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Emergency cesarean sections can be predicted by markers for stress, worry, and sleep disturbances in first-time mothers

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Abbreviations
ANC, antenatal clinics;
BMI, body mass index;
CI, confidence interval;
CS, cesarean section;
EDA, epidural anesthesia;
EMR, electronic medical records;
ICD-10, International Classification of Diseases, 10th Revision;
OR, odds ratio

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Abstract

Objective. To identify predictors as free-text markers for mental ill-health from an electronic perinatal record (EMR) system and the association with emergency cesarean section (CS) in nulliparous women.

Material and methods. This was a population-based study using an EMR system, set in the catchment area of Malmö University Hospital in Sweden. Of 10 662 nulliparous women presenting with a singleton cephalic baby for vaginal delivery between 2001 and 2006, 6 467 women with complete EMRs were selected. A free-text search of markers for mental ill-health was carried out, and results were analysed by multivariate logistic regression. Eleven markers for mental ill-health were tested with Cohen's kappa for agreement and used as exposure variables. Odds ratios (OR) with 95% confidence intervals (CI) were calculated for emergency CS, and adjusted for maternal age, diabetes, epidural anesthesia and gestational weeks <37 and >41 by a multivariate logistic regression model with vaginal delivery as the reference. Results. Three markers identified from the EMR system reached statistically significant associations with an increased risk for emergency CS in nulliparous women: stress, adjusted OR 1.66 (95% CI 1.34–2.06); sleep, adjusted OR 1.57 (95% CI 1.14–2.16); and worry, adjusted OR 1.41 (95% CI 1.10–1.79). Conclusion. Free-text words in medical records that indicated stress, sleep disturbances or worry predicted increased adjusted OR for emergency CS in first-time mothers. Recognizing pregnant women's reporting of their mental health status could have a predictive bearing on delivery outcomes.

Introduction

Cesarean section (CS) rates vary from 5-30% and are increasing globally (1, 2). Although the general rate of 17% for singleton babies in Sweden is low in comparison with some other countries (2), it has tripled over the past 30 years (3). The growing CS rate has initiated an international debate on elective CS and the growing phenomenon of CS on request (4, 5). However, studies on predicting or preventing emergency CS (6), especially in first-time mothers, are lacking. Women who have had one CS are at increased risk of a subsequent CS (2, 6-8). There is evidence of adverse health effects for mother and child after any type of CS (8-11). Thus, avoiding CS in first-time (nulliparous) mothers would greatly reduce cost to the individual and society (1, 2, 12) and it may be possible to find ways to predict an increased risk for emergency CS. Concurrent with increasing CS rates mental health problems among women of reproductive age have increased in recent decades (13, 14). Self-reported levels of stress or lack of sleep are common, and may be used to gauge mental health status in a population (14). Cross-sectional studies screening women before and after childbirth, report symptoms of any mental disorder at levels of 20–30%, depressive disorders at 10–15%, and anxiety disorders at 2-6% (15, 16). Studies of mental illness and pregnancy attempt to estimate the risk of preterm delivery, obstetric outcomes, and postnatal mental disorders by different methods of antenatal screening (17-19).

It has been shown that self-rated health assessments taken from health care claim files predict mortality better than objective health status, providing empirical support for the "belief that the way a person views his/her health is importantly related to subsequent health outcomes" (20). Computerized record systems open new pathways for research, such as on quality control and patient follow-up (21, 22). The Swedish public health system has a long tradition of recording medical data by utilizing a unique personal identification number. However, at antenatal clinics (ANC) no standardized variables are recorded to assess mental health status. Antenatal care is free of charge for all pregnant women residing in Sweden.

At Malmö University Hospital a computerized antenatal and perinatal recording system named KIKA™ has been in use since 1998. It links the ANC within the hospital's catchment area to the general electronic medical records (EMR) system used in the area. KIKA™ consists of four modules: antenatal and inpatient care records; labor, delivery, and newborn records; ultrasound records; and free-text clinical notes. Nurse-midwives enter routine information for preset standard variables. Additional free-text entry is possible whenever clinically requested. Both free-text and preset variables can be used for data mining and follow-up studies. In order to capture the meaning of free-text words indicating less than optimum mental health, we have used the term "mental ill-health" as a prelude to measurable mental health problems. Our study aimed to analyze the association between the occurrence of markers of mental ill-health, as identified by free-text search in the perinatal EMR system, and delivery outcomes for nulliparous women.

Material and Methods

Malmö, the third largest city in Sweden, had 276 000 inhabitants in 2006, 28% of whom were foreign-born. We obtained perinatal records from the KIKA™ EMR system for a population-based record study. The original dataset included 22 053 deliveries, representing 17 443 women who gave birth between 1 January 2001 and 31 December 2006. Coded numbers replaced the original unique personal identification numbers in order to preserve patient anonymity. We selected 11 761 nulliparous for the study. To minimize confounding we excluded 985 women: those with pregnancies 23<28 gestational weeks, stillborns, multiple births, breech presentations, overlapping records, and women with elective CS (10). We then

excluded from statistical analysis 4 195 (39.3%) nulliparous women who received antenatal care at clinics not linked to the public EMR system. The study population consisted of 6 467 nulliparous women presenting with a cephalic singleton baby for vaginal delivery. The flow chart (Figure 1) presents the inclusion and exclusion criteria of the final study population.

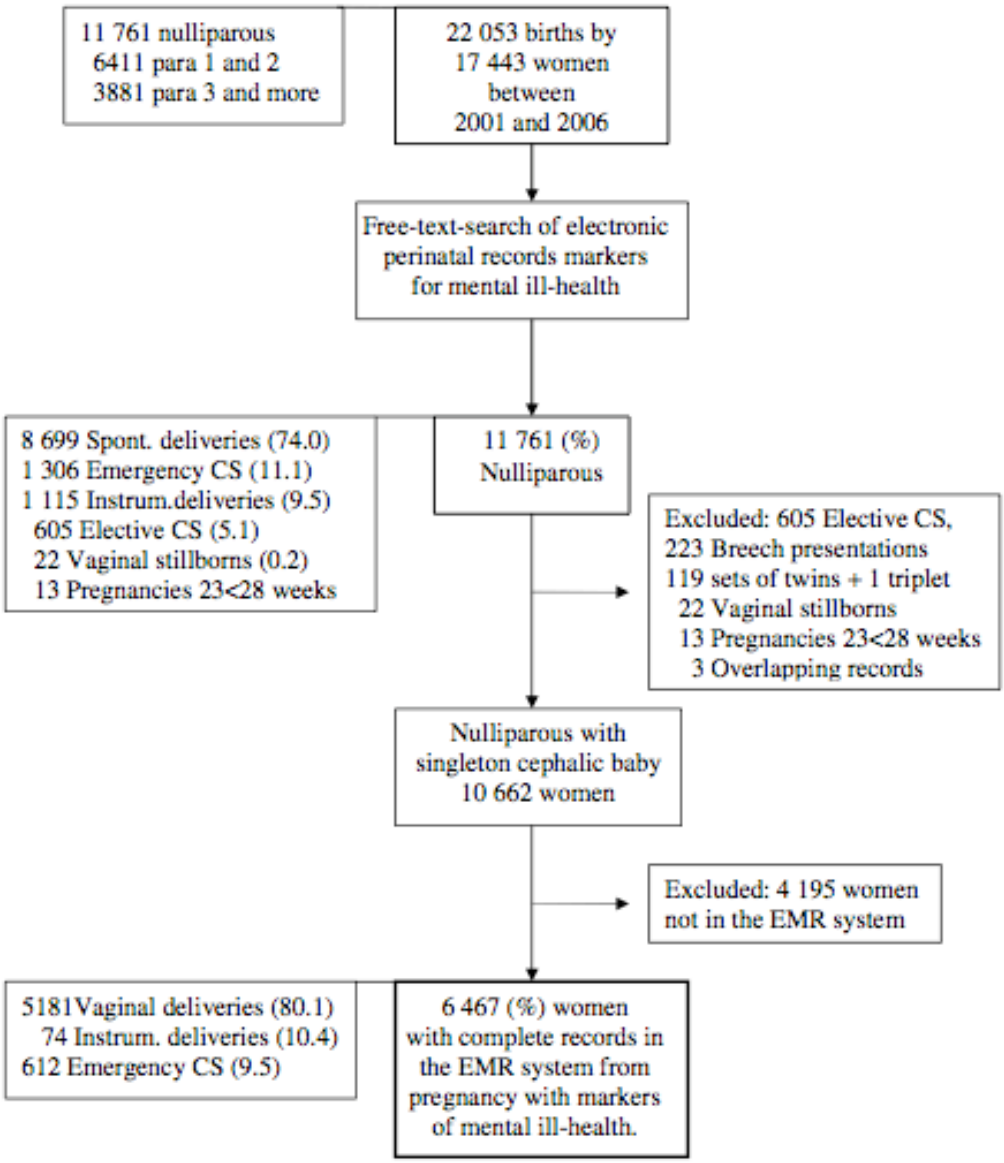

Figure 1. Flow chart showing inclusion of first-time mothers with complete electronic medical records (EMR) during pregnancy (n = 6 467) giving birth between January 2001 and December 2006 at Malmö University Hospital, Sweden

Markers of mental ill-health

We used a free-text analysis to identify markers for mental ill-health. In a pilot study, we explored the Swedish written language/discourse used as free-text entry for mental ill-health related status documented in the KIKA™ system. We identified psychiatric ICD–10 codes F00-F99 [International Classification of Diseases, 10th Revision] (23) and the truncated expression (indicated by an asterisk) "antidepress*" from perinatal records. We systematically analyzed the records to capture expressions of mental status. We identified theoretical concepts related to subjective symptoms of mental ill-health by counting and sorting

adjectives, nouns, and descriptive words. We then compared semantic concepts with validated instruments for mental problems and pregnancy (19, 24). We performed a content analysis and reduction into common words, followed by face validity testing (25) with clinical staff, counselors, a psychiatrist, and obstetricians by discussing usage and recognition in clinical practice. A free-text search for 30 identified, truncated word units was performed by processing all 528 728 record entries between 1998 and 2006 in the KIKA™ system. We discarded word units that occurred in more than 2 000 and in less than 20 records, for reasons of reliability, then tested and utilized the truncated word units through a pilot test-run prior to the final free-text search.

The markers (word units) were translated into English as: stress* (including words like distress, stressed, etc.), sleep* (including sleepless, sleep disturbances, sleep/-ing problems), worry (including worried, worrying), anxie* (including anxiety, anxious), depress* (including depression, depressed, depressive), deject* (including dejected, dejection, feeling low or blue, panic* (including panicky, panicked) and antidepress* (including anti-depressant, anti-depressive). In addition, we chose to define three professional support markers reflecting the words for psychiat* (including psychiatric, psychiatrist); psychol* (including psychologist, psychological); and Viktoria*, an institution for women with perinatal attachment problems. Since none of these expressions are routinely used in free-text documentation in this patient group, the finding of one of these expressions is a positive marker for the existence of the specific condition.

Markers were coded as binary variables and we performed a Cohen's kappa measure of agreement for eight markers of mental ill-health and three professional support markers. A level of agreement at 0.21–0.40 was considered fair, 0.41–0.60 moderate, and >0.61 substantial (26). Since, the word units panic* and anxie* had a kappa value of 0.537, we created a new combined "PanicAnxie" marker. All the remaining variables had kappa values below 0.35. These we retained as separate variables for the analyses. We used these independent (exposure) variables for the regression analyses and modeling. Specifically, we sought to determine which markers of mental ill-health predicted an increased or decreased risk for emergency CS in nulliparous women (27).

Outcome and definitions

After including background and delivery outcome variables from the KIKA™ system, string variables for pregnancy and delivery outcomes were recoded as categorical binary variables. We regrouped spontaneous vaginal delivery and vaginal delivery with abdominal pressure as "spontaneous delivery" (ICD–10 code O80) (23), and vaginal instrumental, including low and mid-level forceps and vacuum extractions, as "instrumental delivery" (code O81). Finally, "vaginal delivery" consisting of spontaneous and instrumental delivery combined, we used as a reference group. Crash CS (n = 54) and emergency CS we regrouped as "emergency CS" (code O82.1–4). We recoded continuous variables such as birthweight, gestational weeks, and body mass index (kg/m² = BMI) of women at time of delivery as categorical variables. Other string and background variables, such as country of birth, we sorted and re-coded into categories; where necessary we re-coded these as binary variables for statistical analyses.

Statistical analyses

We tested nominal variables for linear-by-linear association. Pearson's chi-squared test was used for association between categorical background variables. We tested known risk factors (i.e., plausible confounders) for emergency CS compared with vaginal delivery by binary logistic regression for the study group. We also added the binary variable "induced labor" to the model for emergency CS as a plausible confounder. For the multivariate logistic regressions we used emergency CS as the dependent variable. We then calculated adjusted

ORs for emergency CS in relation to the markers as independent variables and used a separate multivariate logistic regression model for each marker. Each model was adjusted for maternal age (continuous variable) and binary variables: diabetes (ICD–10 code 024), epidural anesthesia (EDA) at vaginal delivery and gestational age category <37 and >41 gestational weeks, i.e. known risk factors for emergency CS (6). These risk factors remained significant after adjusting for BMI where this was possible. Although BMI is a risk factor for CS and for diabetes, we present data without adjustment for BMI, since BMI was missing for more than 30% of the women.

We present 95% confidence intervals (CI) and p-values. Since multiple analyses were performed, we show p-values <0.05 and considered those <0.001 as significant for the risk estimates**.** We used the statistical software package SPSS 15.0 (SPSS, Chicago, IL, USA). The Regional Ethics Committee of Lund, Sweden, approved the study (Dnr350/ 2007). Prior to collating the study population, individual exclusion from the birth record database was possible through adverts in two daily local papers. Nine women responded which we excluded.

Results

Background characteristics of the 6 467 nulliparous women presenting for vaginal delivery are shown in Table 1.

Table 1. Characteristics of 10 662 nulliparous women presenting for vaginal delivery with a singleton cephalic baby between 2001 and 2006 by EMR status

	Non-EMR *n* = 4 195 (%)	EMR *n* = 6 467 (%)
Age at delivery		
≤19 yrs	69 (1.6)	367 (5.7)
20–24 yrs	342 (8.2)	1 628 (25.2)
25–29 yrs	1 251 (29.8)	2 247 (34.7)
30–34 yrs	1 759 (41.9)	1 700 (26.3)
35–39 yrs	685 (16.3)	458 (7.1)
40+ yrs	89 (2.1)	67 (1.0)
Missing	0	0
BMI at delivery:		
Underweight ≤ 18.5	8 (0.2)	4 (0.1)
Normal 18.6– 24.9	518 (12.3)	771 (11.9)
Overweight 25–29.9	1 629 (38.8)	2 115 (32.7)
Obese 30–39.9	957 (22.8)	1 426 (22.1)
Extreme obesity ≥ 40	58 (1.4)	108 (1.7)
Missing	1 025 (24.4)	2 043 (31.6)
Diabetes		
ICD10–O24 registered	80 (1.9)	173 (2.7)
Swedish-born	3 944 (94.0)	4 173(64.5)
Foreign-born	251 (5.7)	2 294(35.5)
Missing	(0.3)	0.01

Women those records were analyzed for markers (EMR) were more often foreign born (p = 0.0001), were younger (p = 0.001), and more were ICD-coded with diabetes (p= 0.011) than the non-EMR group. Neither obstetric outcomes (mode of delivery, induced labor, EDA, and gestational age) nor the sex of the baby (Table 2) showed any significant differences between the two groups. The birthweight of babies born to EMR group were lower (category by grams) than the babies of the non-EMR group (p <0.0001).

Table 2. Comparison of obstetric and baby outcome of 10 662 nulliparous women by EMR status

	Non-EMR $n = 4\ 195$ (%)	EMR $n = 6\ 467$ (%)
Mode of delivery		
Spontaneous vaginal	3 368 (80.3)	5181 (80.1)
Instrumental vaginal	428 (10.2)	674 (10.4)
Emergency CS	399 (9.5)	612 (9.5)
Induced labour		
ICD–code registered	364 (8.7)	596 (9.2)
Epidural (EDA)		
At vaginal delivery	922 (22.0)	1 370 (21.2)
Gestational weeks		
≤ 28	9 (0.2)	10 (0.2)
29–32	26 (0.6)	41 (0.6)
33–36	190 (4.5)	253 (3.9)
37–41	3 678 (87.7)	5 702 (88.2)
42+	292 (7.0)	461 (7.1)
Missing	0	0
Boys	2 160 (51.5)	3 350 (51.8)
Girls	2 35 (48.5)	3 116 (48.2)
Missing	0	1
Birth weight (grams)		
≤1499	14 (0.3)	18 (0.3)
1 500–2 499	121 (2.9)	188 (2.9)
2 500–3 499	1 814 (43.2)	3 289 (50.9)
3 500–4 499	2 096 (50.0)	2 820 (43.6)
≥ 4 500	135 (3.2)	135 (2.1)
Missing	15 (0.4)	17 (0.3)

Mutually adjusted ORs and 95% CI for emergency CS were: 1.05 (95%CI 1.04 – 1.07) for increasing maternal age, 1.43 (95%CI 1.18 – 1.74) for EDA with vaginal birth, 3.62 (95%CI 2.51 – 5.20) for registered diabetes, and were 3.85 (95%CI 3.69 – 4.69 for gestational weeks <37 and >41. We therefore, adjusted for these factors in all models. When we excluded women with instrumental delivery ($n = 676$) from the vaginal delivery reference group, the OR for emergency CS remained almost the same (data not shown).

The frequency of selected free-text markers varied between 1.6–14.2 %. Table 3 shows the main results as adjusted ORs for the markers for mental ill-health and professional support in relation to emergency CS. Although all markers showed an increased risk for emergency CS, only the markers stress* (adjusted OR 1.66; 95%CI 1.34–2.06), sleep* (1.57; 1.14–2.16), and worry* (1.41; 1.10–1.79) were significant. The results remained approximately the same when women with instrumental delivery were excluded. Adding the binary variable "induced labor" to the model for emergency CS; it slightly lowered the odds for the markers stress* and sleep*, but the odds remained almost the same for worry*, PanicAnxie*, depress*, and deject* (data not shown). We also tested the three professional support markers (psychol*, psychiat*, Viktoria*) and antidepress* and found that none was significant for emergency CS.

Table 3. Markers for mental ill-health and professional support, adjusted ORs for emergency CS compared with vaginal delivery in singleton nulliparous women ($n = 6\,467$)

Markers	$n = 6\,467$ frequency (%) with markers	Vaginal delivery $n = 5\,855$	Emergency CS $n = 612$	
		Ref.	Adjusted† OR (95%CI)	p-value
stress*	917 (14.2)	1.0	1.66 (1.34–2.06)	<0.0001
sleep*	366 (5.7)	1.0	1.57 (1.14–2.16)	0.005
worry*	720 (11.1)	1.0	1.41 (1.10–1.79)	0.006
PanicAnxie*	341 (5.3)	1.0	1.36 (0.97–1.91)	0.07
depress*	476 (7.4)	1.0	1.27 (0.95–1.72)	0.11
deject*	241 (3.7)	1.0	1.31 (0.88–1.95)	0.18
psychol*	181(2.8)	1.0	1.42 (0.91–2.23)	0.13
psychiat*	157 (2.4)	1.0	1.05 (0.62–1.79)	0.84
Victoria*	169 (2.6)	1.0	1.21 (0.74–1.98)	0.45
antidepress*	102 (1.6)	1.0	1.67 (0.94–2.95)	0.79

†Adjusted for maternal age, EDA, diabetes and gestational weeks <37 and >41.

Discussion

We devised a free-text search method that could be applied to a perinatal EMR system. The markers of mental ill-health were identified in records of all pregnancies and births between 1998 and 2006. Thus, the design of this study focus on the association between mental ill-health and emergency CS, in first time mothers presenting with a cephalic singleton baby for vaginal delivery, and having perinatal records in the EMR system. The strength of this study rests in it being population-based and that exposure variables (the potential markers) were gathered and recorded prior to delivery outcome, eliminating recall bias.

There appeared to be a general tendency for the analyzed markers of mental ill-health to be associated with increased risk estimates for emergency CS**.** Three markers reached statistical significance for emergency CS after adjusting for other known and more conventional risk factors. The analysis suggests that common complaints of pregnant women, such as experiencing stress, having sleep disturbances or being worried, constitute (and therefore can be used to predict) an increased risk for emergency CS in first-time mothers. The association between these three markers and emergency CS is in agreement with theories of neuroendocrine-regulated pathways and research indicating that maternal anxiety, stress, and mood disorders may increase the work load of the fetal heart (28, 29). The threat of asphyxia and fetal distress are common indications for emergency CS (2).

There are some limitations to our study. An underestimation of the occurrence of markers as exposure variables might be present. The markers indicating panic, anxiety, feeling depressed, and feeling low/dejected, established clinical symptoms of mental disorder, had no significant association with increased risk of emergency CS. The lack of significance for these markers could be due to underreporting by the staff or by the women, possibly due to self-presentational bias (30). It might be that staff were aware of panic, anxiety, and depression as risk factors for perinatal problems and acted on these indications (16, 18).This could account for panic, anxiety, depressed, and dejected not being associated with an increased risk of emergency CS in our study. Possibly, women who utilized these ‘psychiatric’ words were offered professional help and antidepressant treatment, without specific ´psychiatric’ markers being documented. The occurrence of the markers psychol* and psychiat* (professional

support) would be in agreement with a previous study in Sweden that suggested that the identification of women wishing to have a CS in early pregnancy could reduce CS rates (7). Furthermore, in the initial study year being the second year that the EMR system was in general use not only for delivery but also for antenatal care, all markers were less frequent than in the following five years. Also, the markers originate from clinical notes written by 100 different midwives during a six-year time span. Perinatal staff (nurse midwives in particular) received technical training prior to being licensed to operate the EMR system. The writing of clinical notes is regulated by the Patient Record Act of 1980 and the Secrecy Act of 1985. These acts allow patients to read their own records and to file complaints regarding their record's wording. The notes must convey pertinent information only as to the health status of the individual. Hence, a certain degree of "documentation culture" is likely to be present. Reluctance to document words with psychiatric overtones might be part of this "culture", leading to an unknown degree of measurement bias. In the end, underreporting may have biased our results towards the null, since the number of women with markers for panic, anxiety, feeling dejected and, depressed may have been underestimated.

Another limitation of the study is the lack of socioeconomic variables. Since some variables had many missing values, we were unable to compile a socio-economic profile of the study population. First-time mothers in the EMR system were younger, had lower BMI at delivery, had more coding for diabetes, were more often foreign-born, and their babies weighed less than non-EMR women (Table 1). However, there were no significant differences between the two groups as to mode of delivery (Table 2).

Our findings show that 9.5% of nulliparous women presenting for vaginal birth with a singleton cephalic baby had emergency CS. The risk for an emergency CS appears to increase by 60% due to stress, 57% due to sleep-related disturbances, and 41% due to worry. Any level of risk reduction might save women from having emergency CS and conserve resources that could be allocated to preventive measures or other health care needs (2). This study provides support to the conviction that the way a person, here a pregnant woman, views her health is "importantly related to subsequent health outcomes", as stated by Mossy and Shapiro (20). Perinatal staff should be trained to recognize and document a pregnant woman's reporting of her mental health status as it could have a predictive bearing on her delivery. In clinical practice a sensitive and attentive ear is needed to identify these women and thereby facilitate the reduction of their stress, sleeping disturbances, and worry before their due date. This awareness could be used to identify pregnant women who could benefit from psycho-prophylaxis, as a recent study from Sweden showed that using this method may reduce the rate of emergency CS (31). An increased percentage of CS rates is not only a Swedish problem, but found globally with a concurrent increase of mental health problems in women in reproductive ages. Evidence shows that any types of CS gives a significant increased risk of a subsequent CS and adverse health effects for the mother and child (2, 6, 8, 10, 11). Avoiding a CS in first-time mothers would greatly reduce the cost to the individual and society.

In conclusion, this is, to our knowledge, the first study to report an increased risk of emergency CS in relation to documented words in an EMR system of women having stress, sleep disturbances, and worry during pregnancy. Thus confirmatory studies are warranted. If confirmed, screening for mental health status during pregnancy may be useful as a tool for stress-reducing intervention in order to lower the numbers of emergency CS in first-time mothers (17, 18, 32, 33). Recognizing and documenting pregnant women's reporting of their mental health status could have a predictive bearing on delivery outcomes.

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