefit ratio must be carefully considered (30). Occurrence of maternal and neonatal complications is, however, similar to SUH and NMH with the exception of lower sphincter rupture rates in all groups.

Conclusion

We present cesarean section rates, maternal characteristics together with labor and fetal outcomes using the TGCS as a starting point. This is a systematic method of assessing the events and outcomes, which may contribute to the judgment of quality of care in labor and delivery. We encourage other labor and delivery wards to make use of the same classification and then by working together and sharing our knowledge we can learn from each other. The first step in providing quality of care is to be aware of your results.

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Conflicts of interest notification: Michael Robson developed the 10-Group classification system. The authors have no conflicts of interest.

Data sharing statement: There are no additional data available.

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Legends:

Table 1 The 10-Group Classification System for Stavanger University Hospital, Norway, National Maternity Hospital Dublin, Ireland, Slovenian National Perinatal Database, Slovenia 2007-2011

Table 2 Maternal characteristics stratified in the 10-Group Classification System groups 1-5

Table 3 Labor outcomes stratified in the 10-Group Classification System groups 1-5

Table 4 Labor outcomes stratified in the 10-Group Classification System groups 1-5

Table 5 Neonatal outcomes stratified in the 10-Group Classification System groups 1-5

Figure 1 The 10-Group Classification System

Table 1 The 10-Group Classification System for Stavanger University Hospital, Norway, National Maternity Hospital Dublin, Ireland, Slovenian National Perinatal Database, Slovenia 2007-2011

	Relative size of the group (%)			CD rate in each group **(%)**			Contribution made to overall CD rate (%)		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Overall				(340/9848)	(1980/9250)	(18454/106167)	CD rate 13.6	CD rate 21.4	CD rate 17.4
Group 1	28.9	25.8	33.2	6.5	7.4	10.0	1.9	1.9	3.3
Group 2	9.3	14.8	10.1	25.7	34.9	30.4	2.4	5.3	3.1
Group 2a	8.6	13.8	9.1	19.6	30.2	23.0	1.7	4.2	2.1
Group 2b	0.5	1.0	1.0	100.0	100.0	100.0	0.5	1.0	1.0
Group 3	37.9	29.8	32.3	1.7	1.1	2.4	0.6	0.3	0.8
Group 4	9.7	9.4	8.8	19.5	12.7	14.9	1.9	1.2	1.3
Group 4a	8.4	8.7	7.9	6.4	5.8	4.2	0.5	0.5	0.3
Group 4b	1.3	0.7	1.0	100.0	100.0	100.0	1.3	0.7	1.0
Group 5	5.5	10.2	4.8	46.0	60.9	74.7	2.5	6.2	3.6
Group 6	1.8	2.4	2.3	79.4	93.2	82.6	1.5	2.2	1.9
Group 7	1.0	1.4	1.1	66.7	85.0	71.7	0.6	1.2	0.8
Group 8	1.7	2.2	1.8	40.8	64.9	54.2	0.7	1.4	1.0
Group 9	0.2	0.4	0.6	100.0	100	92.8	0.2	0.4	0.6
Group 10	4.0	3.7	4.9	31.9	37.6	22.1	1.3	1.4	1.1

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

Table 2: Maternal characteristics stratified in the 10-Group Classification System groups 1-5

	Body mass index > 30 %			Maternal age > 35 years %		
	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	5.3	8.1	5.1	5.2	16.7	6.3
Group 2a	10.3	12.7	11.0	10.7	25.4	8.1
Group 2b	9.8	11.2	11.6	21.7	46.7	23.4
Group 3	6.1	11.4	8.2	18.5	37.3	20.5
Group 4a	12.6	16.1	14.9	23.0	45.9	23.7
Group 4b	16.7	14.3	16.6	32.8	57.1	27.8
Group 5	11.6	19.1	14.8	26.7	46.2	23.8

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

Table 3 Labor outcomes stratified in the 10-Group Classification System groups 1-5

	Episiotomy %			Obstetric anal sphincter injuries %			Duration of labor > 12 hours %			Operative vaginal delivery %		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	35.8	56.8	50.9	2.4	2.5	0.4	11.3	2.8	1.2	23.7	24.6	5.9
Group 2a	40.6	46.1	45.8	3.7	2.2	0.4	9.9	5.8	1.6	31.9	23.4	7.2
Group 2b	-	-	-	-	-	-	-	-	-	-	-	-
Group 3	7.3	8.8	20.4	0.6	1.0	0.2	2.5	0.2	0.1	3.5	2.5	0.7
Group 4a	11.8	12.2	21.8	0.6	0.6	0.2	3.4	0.4	0.2	6.7	4.9	1.3
Group 4b	-	-	-	-	-	-	-	-	-	-	-	-
Group 5	17.9	18.7	12.1	2.4	0.6	0.1	10.1	0.1	0.2	13.8	8.3	1.7

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

-; not applicable

Table 4 Labor outcomes stratified in the 10-Groups Classification System groups 1-5

	Acceleration with Oxytocin %			Epidural in labor %			Postpartum hemorrhage > 1000 milliliters %			Transfusions %		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	33.2	53.2	69.1	43.7	73.7	4.2	4.5	1.0	x	2.6	1.5	0.2
Group 2a	68.3	69.0	79.4	71.8	76.1	5.3	9.9	3.1	x	2.2	3.1	0.2
Group 2b	-	-	-	-	-	-	17.6	1.1	x	2.0	x	0.4
Group 3	6.7	4.0	43.5	19.2	34.9	1.2	2.5	0.5	x	2.8	0.7	0.1
Group 4a	46.9	25.0	68.5	44.7	48.2	2.6	4.1	1.1	x	3.0	1.0	0.3
Group 4b	-	-	-	-	-	-	5.6	4.8	x	1.6	x	0.6
Group 5	12.7	9.0	23.0	39.8	31.7	1.5	5.7	1.6	x	1.8	2.0	0.2

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

-; not applicable

X; missing data

Table 5 Neonatal outcomes stratified in the 10-Group Classification System groups 1-5

	Apgar score <7 at 5 min %			Umbilical cord pH<7.0 %			Antepartum death ‰			Hypoxic-ischemic encephalopathy ‰			Perinatal death ‰		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	0.9	1.1	0.4	0.6	0.5	x	0.7	0	0.5	1.1	3.4	0.8	1.1	0	0.7
Group 2a	2.5	1.6	0.8	0.5	0.3	x	2.4	3.1	3.0	1.1	4.3	1.4	2.4	3.9	3.2
Group 2b	0	x	0.7	0	x	x	0	0	0.9	0	0.1	1.6	0	0	1.9
Group 3	0.4	0.3	0.1	0.2	0	x	0.5	0.4	0.5	0.5	0.4	0.3	0.5	0.4	0.6
Group 4a	0.2	0.9	0.3	0.4	0.9	x	2.4	1.2	3.6	0	0	0.5	2.4	2.3	3.9
Group 4b	0	x	0.8	0	x	x	7.5	0	1.0	0	0.3	0.7	7.5	0	0.1
Group 5	1.3	0.2	0.6	0	0.4	x	5.5	0	0.8	1.8	0	0.6	5.5	0	1.0

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011
X; missing data

Group	Description
1	Nulliparous, single cephalic, ≥37 weeks, spontaneous labor
2a	Nulliparous, single cephalic, ≥37 weeks, induced labor
2b	Nulliparous, single cephalic, ≥37 weeks, cesarean before labor
3	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, spontaneous labor
4a	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, induced labor
4b	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, cesarean before labor
5	Previous cesarean, single cephalic ≥37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous cesareans)
8	All multiple pregnancies (including previous cesareans)
9	All abnormal lies (including previous cesareans)
10	All single cephalic, ≤36 weeks (including previous cesareans)

Figure 1 The 10-Group Classification system

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 and 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4, introduction
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 and 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5 and 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not applicable
Bias	9	Describe any efforts to address potential sources of bias	5 and 6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Not applicable
		(*b*) Describe any methods used to examine subgroups and interactions	Not applicable
		(*c*) Explain how missing data were addressed	Excluded
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	Nor applicable

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 and Table 1
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and 2
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	5 (MM)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Table 3,4 and 5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 1-5. Confidence intervals can be calculated, but are not included
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7 and 8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	This method of the expanded use of TGCS is earlier not presented. Limitations (page 7 and 8) and interpretations (page

			8-10) are being discussed.
Generalisability	21	Discuss the generalisability (external validity) of the study results	8 and 10 (conclusion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11 (not applicable)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A method to assess obstetric outcomes using the 10-Group Classification System: a quantitative descriptive study

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A method to assess obstetric outcomes using the 10-Group Classification System: a quantitative descriptive study

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ABSTRACT

Objectives: Internationally, the 10-Groups Classification System (TGCS) has been used to report cesarean section rates, but analysis of other outcomes are also recommended. We now aim to present the TGCS as a method to assess outcomes of labor and delivery using routine collection of perinatal information.

Design: A methodological study to describe the use of the TGCS

Setting: Stavanger University Hospital (SUH) Norway, National Maternity Hospital Dublin (NMH) Ireland and Slovenian National Perinatal Database (SLO) Slovenia

Participants: 9848 women from Stavanger University Hospital, Norway, 9250 women from National Maternity Hospital Dublin, Ireland and 106 167 women, from Slovenian National Perinatal Database, Slovenia

Main outcome measures: All women were classified according to the TGCS within which cesarean section, oxytocin augmentation, epidural analgesia, operative vaginal deliveries, episiotomy, sphincter rupture, postpartum hemorrhage, blood transfusion, maternal age>35 years, body mass index >30, Apgar score, umbilical cord pH, hypoxic ischemic encephalopathy, antepartum and perinatal deaths were incorporated.

Results: There were significant differences in the sizes of the groups of women and the incidences of events and outcomes within the TGCS between the three perinatal databases.

Conclusions: The TGCS is a standardized objective classification system where events and outcomes of labor and delivery can be incorporated. Obstetric core events and outcomes should be agreed and defined in order to set standards of care. This method provides continuous and available observations from delivery wards, possibly used for further interpretation, questions and international comparisons. The definition of quality may vary in different units and can only be ascertained when all the necessary information is available and considered together.

Key words:

Cesarean section, quality of care, labor outcome, neonatal outcome, the 10-Group Classification System, core outcome

Abbreviations:

SUH, Stavanger University Hospital; NMH, National Maternity Hospital; SLO, Slovenian National Perinatal Database; TGCS, the 10-Group Classification System; WHO, World Health Organization; FIGO, The International Federation of Gynecology and Obstetrics

Strengths and limitations of this study:

- This study proposes the use of an available method which may elaborate potential trends in delivery units and thus guide labor and delivery management
- Events and outcomes of labor are incorporated in the 10-Group Classification System from three different populations in Europe
- The 10-Group Classification System is limited by unclear definitions of some of the outcomes used and encourage the importance of an agreed set of obstetric core outcomes
- Comparing obstetric outcomes using the 10-Group Classification System do not adjust for risk factors
- The design as a quantitative descriptive study limits the ability to explore causes of the different prevalence's of outcomes and events observed

INTRODUCTION

Safety, consistency and quality in labor and delivery are key priorities for all labor and delivery units. It is difficult to determine what quality in labor and delivery is, but attempts to develop important outcomes are taking place (1-4). An agreed classification system, incorporating key outcomes that are objective, measurable and relevant to clinical practice is required in order to assess consistency and quality of care.

Clinical practice and guidelines do vary internationally and occasionally also nationally. However, agreeing on a standard classification for assessment of quality of care should be less contentious. It is essential that providers and users of maternity care are aware of events and outcomes in their units and in addition having the ability to compare their results objectively over time and to other units. Only then can assessment of the quality of care take place (5, 6). The emphasis on evidence-based medicine should be supported by prospective databases combined with a multidisciplinary quality audit programme. Acceptance and commitment to this philosophy will provide insight about labor and delivery and importantly ensuring that we are providing safe and quality care (7).

The 10-Group Classification System (TGCS) was first described in 2001 and originally popularized as a method to assess cesarean section rates (8). The intention however, was to introduce a generic perinatal classification to assess all perinatal events and outcomes of which cesarean section is only one. The way the ten groups are structured make them relevant to all clinicians and women themselves and can provide a common language and starting point for any discussion on safety, quality of care and perinatal audit (9). The TGCS is endorsed by the World Health Organization (WHO) and the International Federation of Gynecology and Obstetrics (FIGO) and increasingly used by labor and delivery units to report their cesarean section rates (10-18). The WHO and FIGO also recommend that other events and outcomes surrounding labor and delivery are analyzed in relation to cesarean section using this classification.

This paper classifies data from three perinatal databases in different countries and explores the usefulness of the TGCS as a method to assess the quality of care. It also discusses the challenges that occur even using a standard classification system.

METHODS

Data related to pregnancies and deliveries were prospectively collected in Stavanger University Hospital (SUH) Norway 2010-2011, National Maternity Hospital Dublin (NMH) Ireland 2011 and Slovenian National Perinatal Database (SLO) Slovenia 2007-2011. The study population included 9848 women in SUH, 9250 women in NMH and 106 167 women in SLO. All women were classified according to the TGCS (Figure 1). The NMH had a complete TGCS-registration initially. A complete registration was also confirmed at SUS and SLO after cross checking of data. Cesarean section was defined as after spontaneous onset, induction or pre-labor. Pre-pregnancy body mass index was calculated as weight in kilograms/height in meters squared. Episiotomies were either lateral or mediolateral and perineal tears affecting the external or the external and internal sphincter were classified as obstetric anal sphincter injuries. The attending midwife or obstetrician visually estimated blood loss and postpartum hemorrhage > 1000 millilitres were registered at SUH and NMH, and postpartum hemorrhage > 500 millilitres in SLO.

Perinatal deaths included all intrauterine deaths after 22 weeks gestational age and within the first week after delivery. Hypoxic ischemic encephalopathy was classified using the Sarnat or modified Sarnat definition as grade I (mild), grade II (moderate) and grade III (severe). All data are presented as descriptive statistic and any comparisons between groups and hospitals described in the manuscript do not represent statistically significant differences.

Stavanger University Hospital

Stavanger University Hospital has a catchment population of approximately 320 000 and is the regional maternity unit in the west of Norway. It has a tradition of low obstetrical intervention rates. Women with one previous cesarean were encouraged to deliver vaginally. Information related to pregnancies and deliveries was prospectively collected and recorded in an electronic obstetrical journal system (Natus).

The Regional Committee for Medical and Health Research Ethics classified the study as a quality assurance study of routinely recorded data (REK Vest 2012/1522) and the local committee for data protection (2012/41) approved the project.

National Maternity Hospital

The National Maternity Hospital is a tertiary referral maternity hospital in Dublin, Ireland and one of the largest labor and delivery units in Europe delivering over 9000 women a year. It is well known for its Active Management of Labor philosophy on labor (19). This package of

care is based on the prevention of prolonged labor and the physical and emotional sequelae that follow. Labor and delivery information is collected prospectively on an obstetrical and neonatal database. The hospital has traditionally for many years completed an Annual Clinical Report detailing each year's results.

Slovenian National Database

Slovenia is a European Union member state in Central Europe with approximately 2.1 million of inhabitants and 20 000 deliveries per year. Health care in Slovenia is a public service provided through the public health service network. Perinatal care is almost entirely covered by compulsory health insurance, which is publicly funded. Slovenia has had a National Perinatal Information System (NPIS) since 1987 and registration into a computerized database by the attending midwife and doctor is mandatory. Data from all 14 country's maternity unit are collected. To assure quality of data collection, controls are built in the computerized system and audited periodically.

RESULTS

The populations contained 43%, 46% and 48% nulliparous women in SUH, NMH and SLO. The overall cesarean section rates were 13.6%, 21.4% and 17.4% in SUH, NMH and SLO, respectively. The highest rate of cesarean in groups 1 and 2a was observed in SLO. NMH presents the lowest rate of cesarean in group 3 and SUH the lowest rate in group 5. Rupture of the uterus was diagnosed in 0.02% (2/9848) women in SUH, no women in NMH and 0.04% (39/106 167) women in SLO during the study period. The relative sizes of the groups and cesarean section rates are presented in Table 1.

The overall pre-pregnant body mass index > 30 was 9.7%, 12.8%, 8.3% and the frequency of maternal age >35 years was 14.9%, 32.2%, 14.9% in SUH, NMH and SLO, respectively. Maternal characteristics stratified according to the TGCS are presented in Table 2.

The overall use of epidural analgesia varied from 35.0% at SUH and 49.0% at NMH to 2.7% in SLO. The overall operative vaginal delivery rate varied from 12.7%, 11.9% and 3.2% in SUH, NMH and SLO, respectively. The overall induction rates were 20.1%, 24.9% and 23.5% and the frequencies of use of oxytocin were 23.6%, 28.3% and 57.3% in SUH, NMH and SLO. The overall rates of episiotomy were 19.7%, 28.7% and 32.0% and the rates of obstetric anal sphincter injuries were 1.5%, 1.5% and 0.3% in SUH, NMH and SLO, respectively. The overall red cell blood transfusion rate was 2.7%, 1.4% and 0.2% in SUH,

NMH and SLO. Labor outcomes stratified according to the TGCS group's 1-5 are presented in Table 3 and 4.

Overall perinatal death in SUH was 4.2 per 1000, in NMH 3.9 per 1000 and 5.0 per 1000 (540/108070) in SLO. Perinatal deaths among groups 1 and 2 together were 1.3‰, 1.4‰ and 1.2‰, among groups 3 and 4 together 0.1‰, 0.8‰ and 1.2‰ and among women with previous cesarean (group 5) 5.5‰, 0‰ and 0.9‰ in SUH, NMH and SLO, respectively. Neonatal outcomes stratified according to the TGCS 1-5 are presented in Table 5.

DISCUSSION

Every labor and delivery unit has a responsibility to record and publish their results. The results also need to be presented in a standardized and structured way, as the management and implications will vary in different groups of women. Any one event or outcome cannot be considered on their own without the understanding of any effects on other events, outcomes or complications. Care during labor and delivery has changed dramatically over the last 30 years (20). In particular, the cesarean section rate has risen and a common classification system might be helpful exploring benefits and risks associated to this intervention.

Limitations

Several challenges were discovered writing this manuscript. When comparing maternal, labor and perinatal outcomes between units and countries, objective variables (blood transfusion rates, perinatal deaths) have advantages over subjective assessed outcomes (postpartum hemorrhage, Apgar score <7 and hypoxic ischemic encephalopathy). In addition, some of our outcomes were differently defined and registered such as postpartum hemorrhage .This issue has been recognized and highlighted as a general problem in clinical trials (3, 4, 21). Standardizing and agreeing on which core outcomes to be used to assess quality would not only increase the usefulness of the information collected but also encourage delivery units to use the same definitions. Due to different databases and registration, we only succeeded in completing Table 1 with data from all the 10 groups. Ensuring quality data from national databases may be challenging and the low rates in SLO particularly of obstetric anal sphincter injuries and transfusion rates should have been validated. Even more important is the need for a structured and standardized collection and registration of defined core outcomes in delivery units and in national registers.

We present the use of the TGCS as a method of which possible patterns within the observed population may uncover. This does not include risk adjustment, which limits the ability to compare absolute percentages of the outcomes observed. However, by comparing outcomes and events between standardized groups of women, hypotheses requiring further attention might be suggested. To explore causality further studies are needed.

The 10-Group Classification System

To achieve good data quality, proper registration and standardized definitions of outcomes are essential. The ability to classify all deliveries into one of the ten groups is however a quality indicator which many institutions, countries and perinatal databases struggle to do (5). Stressing this issue is important as the reliability of the data may affect the interpretation if the number of unclassified cases is significant. By presenting data using the TGCS, the ability to demonstrate significant differences in smaller units is limited. However, examining even a small number of cases may be helpful to develop local strategies to improve the quality of care (14). Risk is not only the chance of certain events occurring but also the implications if it did occur.

The TGCS presents a method of risk stratification, which visualizes how the cesarean section rate varies between different units and countries. Interpretation of other outcomes in the different groups may be used as a guidance to assess obstetric quality. Cesarean section rates can only be evaluated if perinatal and maternal outcomes are included (14, 22). Using the TGCS, there are only three possible explanations for differences in the sizes of the groups and the events and outcomes within the groups: data quality, significant differences in important epidemiological variables and differences in clinical practice (9).

To improve management in labor and optimizing care, collection and simple interpretation of data are necessary (1). The data quality must be validated and by working together at multiple levels within the unit, improvements and adverse trends can be detected (2). The TGCS is shown to be consistent in size and the different cesarean section rates in the groups together with the size allow an informative interpretation of a given overall cesarean section rate (Table 1). When other epidemiological information, events, outcomes and processes are analyzed within the different groups as opposed to a proportion of the overall population, they increase in relevance. The TGCS do not adjust for risk factors, but by quantifying patient's populations and different practice patterns it allows a comparison of clinical value and may encourage a more in depth analysis of individual groups or sub-groups. Following are some examples of how our observations may be interpreted.

Focusing on the management of both physical and emotional care of nulliparous women (group 1) is important as this will prevent the cesarean rate from a further increase when these women return for a future delivery (23, 24). SLO has an overall lower cesarean section rate than NMH, but a higher cesarean section rate of 10% in group 1 (Table 1). Table 5 shows that lower cesarean section rates at SUH and NMH do not compromise good perinatal outcome.

A greater than a 2:1 ratio of the size of groups 1 and 2 reflects a low intervention rate in term single cephalic nulliparous women (5). This is influenced by culture, obstetric practice and case mix of the particular population. The ratios in our populations were 3.1, 1.7, and 3.3, SUH, NMH, SLO, respectively. The definition of pre-labor cesarean will additionally define in which group the women are classified (group 1 or group 2b) with an impact of this ratio. Clearly, the benefits of labor induction must be weighed against the potential maternal and fetal risks associated with the procedure, as well as knowledge of the population and the incidence of antenatal stillbirths (23, 25). Maternity care before and in relation to the management of labor will further influence to which group and following risk the woman belongs to in her next pregnancy (group 3, 4 or 5) (10). The rate of cesarean section in the subsequent pregnancy was 5.3%, 3.8%, 5.1% (SUH, NMH, SLO respectively) in women without a previous cesarean (group 3 and 4 combined) compared to 46.0%, 60.5%, 74.7% (SUH, NMH SLO respectively) in women with a previous cesarean (group 5).

As presented in Table 2, the women delivering at NMH were in all groups older than the women delivering at SUH and in SLO. When comparing cesarean section rates (Table 1), the low rate at NMH in group 1 might reflect a certain type of labor management as high maternal age is normally associated with an increased incidence of interventions.

SUH has the lowest overall cesarean section rate and the lowest overall use of oxytocin. However, stratified by the TGCS, the use of oxytocin at SUH was lowest in group 1 only. SUH practice a judicious use of oxytocin that includes a definition of the start of active labor, prolonged labor and thereby indication for oxytocin use, which differ from NMH and SLO (26). Compared to NMH and their philosophy of prevention of prolonged labor this may lead to more labors that are prolonged. The package of Active Management of Labor with one to one care and its advantages practiced at NMH and in SLO, has always been an issue of much debate (27). The role of oxytocin in labor management is important, but the optimal dose and timing is yet to be revealed (26). The different types of labor management probably explain the different rates of oxytocin augmentation and prolonged labors observed (Table 3 and 4).

Furthermore, by using the TGCS, a higher rate of obstetric anal sphincter injuries among women in group 2a and 5 at SUH is evident which deserves closer investigation. The overall rate of severe postpartum hemorrhage at SUH, is relatively at least, high and in addition proportionally higher than the transfusion rates (28). This highlights the importance of analyzing both subjective (estimated blood loss) outcomes together with objective (transfusion rates) when evaluating obstetric practice (21, 29).

Compared to SUH and NMH, the operative vaginal delivery rate is lower in SLO. The risk of adverse maternal and neonatal outcomes increases with an operative vaginal delivery but if the alternative is a cesarean at full dilatation, the risk benefit ratio must be carefully considered (30). Occurrence of maternal and neonatal complications is, however, similar to SUH and NMH with the exception of lower sphincter rupture rates in all groups.

Conclusion

Cesarean section rates, maternal characteristics together with labor and fetal outcomes need to be defined by using the same classification system. We propose the TGCS as the standardized method of assessing events and outcomes and comparing inter-institutional rates, which may contribute to the judgment of quality of care in labor and delivery. By working together and sharing our knowledge, we can learn from each other. The first step in providing quality of care is to be aware of your results.

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and MR have assisted the literature research and editing of the manuscript. All authors have read and approved the final manuscript.

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Legends:

Table 1 The 10-Group Classification System for Stavanger University Hospital, Norway, National Maternity Hospital Dublin, Ireland, Slovenian National Perinatal Database, Slovenia 2007-2011

Table 2 Maternal characteristics stratified in the 10-Group Classification System groups 1-5

Table 3 Labor outcomes stratified in the 10-Group Classification System groups 1-5

Table 4 Labor outcomes stratified in the 10-Group Classification System groups 1-5

Table 5 Neonatal outcomes stratified in the 10-Group Classification System groups 1-5

Figure 1 The 10-Group Classification System

Table 1 The 10-Group Classification System for Stavanger University Hospital, Norway, National Maternity Hospital Dublin, Ireland, Slovenian National Perinatal Database, Slovenia 2007-2011

	Relative size of the group (%)			CD rate in each group **(%)**			Contribution made to overall CD rate (%)		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Overall				(340/9848)	(1980/9250)	(18454/106167)	CD rate 13.6	CD rate 21.4	CD rate 17.4
Group 1	28.9	25.8	33.2	6.5	7.4	10.0	1.9	1.9	3.3
Group 2	9.3	14.8	10.1	25.7	34.9	30.4	2.4	5.3	3.1
Group 2a	8.6	13.8	9.1	19.6	30.2	23.0	1.7	4.2	2.1
Group 2b	0.5	1.0	1.0	100.0	100.0	100.0	0.5	1.0	1.0
Group 3	37.9	29.8	32.3	1.7	1.1	2.4	0.6	0.3	0.8
Group 4	9.7	9.4	8.8	19.5	12.7	14.9	1.9	1.2	1.3
Group 4a	8.4	8.7	7.9	6.4	5.8	4.2	0.5	0.5	0.3
Group 4b	1.3	0.7	1.0	100.0	100.0	100.0	1.3	0.7	1.0
Group 5	5.5	10.2	4.8	46.0	60.9	74.7	2.5	6.2	3.6
Group 6	1.8	2.4	2.3	79.4	93.2	82.6	1.5	2.2	1.9
Group 7	1.0	1.4	1.1	66.7	85.0	71.7	0.6	1.2	0.8
Group 8	1.7	2.2	1.8	40.8	64.9	54.2	0.7	1.4	1.0
Group 9	0.2	0.4	0.6	100.0	100	92.8	0.2	0.4	0.6
Group 10	4.0	3.7	4.9	31.9	37.6	22.1	1.3	1.4	1.1

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

Table 2: Maternal characteristics stratified in the 10-Group Classification System groups 1-5

	Body mass index > 30 %			Maternal age > 35 years %		
	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	5.3	8.1	5.1	5.2	16.7	6.3
Group 2a	10.3	12.7	11.0	10.7	25.4	8.1
Group 2b	9.8	11.2	11.6	21.7	46.7	23.4
Group 3	6.1	11.4	8.2	18.5	37.3	20.5
Group 4a	12.6	16.1	14.9	23.0	45.9	23.7
Group 4b	16.7	14.3	16.6	32.8	57.1	27.8
Group 5	11.6	19.1	14.8	26.7	46.2	23.8

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

Table 3 Labor outcomes stratified in the 10-Group Classification System groups 1-5

	Acceleration with Oxytocin %	Episiotomy %	Obstetrical anal sphincter injuries %	Postpartum hemorrhage > 1000 ml %	Duration of labor ≥ 12 hours %	Operative vaginal delivery %				
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	35.8	56.8	50.9	2.4	2.5	0.4	11.3	2.8	1.2	23.7	24.6	5.9
Group 2a	40.6	46.1	45.8	3.7	2.2	0.4	9.9	5.8	1.6	31.9	23.4	7.2
Group 2b	-	-	-	-	-	-	-	-	-	-	-	-
Group 3	7.3	8.8	20.4	0.6	1.0	0.2	2.5	0.2	0.1	3.5	2.5	0.7
Group 4a	11.8	12.2	21.8	0.6	0.6	0.2	3.4	0.4	0.2	6.7	4.9	1.3
Group 4b	-	-	-	-	-	-	-	-	-	-	-	-
Group 5	17.9	18.7	12.1	2.4	0.6	0.1	10.1	0.1	0.2	13.8	8.3	1.7

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

-; not applicable

Table 4 Labor outcomes stratified in the 10-Groups Classification System groups 1-5

	Apgar score <7			Umbilical cord			Antepartum			Hypoxic-ischemic			Perinatal death		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	33.2	53.2	69.1	43.7	73.7	4.2	4.5	1.0	x	2.6	1.5	0.2			
Group 2a	68.3	69.0	79.4	71.8	76.1	5.3	9.9	3.1	x	2.3	3.1	0.2			
Group 2b	-	-	-	-	-	-	17.6	1.1	x	2.0	x	0.4			
Group 3	6.7	4.0	43.5	19.2	34.9	1.2	2.5	0.5	x	2.8	0.7	0.1			
Group 4a	46.9	25.0	68.5	44.7	48.2	2.6	4.1	1.1	x	3.0	1.0	0.3			
Group 4b	-	-	-	-	-	-	5.6	4.8	x	1.6	x	0.6			
Group 5	12.7	9.0	23.0	39.8	31.7	1.5	5.7	1.6	x	1.8	2.0	0.2			

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011

-; not applicable

X; missing data

Table 5 Neonatal outcomes stratified in the 10-Group Classification System groups 1-5

	at 5 min %			pH<7.0 %			‰			encephalopathy ‰			death ‰		
	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO	SUH	NMH	SLO
Group 1	0.9	1.1	0.4	0.6	0.5	x	0.7	0	0.5	1.1	3.4	0.8	1.1	0	0.7
Group 2a	2.5	1.6	0.8	0.5	0.3	x	2.4	3.1	3.0	1.1	4.3	1.4	2.4	3.9	3.2
Group 2b	0	x	0.7	0	x	x	0	0	0.9	0	0.1	1.6	0	0	1.9
Group 3	0.4	0.3	0.1	0.2	0	x	0.5	0.4	0.5	0.5	0.4	0.3	0.5	0.4	0.6
Group 4a	0.2	0.9	0.3	0.4	0.9	x	2.4	1.2	3.6	0	0	0.5	2.4	2.3	3.9
Group 4b	0	x	0.8	0	x	x	7.5	0	1.0	0	0.3	0.7	7.5	0	0.1
Group 5	1.3	0.2	0.6	0	0.4	x	5.5	0	0.8	1.8	0	0.6	5.5	0	1.0

SUH, Stavanger University Hospital 2010-2011; NMH, National Maternity Hospital 2011; SLO, Slovenian National Perinatal Database 2007-2011
X; missing data

Group	Description
1	Nulliparous, single cephalic, ≥37 weeks, spontaneous labor
2a	Nulliparous, single cephalic, ≥37 weeks, induced labor
2b	Nulliparous, single cephalic, ≥37 weeks, cesarean before labor
3	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, spontaneous labor
4a	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, induced labor
4b	Multiparous (excluding previous cesareans), single cephalic, ≥37 weeks, cesarean before labor
5	Previous cesarean, single cephalic ≥37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous cesareans)
8	All multiple pregnancies (including previous cesareans)
9	All abnormal lies (including previous cesareans)
10	All single cephalic, ≤36 weeks (including previous cesareans)

Figure 1 The 10-Group Classification system

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 and 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4, introduction
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 and 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5 and 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not applicable
Bias	9	Describe any efforts to address potential sources of bias	5 and 6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Not applicable
		(*b*) Describe any methods used to examine subgroups and interactions	Not applicable
		(*c*) Explain how missing data were addressed	Excluded
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	Nor applicable

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	Not applicable
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5 and Table 1
		(b) Give reasons for non-participation at each stage	Not applicable
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and 2
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	5 (MM)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	Table 3,4 and 5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 1-5. Confidence intervals can be calculated, but are not included
		(*b*) Report category boundaries when continuous variables were categorized	Not applicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	7 and 8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	This method of the expanded use of TGCS is earlier not presented. Limitations (page 7 and 8) and interpretations (page

			8-10) are being discussed.
Generalisability	21	Discuss the generalisability (external validity) of the study results	8 and 10 (conclusion)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11 (not applicable)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.