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Differentiation of women into low- and high-risk for complications during labor

Graduate thesis in Medicine
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Abstract:

Objective: To ensure that women receive adequate care during labor, women are classified according to risk, low- or high-risk. Classification is carried out on admission to the maternity unit, and risk is continuously evaluated during labor. We studied the assessment performed by midwives in a maternity ward, and then reclassified the women in risk groups by strict following the guidelines. The objective of our study was to evaluate whether the guidelines were followed in clinical practice, both on admission to the hospital and during labor. We also studied whether mode of delivery and outcome for mother and child were related to correct risk assessment.

Subjects and method: This was a retrospective descriptive study of 686 women who gave birth at St. Olavs Hospital in July and October 2016. We collected information of the midwife`s classification into low- and high-risk groups, both on admission to the hospital and during labor, using medical records. Then all of the women were reclassified according to the guidelines for differentiation on admission. Among women correctly classified as low-risk (n=269) by the midwives, we followed the course of labor. Information on whether the midwives had documented change in risk group during labor was registered. At last, the women were reclassified according to the guidelines for change in risk during labor.

Results: Seventeen percent of the women had incorrect risk assessment on admission. Twelve percent were not classified at all. Of the women who had a correct low-risk classification on admission, 46.1% had incorrect risk assessment during labor.

Conclusion: Clinical risk assessment, both on admission and during labor, was to a large extent incorrect. The risk of several women was not documented, neither on admission nor during labor. The course and outcome of labor were associated with correct risk assessment. The rate of operative delivery was lower among newborns of women correctly classified low-risk on admission compared to those who were misclassified low-risk. Apgar-scores were higher among newborns of women that correctly stayed low-risk during labor compared to those who were misclassified low-risk. If a midwife-led care unit is implemented in our department, improvements in risk assessment are needed in order to know the correct proportion of low- and high-risk.

Keywords: misclassification, birth outcome, labor, low-risk, high-risk, audit

Contents

1. Introduction:

During pregnancy and childbirth there is a general agreement of the need to detect risk-factors and recognize adverse events. In order to reduce maternal mortality and morbidity, as well as to improve outcome of the newborn, there has, in both low- and high-income countries, been developed strategies to identify women at risk of complications.

There are several ways to approach the level of risk of pregnancy and childbirth around the western world, and hence which level of care to be provided. Substantial differences exist concerning who are considered the primary providers of care, whether the midwife, the obstetrician or a combination of these two caregivers (1). A systematic review, published in Cochrane Library in 2013 (2), concludes that midwife-led continuity of care during pregnancy and birth gave a better outcome and less morbidity than a shared system of care between multiple professions such as midwives, obstetricians and general practitioners. This is based on the thought of pregnancy and childbirth as normal, healthy events in life. However, the study encourages caution in applying the results to women with high-risk pregnancies or with increased risk of complications or emergencies during pregnancy and birth. The review states that most pregnant women should have the opportunity to choose midwife-led care during pregnancy and birth, as long as they have healthy, low-risk pregnancies.

In Norway, most women give birth in hospitals, and in the majority of hospitals all women give birth in the same ward whether they have high- or low-risk. Although at some hospitals in Norway healthy, low-risk women can give birth in midwife-led units that are separate, but close to the obstetric hospital clinics.

At St. Olavs Hospital, the university hospital in Trondheim, the midwife selects women to low-risk or high-risk groups as they seek help at the delivery ward suspecting labor. The selection is based on guidelines, and both groups of women give birth in the same ward. Selection of women into low- and high-risk groups aims to avoid unnecessary surveillance and intervention among low-risk women. In the same time, high-risk women are ensured the required surveillance and access to specialist obstetric care. During labor, low-risk women can change to high-risk-group depending on events, the course of the labor and hence the need of surveillance.

To ensure that health care systems maintain, or even improve their intended quality, clinical audit is a frequently used tool (3). Fraser et Al. has defined audit as the process of critically and systematically assessing our own professional activities with a commitment to improving performance and, ultimately, the quality and/or cost effectiveness of patient care. This study was a clinical audit evaluating the selection of low- and high-risk women according to guidelines before birth and whether, when complications occurred during labor, this was registered as a change to high-risk group.

The aim of our study was to evaluate 1) risk classification on admission to the hospital 2) risk classification during labor 3) whether risk group classification was associated with outcome for mother or child.

2. Subjects and method:

This is a retrospective descriptive study and data were collected from "Natus" version 3.1.6.3 (complete delivery and maternity chart at The Women's Clinic, St. Olavs Hospital), "Health Record Card for Pregnant Women" and the women's medical record in Doculive, version 7.0.2. The study included all women giving birth to one or more vital children at St. Olavs Hospital in July and October 2016, in total 686 women. After excluding women with intrauterine fetal death (IUFD) and planned cesarean section, 638 women remained. Eighty-five of these had not been classified to any risk-group, leaving 553 women used for data collection (Figure 1).

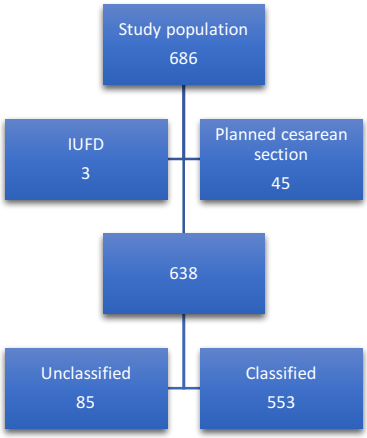

Figure 1

2.1 Criteria for differentiation on admission: *(Textbox 1)*

Guidelines for classification of risk groups during labor of women giving birth at St.Olavs hospital are based on report no. 12 to the Storting (2008-2009) called "En gledelig begivenhet" (4) and national guidelines for pregnancy and birth (5).

Low-risk pregnancy and birth is defined as healthy women carrying one fetus in head position, having spontaneous onset of labor within gestational week 37-42. The selection criteria of the high-risk group were defined as women with one or more of the following features of medical risk factors, complications concerning previous pregnancy and birth, as well as conditions in current pregnancy.

Medical risk factors	Complications during previous pregnancy and labor	Current pregnancy
•Medical conditions of the mother: •Diabetes mellitus •Epilepsia •Inflammatory bowel disease (IBD) •Severe psychiatric illness •HIV •Hepatitis B and C •Genital mutilation-individual assessment by the midwife	•Complicated vaginal delivery, vacuum or forceps due to prolonged labor •Shoulder dystocia •Cesarean section or corpus uteri surgery •Perinatal death/severe perinatal disease •Bleeding ≥ 1000ml •Atonic bleeding ≥ 500ml •Placenta accreta/percreta •HELLP •Intrahepatic cholestasis of pregnancy (ICP) •Severe preeclampsia •Vaginal tear, grade 3 or 4	•Growth abnormalities < -20% or >+30% •Oligohydramnion > week 40+2 •Induction of labor •Preeclampsia •Gestational hypertension •Gestational diabetes mellitus •BMI>30 •Smoke/snuff •Drug abuse •Multiple pregnancy •Breech position •Labor later than week 42+0 •Rupture of membranes >24 hours •Discolored amniotic fluid •Body temperature ≥ 38 degrees •Prelabor non-reassuring CTG

Textbox 1

Women in need of prophylactic antibiotics due to group B streptococci (GBS), thrombotic prophylaxis or well-regulated thyroid disease did not qualify for the high-risk group.

2.2 Criteria for differentiation during labor: *(Textbox 2)*

In order to evaluate the differentiation during labor, the course of labor of women correctly classified low-risk on admission was documented. Women misclassified high-risk may have received too high level of care and were not considered relevant for further investigation. The criteria for transition from low- to high-risk during labor are listed in textbox 2.

Causes for altered classification of risk
•Prolonged labor(crossing of "tiltakslinje" in Natus, >1 hour with 10 cm expulsion, >1 hour with active pushing) •Non-reassuring CTG •Body temperature ≥ 38 degrees •Signs of infection(elevated CRP and/or Leucocytes) •Oxytocin stimulation during labor •More than 5 contractions in 10 minutes •Abnormal bleeding, ≥ 500ml •Adherent placenta •Vaginal tear, grade 3 or 4 •Discolored amniotic fluid

Textbox 2

2.3 Outcome variables:

The women's age, parity, gestational age in days and method of birth, as well as sex, weight, length, head circumference and Apgar score of the newborn after 1,5 and 10 minutes were registered. Eleven women delivered twins, thus 22 newborns were born from twin pregnancies. In these cases the woman and her risk was handled as one case, and the method of birth and the newborns as two cases.

Two medical students in 5th year at Norwegian University of Science and Technology (NTNU) collected the data. To secure the quality, a senior consultant in obstetrics has controlled the data collection in 10% of the women. Data have been analyzed using descriptive statistics and independent sample T-tests in the statistical software SPSS version 24.

3. Results:

Characteristics of the women included in the study are presented in table 1. The table is divided in two: classification on admission and classification during labor. Each part is divided into four. First: women correctly classified low-risk. Second: those misclassified low-risk, meaning they were a high-risk group. Third: women correctly classified high-risk. Fourth: those misclassified high-risk, meaning they were a low-risk group. In addition women being unclassified, experiencing IUFD or having planned cesarean section are presented as one group.

The age range of the women was from 17 to 44 years, and the parity varied from zero to seven. On admission to the hospital, the women correctly classified low-risk had a lower

mean age than both women misclassified low-risk (p=0.05) and women correctly classified high-risk (p=0.03). There was no difference in parity between women correctly classified low-risk and women misclassified low-risk (p=0.06) on admission. Women correctly classified high-risk had a higher mean parity than women correctly classified low-risk (p=0.00). 326 out of all 686 (47.5%) women in our population were nulliparous, whereas 158 out of 269 (58.7%) of women correctly registered low-risk on admission were nulliparous.

During labor, there was no difference in mean age between the different risk groups (p=0.25 for correctly classified low-risk vs. misclassified low-risk, p=0.16 for correctly low-risk vs. correct high-risk). The women correctly classified low-risk during labor had a significant higher parity both compared to misclassified low-risk and correctly classified high-risk (p=0.00 for both).

	N (%)	Mean age	Mean parity
Study population	686	29.8	0.8
Unregistered/planned CS/IUFD	133 (19.4%)	30.3	1.0
On admission:	553		
Correctly classified low-risk	269 (48.6%)	29.1	0.6
Misclassified low-risk	114 (20.6%)	30.1	0.8
Correctly classified high-risk	166 (30.0%)	30.1	0.9
Misclassified high-risk	4 (0.7%)	31.3	1.3
During labor:	269		
Correctly classified low-risk	95 (35.3%)	29.6	1.0
Misclassified low-risk	122 (45.4%)	29.0	0.4
Correctly classified high-risk	50 (18.6%)	28.5	0.3
Misclassified high-risk	2 (0.7%)	31.0	1.0

Table 1

3.1 On admission:

Actual classification: (Figure 2)

Among all 553 registered women, 269 (48.6%) were correctly classified low-risk on admission according to guidelines. 114 women (20.6%) were misclassified low-risk, thus having risk-factors in their history qualifying for high-risk classification. Furthermore 166 of

the women (30.0%) were correctly classified high-risk on admission, and only four women (0.7%) were misclassified high-risk.

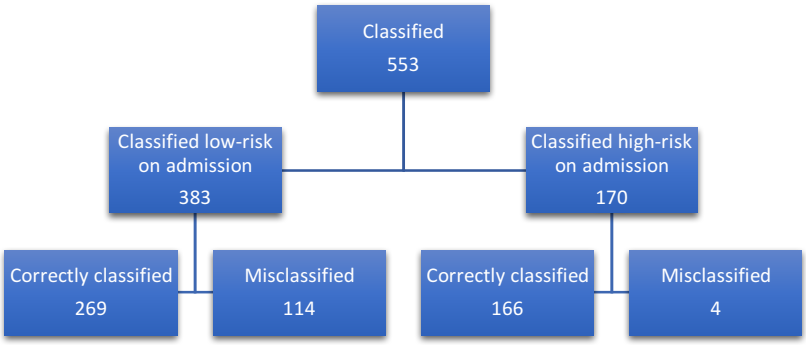

Figure 2

Seventy one of the 114 women (62.3%) misclassified low-risk had severe risk-factors, such as previous cesarean section, induction of labor, HELLP, preeclampsia, hypertension, growth abnormalities of the fetus (<-20% or >+30%), oligohydramnion later than week 42, multiple pregnancy, discolored amniotic fluid, body temperature ≥38 degrees Celsius, prelabor non-reassuring CTG or rupture of membranes >24 hours.

Reclassification according to guidelines: (Diagram 1)

When we compared the classification performed by the midwives with the reclassification according to guidelines, we found a large number of risk factors that had not been considered. As much as 41% of women reclassified high-risk were misclassified low-risk on admission. Only a small percentage, 1%, of the women reclassified low-risk were misclassified high-risk on admission.

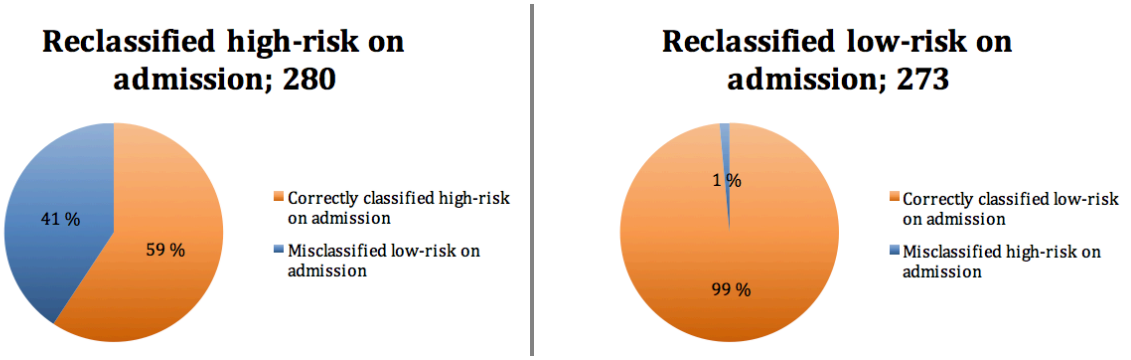

Diagram 1

3.2 During labor:

Actual classification: (Figure 3)

Among the 269 women correctly classified low-risk on admission, 95 women (35.3%) were correctly classified low-risk during labor. This means that they never, during pregnancy and labor, developed any risk factors, need of intervention or increased surveillance. Fifty women (18.6%) were correctly classified high-risk during labor. As many as 122 women (45.4%) were misclassified low-risk, and only two women (0.7%) were misclassified high-risk during labor.

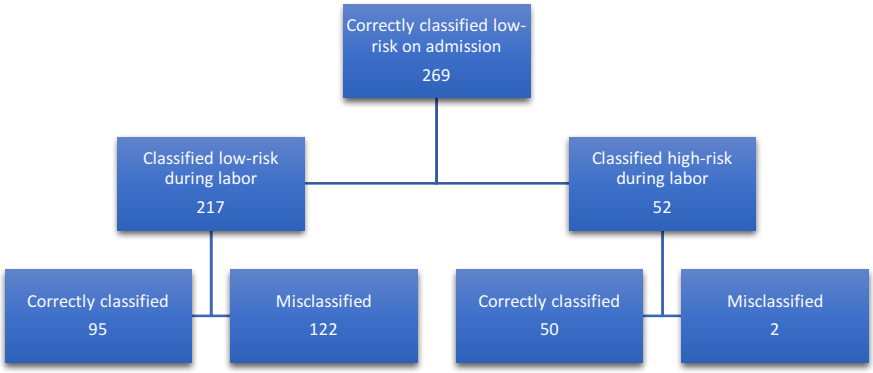

Figure 3

Reclassification according to guidelines: (Diagram 2)

All women were reclassified according to guidelines for change in risk group during labor, and this was compared to the classification performed by the midwives. We found that a large number of risk factors, that developed during labor, did not result in transfer to the high-risk group. As much as 71% of women reclassified high-risk were misclassified low-risk during labor. Only a small percentage of the women reclassified low-risk were misclassified high-risk during labor.

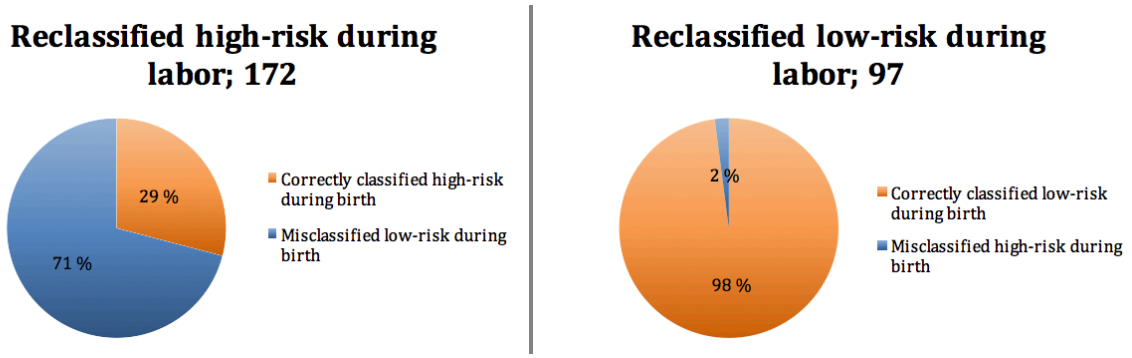

Diagram 2

Causes of altered classification of risk: (Table 2)

The most frequent reasons for risk, both among the correctly classified and the misclassified ones were; oxytocin stimulation, prolonged labor and non-reassuring CTG. The share of women who experienced signs of infection, non-reassuring CTG or was in need of oxytocin stimulation was larger among those correctly classified high-risk during labor compared to those misclassified low-risk during labor. Women who bled ≥ 500 ml were the same in both groups. All premature labors (before 37 weeks) were correctly classified high-risk during labor.

In the group of women correctly classified high-risk during labor, multiple adverse events occurred. Among those who bled ≥ 500 ml, 10 out of 14 (71.4%) also had prolonged labor. Four out of five women (80.0%) in the same group whose bleeding exceeded 1000 ml had prolonged labor. Among those misclassified low-risk during labor, 11 out of 35 women (31.4%) both bled ≥ 500 ml and had prolonged labor, whereas three out of seven (42.9%) women, whose bleeding exceeded 1000 ml, also had prolonged labor.

		Causes of altered classification of risk							
	N (%)	**Prolonged labor**	**Oxytocin stimulation during labor**	**Non-reassuring CTG**	**Signs of infection (including temperature ≥ 38°C)**	**Discolored amniotic fluid**	**Bleeding ≥500 ml**	**Vaginal tear grade 3 or 4**	**Labor <37 weeks**
Correctly classified high-risk during labor	50 (18.6%)	33 (66.0%)	37 (74.0%)	28 (56.0%)	11 (22.0%)	21 (42.0%)	14 (28.0%)	2 (4.0%)	6 (12.0%)
Misclassified low-risk during labor	122 (45.4%)	64 (52.5%)	50 (41.0%)	47 (38.5%)	4 (3.3%)	25 (20.5%)	35 (28.7%)	1 (0.8%)	0 (0.0%)

Table 2

Prolonged labor and oxytocin stimulation: (Diagram 3)

Ninety-seven women were diagnosed with prolonged labor, and 73 of them (75.3%) had oxytocin stimulation. Twenty-four women (24.7%) with prolonged labor were not given oxytocin stimulation. Among the 122 women misclassified low-risk during labor, 64 women (52.5%) had prolonged labor, among these 43 (67.2%) were given, and 21 (32.8%) were not given oxytocin stimulation. In the misclassified low-risk group the share of women not given stimulation was larger than among the women correctly classified high-risk. We also found that 14 women, who did not have prolonged labor, were given oxytocin stimulation.

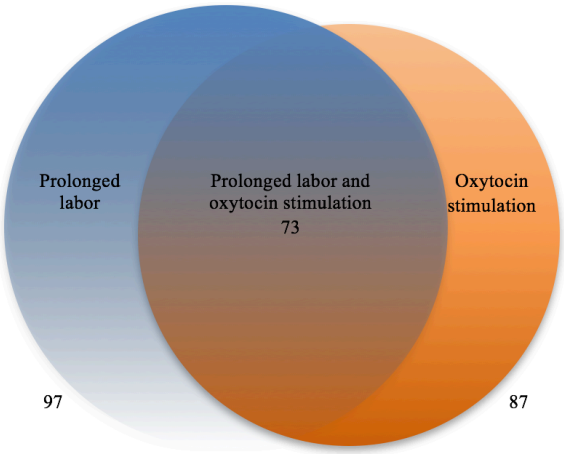

Diagram 3

3.3 Mode of delivery and outcome of birth: *(Table 3 and 4)*

The frequency of operative delivery (acute cesarean section, vacuum, forceps) was lower (17.1%) in the group correctly classified low-risk on admission, than among those misclassified low-risk on admission (31.6%). In the group correctly classified high-risk on admission 36.8% had operative deliveries.

Operative delivery rate was higher in the group correctly classified high-risk during labor (38.0%) than among those misclassified low-risk (22.1%). Over all, 46 of 172 women (26.7%) reclassified high-risk during labor had operative deliveries.

The most frequent indication for acute cesarean section (CS) was prolonged labor. In the group correctly classified high-risk during labor, four out of six women (66.7%) having acute CS had prolonged labor as indication. In the group misclassified low-risk four out of five women (80.0%) having acute CS had prolonged labor as indication.

Risk group		**Mode of delivery**					
		Spontaneous vaginal		**Operative vaginal**		**Cesarean section**	
	N	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**
On admission							
Correctly classified low-risk	269	223	(82.9%)	35	(13.0%)	11	(4.1%)
Misclassified low-risk	117	80	(68.4%)	17	(14.5%)	20	(17.1%)

Correctly classified high-risk	171	108	(63.2%)	22	(12.9%)	41	(24.0%)
Misclassified high-risk	4	4	(100.0%)	0	(0.0%)	0	(0.0%)
During labor							
Correctly classified low-risk	95	95	(100.0%)	0	(0.0%)	0	(0.0%)
Misclassified low-risk	122	95	(77.9%)	22	(18.0%)	5	(4.1%)
Correctly classified high-risk	50	31	(62.0%)	13	(26.0%)	6	(12.0%)
Misclassified high-risk	2	2	(100.0%)	0	(0.0%)	0	(0.0%)

Table 3

Offspring of women correctly classified low-risk on admission had higher birthweight (p=0.01), longer length (p=0.04) and larger head circumference (p=0.02) than the offspring of women correctly classified high-risk. There were no difference in birthweight (p=0.81), length (p=0.37) or head circumference (p=0.20) in offspring of women correctly classified low-risk and of women misclassified low-risk.

When we followed the course of labor of the group that was correctly classified low-risk on admission, we found no difference in birthweight (p=0,43), head circumference (p=0.17) or length (p=0.75) among women having correctly classified low-risk courses, compared to those who were correctly classified high-risk during labor. Newborns of women correctly classified low-risk during labor had a significantly smaller head circumference than newborns of women misclassified low-risk during labor (p=0.05). There were no differences in length between these latter two risk groups (p=0.75).

Apgar scores of newborns of women correctly classified low-risk on admission were not significantly different from neither newborns of women misclassified low-risk, nor newborns of women correctly classified high-risk (correctly classified low-risk vs. misclassified low-risk: p= 0.48 after 1 min, p=0.64 after 5 min, p=0.93 after 10 min, correctly classified low-risk vs. correctly classified high-risk: p=0.33 after 1 min, p=0.23 after 5 min, p=0.64 after 10 min). Apgar scores were higher among newborns of women who did not develop risk factors and thus correctly stayed in the low-risk group during labor, than both those who were misclassified low-risk during labor (p=0.03 after 1 min, p=0.06 after 5 min, p=0.05 after 10 min) and those who correctly were changed to high-risk during labor (p=0.00 after 1 min, p=0.01 after 5 min, p=0.00 after 10 min).

Risk group	Outcome of the newborn					
	Mean weight, g	**Mean length, cm**	**Mean head circumference, cm**	**Mean Apgar score 1**	**Mean Apgar score 5**	**Mean Apgar score 10**
On admission						
Correct classified low-risk	3584.1	50.1	35.3	8.7	9.7	9.8
Misclassified low-risk	3559.1	50.2	35.5	8.7	9.6	9.8
Correct classified high-risk	3421.2	49.5	34.9	8.6	9.5	9.8
Misclassified high-risk	3588.8	49.3	34.8	8.6	9.8	9.8
During labor						
Correct classified low-risk	3520.8	50.1	35.1	9.0	9.8	10.0
Misclassified low-risk	3623.0	50.2	35.4	8.7	9.6	9.8
Correct classified high- risk group	3593.5	50.1	35.5	8.4	9.5	9.7
Misclassified high-risk	3990.0	50.5	36.5	9.0	9.0	10.0

Table 4

4. Discussion:

The selection process for low-risk labors is crucial in all hospitals providing midwife led care, or even when providing the possibility of home birth. Midwife-led care units seem to be a safe option, that keep the intervention ratio low, for women having uncomplicated pregnancies and low-risk of complications during labor (6). Differentiation requires clear guidelines concerning different adverse effects that arise before and during labor as well as a staff that is trained to identify these risk factors (7). Guidelines in our hospital are in agreement with other guidelines identifying risk during pregnancy and labor (5, 8, 9).

Both women misclassified low-risk, and women correctly classified high-risk on admission, had a higher mean age than women correctly classified low-risk on admission. Previous birth history is the most important risk factor for upcoming deliveries. Thus, higher parity among older women partly explains this age difference. Older women are also at increased risk to complications during pregnancy and birth, regardless of parity (10, 11) and have higher morbidity in general (12).

According to guidelines women with history of complicated labor, qualify for the high-risk group on admission. As stated, previous birth history is considered the sole most important risk factor for upcoming deliveries (13-15). This is probably why women correctly classified high-risk on admission had a significantly higher mean parity than women correctly classified low-risk on admission. However, women misclassified low-risk and correctly classified low-risk on admission did not have different parity. We speculate that midwives have higher attention for complications in previous pregnancy and birth than to medical risk-factors and complications in current pregnancy.

When we followed the course of labor of women classified low-risk on admission, we found that women who went through labor as low-risk, had a significantly higher parity than both women correctly classified high-risk and women misclassified low-risk during labor. This finding is as expected, as multiparous women with previous history of uncomplicated labors are likely to go through upcoming deliveries without complications (16).

4.1 On admission:

We found that a surprisingly low proportion, 48.6% of all classified women was correctly classified low-risk on admission. As many as 20.6% of all registered women were misclassified low-risk. Only four out of 553 women (0.7%) misclassified high-risk on admission, thus the risk of unnecessary surveillance and interventions did not seem to be a major problem. If this group was large, it could act as an obstacle, most of all for the women giving birth, limiting their modes of delivery, the mode of care etc.

Among women misclassified low-risk on admission, 62.3% had severe risk-factors important to notice. It is serious if severe risk factors such as previous cesarean section, preeclampsia or hypertension were not considered by the primary midwife, but further studies are needed to explore whether women misclassified low-risk received the adequate surveillance and treatment. Other risk factors, such as chronic maternal disease, smoking and maternal obesity might also affect outcome of birth, and are important to recognize (17-19).

Additionally the software "Natus" that midwives use for classifying women, on admission and during labor, has some challenging options. As it is performed on a check-box basis, and several check-boxes can be filled in, both under the tablets "*on admission"* and "*during*

labor", it allows some errors in registration. This means that women having cesarean section and induction of labor can be misclassified low-risk on admission because of a simple crossing mistake by the midwife.

4.2 During labor:

During labor, lack of acknowledgement of developing risk factors, or an oversight to change of risk group, may have led to misclassification. As many as 45.4% of women correctly classified low-risk on admission, developed risk factors during labor that were not registered as shift to high-risk group. Whether the misclassification led to inadequate surveillance and intervention may be questioned. Among women having prolonged labor in the correctly classified high-risk group, 90.9% got oxytocin stimulation, compared to only 67.2% among women misclassified low-risk. We speculate that missed identification of prolonged labor resulted in lack of intervention.

Only 36.0% of the women classified low-risk on admission remained low-risk during labor, according to guidelines. Even among women that were correctly classified low-risk on admission, as many as 63.9% developed risk factors during labor. This number is remarkably higher than in the midwife led Alternative Birth Centre (ABC) in Oslo where 22% developed risk factors during labor that resulted in transfer to hospital (8). Women correctly classified low-risk on admission in our population were quite similar to women that were allowed to start labor at ABC. An important difference between our low-risk women and women starting labor at ABC is the woman´s opportunity to choose. Women can choose to give birth at ABC if they are qualified according to guidelines. This contrasts women giving birth in our hospital where there is no opportunity to choose. By choosing ABC women are prepared to not have epidural for pain relief during labor, as this require transfer to hospital. However, epidural for pain relief do not qualify for change to high-risk in our hospital, and can thus not contribute to explain the difference between transfer from ABC to hospital and change to high-risk group in our hospital. Parity might also contribute to the differences between ABC and our hospital in development of risk during labor. Among all 341 women that started labor at ABC, 164 (48.1%) were nulliparous. In agreement with our findings, the study from ABC shows that nulliparous women are more prone to complications during labor than multiparous. The shear of nulliparous women in our correctly classified low-risk group (58.7%) on admission was larger than among women that started labor at ABC (48.1%), and this might partly explain our larger proportion of women that became high-risk during labor.

4.3 Mode of delivery and outcome of birth:

We saw that differentiation into risk groups according to the guidelines is associated with intervention during labor. Among women correctly classified high-risk on admission 36.8% had operative delivery. As many as 31.6% of women misclassified low-risk on admission had operative delivery, compared to only 17.1% among women correctly classified low-risk. Thus women in the misclassified low-risk group have factors that impact the course of labor and outcome of birth, and hence have real risks for non-normal labor. Nevertheless, women misclassified low-risk on admission do not have a total higher rate of operative delivery than women correctly classified high-risk. Thus the actual surveillance and treatment given was probably adequate, as one can imagine that lack of surveillance of these misclassified women would lead to a higher rate of emergency interventions than among women correctly classified high-risk. Twenty-two percent of women that were classified low-risk during labor by the midwife, ended with operative delivery, which is impossible according to guidelines as operative delivery is a clear reason for change in risk group. This can therefore be seen as a simple crossing error. The same type of inaccuracies due to lack of awareness when registering women in Natus, can affect the results and thus give several biases difficult to detect. Thus several of these apparently low-risk women had the need of an obstetrician and could not have stayed in a low-risk unit.

The relevance of the guidelines for selection is reflected in outcome of the newborns. We found significantly higher birthweight, length and head circumference among newborns of women correctly classified low-risk on admission compared to women correctly classified high-risk on admission. This is in accordance with the literature that states that low-risk women have healthier pregnancies and give birth to newborns with higher birthweight than high-risk women(20-22). These differences between the newborns were not found between correctly classified low-risk and misclassified low-risk on admission. We might speculate whether the misclassified low-risk women presented with less severe risk factors that affect growth of the fetus to a lesser extent than the correctly classified high-risk ones.

There were no significant differences in the Apgar scores among newborns of women correctly classified low-risk, misclassified low-risk or correctly classified high-risk on admission. However, the newborns of women who correctly stayed low-risk during labor had higher Apgar scores than both women correctly classified high-risk and women misclassified

low-risk during labor. We may speculate whether the surveillance and intervention were adequate among women misclassified low-risk, as also reflected by the high operative delivery rates in this group.

5. Strengths and limitations of the study:

The sample size of this study is small when it is divided into subgroups, and non-significant differences may be questioned.

We collected data retrospectively based on what was written by the midwife in the medical records. Whether the medical procedures were followed and adequate treatment was given were not evaluated. This was not included as part of the present study.

A senior consultant in obstetrics has controlled about 10% of the data collected. Her findings accorded with the data collected and evaluated by the students. Additionally the data have been analyzed multiple times, and inaccuracies have thereby been discovered. The remaining inaccuracies are to be considered as few, and will by that have a small impact on total sample size. When dividing the population into smaller groups, few mistakes can have a larger impact on the results.

The program that is used to register the women, "Natus", has a couple of limitations that might have affected the results. It is possible to register "induction of labor" under two different tablets, both *"on admission"* and *"during labor"*. Induction of labor is never done during labor, so this is a bias that might have affected the results. These women should have been high-risk on admission, but because the "induction" is set to *"during labor"* the selection into the high-risk group is not registered before *"during labor"*. This gives more women that are "misclassified low-risk on admission". Moreover, it is important to enlighten the fact that it, in Natus, is possible to register a woman throughout labor, without documenting the evaluation of risk. Consequently, a fraction of women have not been classified and are thus not a part of the study.

6. Conclusion:

Women who gave birth at St. Olavs Hosiptal in July and October 2016 were largely incorrectly grouped concerning risk, both on admission and during labor. In a large share of women, risk factors were not registered. We have identified a wide gap between our detailed guidelines and the daily practice in our labor ward. Further investigation and studies are needed to see whether women misclassified low-risk had necessary interventions and adequate surveillance. It is of great importance that the actual numbers of low- and high-risk women, both on admission and during labor, are known when a midwife-led care unit is planned.

We suggest a prelabor consultation with a midwife a couple of weeks before due date, in order to evaluate and improve the risk classification on admission. Introducing of checkpoints for risk evaluation during labor may improve this classification.

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