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Full length article

Experiences with intrapartum fetal monitoring in the Netherlands: A survey study

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ABSTRACT

Introduction: Worldwide, cardiotocography is used for continuous monitoring of fetal heart rate (FHR) and uterine contractions during labour. Different methods for FHR registration and registration of contractions are available. Literature about the frequency of use of different fetal monitoring methods is lacking.
Objective: To evaluate the use of and preferences for fetal monitoring methods for intrapartum fetal monitoring among Dutch obstetric care providers.
Study design: Between October and November 2020 the Dutch Society of Obstetrics and Gynaecology sent an email invitation to all secondary care midwives and gynaecologists (in training) in the Netherlands to complete an online survey regarding the use and personal experience with fetal monitoring methods. The survey mainly consisted of multiple choice questions. Descriptive statistics are reported. Continuous variables were presented as median with interquartile ranges (IQR). Categorical variables were expressed as numbers with percentages.
Results: The response rate was 29 % (n/N = 510/1748). All Dutch hospitals were represented. The respondents estimated the use of fetal scalp electrode (FSE) at 71 % (IQR 58–85 %) of deliveries. The most common indication for use of the FSE was inadequate external FHR registration (94 %). More than half (54 %) of the respondents reported to use intrauterine pressure catheter with an estimated use of 5 % (IQR 2–8 %) of deliveries. The most common indication for use of intrauterine pressure catheter was inadequate external contraction registration (75 %). The use of ST-analysis was reported in 25 % of the respondents with an estimated use of 60 % (IQR 30–72 %) of deliveries. Almost all respondents (99 %) reported to use fetal blood sampling with an estimated use of 15 % (IQR 10–23 %) of deliveries. Ninety percent of respondents would prefer a valid and reliable external monitoring technique during labour. Thirty-one percent of respondents assume that external fetal monitoring with non-invasive fetal electrocardiography and electrohysterography will become standard care within the next 5 years.
Conclusions: Currently, the FSE is the most used technique for FHR monitoring during labour in the Netherlands. The most common indication for use of FSE is inadequate external FHR registration. Obstetric care providers would prefer a non-invasive external registration method that provides reliable data.

Introduction

Cardiotocography (CTG) is used for continuous fetal monitoring during labour. Fetal heart rate (FHR) can be monitored externally by Doppler Ultrasound (DU) or by non-invasive fetal electrocardiography (NI-fECG) or internally by fetal scalp electrode (FSE). Uterine contractions can be monitored externally by tocodynamometry (TOCO) or by electrohysterography (EHG) or internally by intrauterine pressure catheter (IUPC).

Invasive monitoring (FSE or IUPC) has the highest registration success rate and reliability [1]. However, several contra-indications for the application of FSE exist, such as preterm labour, maternal HIV or Hepatitis-B infection and the risk of fetal bleeding disorders [2]. Additionally, it can only be used when the head is engaged, the membranes

Abbreviations: CTG, Cardiotocography; FHR, Fetal heart rate; DU, Doppler Ultrasound; FSE, Fetal scalp electrode; NI-fECG, Non-invasive fetal electrocardiography; TOCO, External tocodynamometry; IUPC, Intrauterine pressure catheter; EHG, Electrohysterography; FBS, Fetal blood sampling; STAN, ST-analysis.

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have ruptured and with sufficient dilation. In addition, this invasive method causes minor skin lesions in 41 % of fetuses and has a risk of complications, such as cephalohematoma (1 %) and scalp abscesses (0.1–4.5 %) [3]. In case reports rare but serious complications, such as brain abscess and cerebrospinal fluid leak, are reported [3–5]. IUPC may cause severe fetal and maternal complications such as uterine perforation, placental abruption and perinatal mortality [6]. Therefore, invasive monitoring methods are not always used as standard care.

The international FIGO and national guidelines on fetal monitoring from Germany, Australia and Canada advice to only use FSE and/or IUPC if there is insufficient external registration [7–9]. The British and American guidelines do not provide an advice about registration of FHR and contractions [10,11]. The Dutch guideline on fetal monitoring does not provide an advice on the method of FHR monitoring [12]. The guideline advices only to use the IUPC for registration of contractions in case of inadequate external registration using TOCO [12].

A normal CTG tracing is a strong indicator of fetal wellbeing. However, an abnormal CTG tracing is not always associated with acidosis [13]. Fetal blood sampling (FBS) and ST-analysis (STAN) may then provide additional information and prevent unnecessary interventions [12,13]. The Dutch guideline on fetal monitoring recommends that FBS is used in the case of abnormal CTG without STAN or doubts about STAN [12]. STAN is a technique that detects changes in the ST segment of the fetal electrocardiogram (ECG) which are related to metabolic acidosis. These are interpreted together with the CTG according to specific clinical guidelines [14]. Different *meta*-analyses of randomized controlled trials have shown that STAN does not improve perinatal outcome [15–20]. However, STAN does result in a reduced number of FBS and assisted vaginal deliveries [15–20].

To date, research on the frequency and preferences of use of the different intrapartum fetal monitoring methods among Dutch obstetric care providers is lacking. Therefore, for the current study a nationwide questionnaire was sent out to evaluate this.

Material and methods

Study design and participants

Between October and November 2020 a cross-sectional questionnaire-based survey was conducted among all secondary care midwives (n = 250) and gynaecologists (in training) (n = 1079 and n = 419 respectively) in the Netherlands. The Dutch Society of Obstetricians and Gynaecology sent an invitation to fill in the online questionnaire within 4 weeks. A reminder was sent out after two weeks. Respondents were excluded if they only filled out the questions about informed consent and function but none of the substantive questions.

Questionnaire

The questionnaire consisted of 40 questions including profession, name and location of the hospital and the following fetal monitoring methods: (wireless) CTG, FSE, IUPC, STAN, FBS, non-invasive fetal electrocardiography (NI-fECG) and electrohysterography (EHG). We assumed that DU and TOCO were standard use in all hospitals and therefore no separate questions were asked about these methods. If participants responded that they were not familiar with EHG and NI-fECG, they were provided with information about these methods before continuing to the further questions. The survey mainly consisted of multiple choice questions and occasional open text options for clarification of multiple choice answers. An English translation of the complete original Dutch survey can be found in Appendix A. The questionnaire was developed with Qualtrics, an online tool for creating surveys.

Data analysis

The results of the questionnaire were exported to IBM SPSS Statistics for Windows, version 22 (IBM Corp., Armonk, N.Y., USA). Categorical questions were presented as numbers with percentages. Open questions were categorized and then presented as percentages. Continuous variables were presented as mean with standard deviation when the data was normally distributed and as median with interquartile range (IQR) when data was not normally distributed. Normality of data distribution was assessed visually with histograms and in addition a Shapiro-Wilk test was performed. If a respondent dropped out during the questionnaire, every completed question up until that point was analysed.

Ethical considerations

All respondents electronically confirmed their informed consent prior to completing the questionnaire. The Board of the Medical Ethics Committee of Maxima Medical Center confirmed that the rules laid down in the Medical Research Involving Human Subjects Act do not apply to this study (METC-number N20.101).

Results

Response rate

The overall response rate was 29 % (n = 510). The response rate among secondary midwives (62 %) was higher than among gynaecologists (in training) (23 % and 25 % respectively). A total of 51 participants (10 %) did not fully complete the questionnaire. All eight academic hospitals and all 62 non-academic hospitals in the Netherlands were represented. Table 1 shows the participant demographics.

Fetal monitoring

Table 2 provides the reported answers by the obstetrical care providers to the questionnaire.

Fig. 1 presents the percentage of care providers that use internal fetal monitoring methods and the median percentage in which they estimate to use them.

Table 3 shows the median percentages of estimated use of internal monitoring methods divided by function.

All obstetric care providers use FSE. The most frequent indications for use were (multiple choice and multiple answers could be selected): Insufficient external monitoring (93 %), abnormal CTG (46 %), suboptimal CTG (45 %), first child of a multiple gestation (30 %), epidural analgesia (27 %), morbid obesity (BMI > 40) (26 %) and meconium stained amniotic fluid (25 %). Indications selected by less than 15 % of the respondents were: fetal growth restriction, vaginal birth after caesarean section and obesity (BMI > 30). Less than 10 % of respondents selected the following indications: suspicion of intra-uterine infection, fever during labour, vaginal blood loss, remifentanil use, induced labour, augmented labour, vaginal breech delivery, prolonged rupture of the membranes (>24 hours), gestational age over 41 weeks and second stage of labour.

The most frequent complications of FSE application mentioned by the respondents were (multiple choice and multiple answers could be

Table 1
Participant demographics.

Total (n = 510)	Midwives (n = 155)	Gynaecologist in training (n = 105)	Gynaecologist (n = 250)
Non-academic hospital	133 (86%)	66 (63%)	221 (88%)
Academic hospital	22 (14%)	39 (37%)	29 (12%)

Table 2
Responses of obstetrical care providers on use of fetal monitoring methods.

	Obstetrical care providers n (%)
Fetal scalp electrode (FSE)	
Is the FSE used in your hospital for fetal monitoring?* (N = 510)	
No	1 (0.2)
Yes, standard after rupture of membranes and technically possible.	126 (24.7)
Yes, standard after rupture of membranes and as soon as a patient is in active labour.	105 (20.6)
Yes, on indication	341 (66.9)
According to protocol, from which gestational age a FSE may be applied? (N = 487)	
I don't know	167 (34.3)
32 weeks	102 (20.9)
34 weeks	148 (30.4)
36 weeks	61 (12.5)
37 weeks	9 (1.8)
Do you ask for informed consent before placing a FSE? (N = 487)	
Yes	360 (73.9)
No	127 (26.1)
Do you discuss possible complications of FSE placement? (N = 487)	
Yes	137 (28.1)
No	350 (71.9)
Intra Uterine Pressure Catheter (IUPC)	
Is the IUPC used in your hospital? (N = 483)	
Yes	261 (54.0)
No	219 (45.3)
I don't know	3 (0.6)
Wireless CTG	
Is wireless CTG available in your hospital (N = 483)	
Yes	401 (83.0)
No	79 (16.4)
I don't know	3 (0.6)
Are patients allowed to take a bath or shower while using wireless CTG? (N = 401)	
Yes	390 (97.3)
No	6 (1.5)
I don't know	5 (1.2)
ST-analysis (STAN)	
Is STAN used in your hospital? (N = 481)	
Yes	122 (25.4)
No	357 (74.2)
I don't know	2 (0.4)
Fetal blood sampling (FBS)	
Is FBS used in your hospital? (N = 480)	
Yes	476 (99.2)
No	4 (0.8)
Is there a maximum number of FBS that may be performed during a delivery in your hospital (N = 474)	
Yes	29 (6.1)
No	390 (82.3)
I don't know	55 (11.6)
What is the maximum number of FBS that may be performed (N = 29)	
1	0 (0)
2	1 (3.4)
3	11 (37.9)
4	11 (37.9)
5	5 (17.2)
6	0 (0)
Unlimited	1 (3.4)
Is the interpretation of FBS based on lactate, pH or both? (N = 474)	
Lactate	43 (9.1)
pH	364 (76.8)
Both	61 (12.9)
I don't know	6 (1.3)
Fetal scalp stimulation	
Is fetal scalp stimulation used in your hospital to assess fetal condition? (N = 465)	
Yes	363 (78.7)
No	77 (16.7)
I don't know	21 (4.6)
Continuous CTG monitoring	
Do you think that continuous CTG monitoring should be performed during all deliveries? (N = 465)	
Yes	27 (5.8)
No	438 (94.2)
Non-invasive fetal monitoring	
Are you familiar with electrohysterography and fetal ECG in the form of non-invasive fetal monitoring (N = 465)	
Yes	175 (37.6)
No	290 (62.4)
Is this technique used in your hospital? (N = 460)	
Yes	13 (2.8)
No	442 (96.1)
I don't know	5 (1.1)
In how many years do you think this method will be introduced as standard care (N = 460)	
0–2 years	34 (7.4)
2–5 years	109 (23.7)
5–10 years	53 (11.5)
>10 years	9 (2.0)
Never	7 (1.5)
I don't know	248 (53.9)
What method of registration would you prefer, if the quality and reliability of registration would be equal? (N = 460)	
External registration	411 (89.3)
Internal registration	49 (10.7)

*Multiple answers could be selected and therefore total percentage is more than 100%.

selected): superficial wound (98 %), infection (64 %), hematoma (33 %), bleeding (33 %) and abscess (15 %). Rare complications (ulcer, neonatal sepsis, leakage of cerebrospinal fluid and *peri*-ocular damage) were mentioned by less than 5 % of the respondents.

Approximately half (54 %) of the respondents report the use of IUPC. Indications mentioned were (multiple choice and multiple answers could be selected): inadequate TOCO-registration (75 %), amnion infusion (25 %), suboptimal CTG (12 %) and abnormal CTG (9 %).

89 % of the respondents preferred external monitoring. Different reasons were mentioned: less invasive (64 %), prevention of complications of internal monitoring (34 %), more patient-friendly (19 %), lower cost (0.5 %) and easier application (0.5 %).

Eleven percent of the respondents preferred internal monitoring. Different reasons were mentioned: certainty of distinction between mother and fetus during registration (28 %), guarantee of registration quality (21 %), improved patient mobility (34 %) and ability to use STAN (14 %).

Discussion

This study aimed to evaluate the use and preferences of intrapartum fetal monitoring methods among secondary and tertiary obstetric care providers in the Netherlands. The respondents of our survey report an estimated use of FSE in median 71 % of deliveries. 54 % of respondents use IUPC in an estimated median 5 % of deliveries. The most common reason for application of FSE and IUPC is insufficient external monitoring (93 % and 75 % respectively).

Frequency of use of FSE and IUPC

To date the research regarding frequency of FSE and IUPC use is scarce. Three cohort studies including a total of 186.625 singleton

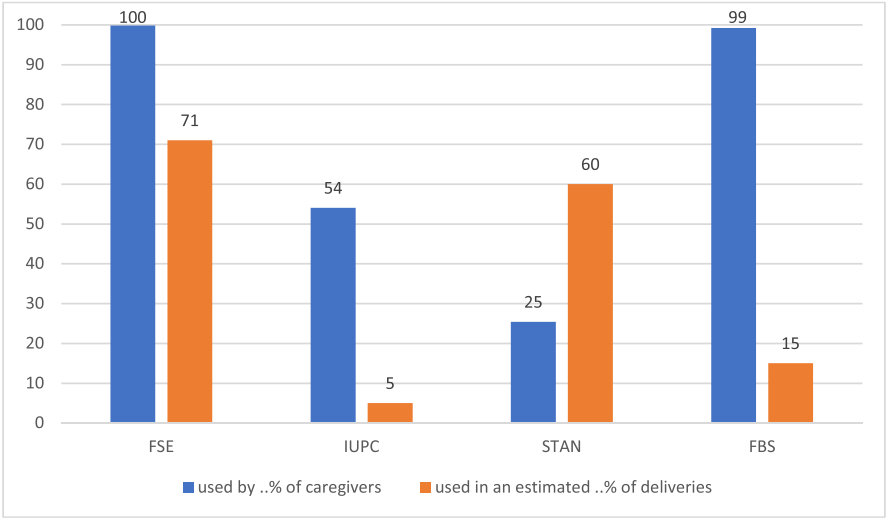

Fig. 1. Estimated use of internal monitoring methods. FSE median estimated use 71% (IQR 58–85%), IUPC median estimated use 5% (IQR 2–8%), STAN median estimated use 60% (IQR 30–72%) and FBS median estimated use 15% (IQR 10–23%).

Table 3
Estimated use of internal monitoring methods divided by function.

Estimated % of use	FSE Median (IQR)	IUPC Median (IQR)	STAN Median (IQR)	FBS Median (IQR)
All respondents	71 (58–85)	5 (2–8)	60 (30–72)	15 (10–23)
Midwives	75 (60–90)	5 (2–9)	54 (15–70)	10 (6–20)
Gynaecologist	71 (52–85)	5 (2–10)	60 (29–74)	15 (10–23)
Gynaecology residents	70 (50–80)	3 (2–5)	65 (50–76)	15 (10–25)

gestations, all conducted in the United States of America between 2002 and 2014, reported the incidence of use of internal monitoring [4,21,22]. Only FSE was used in 11–22 % of cases, only IUPC in 20–33 % of cases and both IUPC and FSE in 56–64 % of cases [4,21,22]. In these cohorts 37–56 % of women had a BMI > 30 [4,21,22].

Our respondents estimated the use of IUPC in 5 % of deliveries, which is a much lower frequency compared with the above mentioned studies [21,22]. Sporadic use of IUPC in our survey may be explained by the fact that the Dutch guideline on fetal monitoring discourages the routine use of IUPC since it does not improve clinical outcomes and increases the risk of complications [12]. On the contrary, our respondents estimated the use of FSE in 71 % of deliveries, which is a higher frequency compared to the above mentioned studies [4,21,22]. Both the American and Dutch guidelines on fetal monitoring do not provide a specific advice on method of registration of FHR [10,12]. The registration success of DU is negatively influenced by maternal obesity and the most common reason for use of FSE is insufficient external monitoring [1]. The worldwide increasing prevalence of obesity might have attributed to the high percentage of use of FSE in our more recent study.

Use of FSE in preterm labour

Most respondents in our survey (34 %) were not sure from which gestational age an FSE may be applied. One third of respondents applies FSE from 34 weeks of gestation and 21 % from 32 weeks of gestation. These different opinions can be explained by the differences between guidelines. The Dutch guideline does not specify from which gestational age the FSE may be applied [12]. The British and German guideline on fetal monitoring state that the minimum gestational age for application of the FSE is 34 weeks [7,11]. The FIGO guideline states that the minimum gestational age for application of the FSE is 32 weeks [2]. In order to provide more guidance to Dutch obstetric healthcare providers, we would advise to make recommendations on the minimum gestational age for application of the FSE in the Dutch guideline on fetal monitoring.

Complications of FSE and informed consent

The majority of our respondents (74 %) asks for informed consent before FSE application. However, only 28 % report discussing the possible complications for FSE application. National law in the Netherlands states that with informed consent, the complications that have a 1 % or higher chance of occurring must be discussed [23]. If a complication is known to be severe but has a less than 1 % chance of occurring, it must also be discussed [23]. The most common complications of the FSE are a superficial wound (incidence 41.6 %) and abscess formation (incidence 0.2–4.5 %) [3]. In a recent qualitative study women expressed concerns about the impact on FSE on their baby and described a lack of adequate information in relation to this [24]. We advise obstetric care providers to give patients information about potential risks and benefits of FSE to enable them to make an informed decision.

STAN

Only 25 % of obstetric care providers use STAN in their practice. This may be partly explained by the fact that STAN has been under debate due to contradictory results from *meta*-analyses [15–20]. Even though STAN does result in a reduced number of FBS and assisted vaginal deliveries, the Dutch guideline on fetal monitoring does not recommend routine use of STAN, since a positive effect on perinatal outcome and caesarean section rate has not been proven [15–20].

Non-invasive fetal monitoring with EHG and fECG

Non-invasive monitoring combining EHG with NI-fECG was known by 38 % of respondents. After an explanation about this method 31 % of respondents assumed that this would become standard care within the next 5 years. This non-invasive monitoring method seems promising as 89 % of respondents would prefer external monitoring over internal monitoring if reliable fetal heart rate and contraction registration was

guaranteed.

Previous studies have shown better performances by using non-invasive monitoring: higher sensitivity of EHG compared to TOCO (90 versus 65 %) and higher reliability of FHR monitoring with NI-fECG compared to DU (86–96 % versus 62–73 %) [1,25]. Furthermore, studies have shown that monitoring with NI-fECG and EHG is less influenced by maternal obesity and has a higher patient satisfaction compared with DU and TOCO [1]. Adequate registration of FHR and uterine contractions is essential for interpretation of CTG. Improved monitoring of contractions may be of clinical benefit since excessive uterine activity increases the risk of fetal acidemia and adverse fetal outcome [26,27].

Strengths and limitations

The strength of our study is that it represents a nationwide survey of secondary and tertiary obstetric care providers in the Netherlands. Furthermore, this is the first Dutch study that reports on the use of and preferences for intrapartum fetal monitoring methods. A limitation is the low response rate to the survey. However, all Dutch hospitals were represented. Even though the amount of respondents per function was unevenly distributed a subgroup analysis showed that there was no major difference in estimated use of internal monitoring methods between obstetric care providers in different functions (Table 3).

Furthermore, the inclusion of both multiple-choice as well as open-ended questions in the questionnaire enabled us to capture the opinions of individual obstetric care providers. However, a limitation of the format of the survey is that an in-depth evaluation of personal preferences and situational differences is not possible. Clinical practice is dependent on many factors and we realize that decisions are often more nuanced than can be reflected in a multiple-choice answer. Another limitation is that the data is self-reported instead of being collected through objective evaluation of hospital protocols and practice.

A more objective representation of the use of intrapartum fetal monitoring methods might be obtained in a prospective or register based study. Unfortunately, the Dutch Perinatal registry does not register specified data about which method is used for fetal heart rate and contraction registration. Furthermore, also on a local level the choice of fetal monitoring method and indication for invasive monitoring is often not registered in patient files. The goal of this study was to evaluate the subjective use of and preferences for fetal monitoring methods for intrapartum fetal monitoring on a national level to serve as a basis for further discussion about the use of long established and more newly introduced fetal monitoring techniques in clinical practice.

Conclusion

This national survey study shows that the FSE is currently the most used method for intrapartum FHR monitoring in secondary and tertiary obstetrical care in the Netherlands. Invasive internal monitors are used for optimal registration quality. However, obstetric care providers would prefer a non-invasive external registration method that provides reliable data. In the near future, this may be provided by NI-fECG and EHG.

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There was no sponsor that had involvement in the study design, collection, analysis, writing of the report or decision to submit the article for publication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

1. I give permission to use my answers for scientific research.
   a. Yes
   b. No
2. In what institution type do you work?
   a. Peripheral hospital
   b. Academic hospital
3. Choose your hospital from the list below:
   a. List of all hospitals in the Netherlands provided
4. What is your function?
   a. Midwive
   b. Midwive in training
   c. Physician assistant
   d. Physician assistant in training
   e. Gynaecologist
   f. Gynaecologist in training
5. Is the fetal scalp electrode used in your hospital for fetal monitoring? (multiple answers possible)
   a. No
   b. Yes, standard after rupture of membranes and technically possible
   c. Yes, standard after rupture of membranes and as soon as a patient is in active labour.
   d. Yes, on indication.
   e. Other: ….
6. If the fetal scalp electrode is only used on indication; for what indications is it used? (multiple answers possible)
   a. Meconium stained amniotic fluid
   b. Abnormal CTG
   c. Suboptimal CTG
   d. Inadequate (external) registration
   e. Fetal growth restriction
   f. Augmented labour (oxytocin infusion)
   g. Obesity (BMI > 30)
   h. Morbid obesity (BMI > 40)
   i. Vaginal blood loss
   j. Trial of labour after caesarean section
   k. Induction of labour (from amniotomy)
   l. Pushing phase
   m. Epidural analgesia
   n. Remifentanyl analgesia
   o. Fever during labour (temperature > 38.0 degrees Celsius)
   p. Suspicion of intra-uterine infection
   q. Approaching serotinity (gestational age > 41 + 0)
   r. Prolonged rupture of membranes (>24 h)
   s. First child of multiple gestation
   t. Breech presentation
   u. Other: ….
7. According to protocol, from which gestational age a fetal scalp electrode may be applied?
   a. I don't know
   b. 32 weeks
   c. 34 weeks
   d. 36 weeks
   e. 37 weeks
8. Do you ask for informed consent before placing a fetal scalp electrode?
   a. Yes
   b. No
9. Do you discuss possible complications of fetal scalp electrode placement?
   a. Yes
   b. No
10. If yes, which possible complications do you discuss? (multiple answers possible).

a. Superficial wound
b. Hematoma
c. Infection
d. Abscess formation
e. Haemorrhage
f. Ulcer formation
g. Neonatal sepsis
h. Perforation of dura with possible cerebrospinal fluid leak.
i. *Peri*-ocular damage
j. Necrotising fasciitis
k. Infection with herpes simplex virus
l. Meningitis
m. Other: …..

11. In what percentage of the deliveries in your hospital is a fetal scalp electrode used? Or what is your estimate?
    a. Certain percentage of use of fetal scalp electrode: 0–100 % (slider) or 'I don't know'
    b. Estimated percentage of use of fetal scalp electrode: 0–100 % (slider) or 'I don't know'
12. Is wireless CTG available in your hospital?
    a. Yes
    b. No
    c. I don't know
13. If yes, are patients allowed to take a bath or shower while using wireless CTG?
    a. Yes
    b. No
    c. I don't know
14. Is the intra-uterine pressure catheter used in your hospital?
    a. Yes
    b. No
    c. I don't know
15. If yes, for what indications is it used? (multiple answers possible)
    a. Amnion-infusion
    b. BMI > 30
    c. BMI > 40
    d. BMI > 50
    e. Inadequate external registration (TOCO)
    f. Suboptimal CTG
    g. Abnormal CTG
    h. Induction of labour
    i. Other: …..
16. In what percentage of the deliveries in your hospital is an intra-uterine pressure catheter used? Or what is your estimate?
    a. Certain percentage of use of intra-uterine pressure catheter: 0–100 % (slider) or 'I don't know'
    b. Estimated percentage of use of intra-uterine pressure catheter: 0–100 % (slider) or 'I don't know'
17. Is STAN (ST-analyse) used in your institution?
    a. Yes
    b. No
    c. I don't know
18. In what percentage of the deliveries in your hospital is STAN (ST-analysis) used? Or what is your estimate?
    a. Certain percentage of use of STAN (ST-analysis): 0–100 % (slider) or 'I don't know'
    b. Estimated percentage of use of STAN (ST-analysis): 0–100 % (slider) or 'I don't know'
19. Is fetal blood sampling used in your institution?
    a. Yes
    b. No
    c. I don't know
20. In what percentage of the deliveries in your hospital is fetal blood sampling used? Or what is your estimate?
    a. Certain percentage of use of fetal blood sampling: 0–100 % (slider) or 'I don't know'
    b. Estimated percentage of use of fetal blood sampling: 0–100 % (slider) or 'I don't know'
21. Is there a maximum number of fetal blood samplings that may be performed during a delivery in your hospital?
    a. Yes
    b. No
    c. I don't know
22. What is the maximum number of fetal blood samplings that may be performed?
    a. 1
    b. 2
    c. 3
    d. 4
    e. 5
    f. 6
    g. Unlimited
23. Is the interpretation of FBS based on lactate, pH or both?
    a. Lactate
    b. pH
    c. Both
    d. I don't know
24. Is fetal scalp stimulation used in your hospital to assess the fetal condition?
    a. Yes
    b. No
    c. I don't know
25. Do you think that continuous CTG monitoring should be performed during all deliveries (also low risk pregnancies)? Can you motivate your answer?
    a. Yes: (open text for clarification)
    b. No: (open text for clarification)
26. Are you familiar with electrohysterography and fetal ECG in the form of non-invasive fetal monitoring?
    a. Yes
    b. No

An electro hysterogram can be produced by placing a wireless, non-invasive electrode sticker on the abdomen of the pregnant women. The sticker measures the electrical activity of the contractions of the uterus. In this manner the frequency of contractions can be presented. With the same sticker a non-invasive fetal ECG can be produced. A combination of the electro hysterogram and fetal ECG (fetal heart rhythm) can be visualized in the form of a cardiotocogram (CTG). In the Máxima Medisch Centrum in Veldhoven the use of this new non-invasive method for fetal monitoring is being researched.

27. Is this technique used in your hospital?
    a. Yes
    b. No
    c. I don't know
28. In how many years do you think this method will be introduced as standard care?
    a. 0–2 years
    b. 2–5 years
    c. 5–10 years
    d. >10 years
    e. Never
    d. I don't know
29. What method of registration would you prefer, if the quality and reliability of registration would be equal?
    a. External registration
    b. Internal registration

References

[1] Lempersz C, Noben L, van Osta G, Wassen MLH, Meershoek BPJ, Bakker P, et al. Intrapartum non-invasive electrophysiological monitoring: A prospective observational study. Acta Obstet Gynecol Scand 2020;99(10):1387–95.

[2] Ayres-de-Campos D, Spong CY, Chandraharan E. FIGO consensus guidelines on intrapartum fetal monitoring: Cardiotocography. Int J Gynaecol Obstet 2015;131 (1):13–24.

[3] de Groot PF, Mol BWJ, Onland W. Complications of fetal scalp electrode placement: a case report, literature review and summary of case reports. null 2013; 8(2):113–20.

[4] Kawakita T, Reddy UM, Landy HJ, Iqbal SN, Huang C-C, Grantz KL. Neonatal complications associated with use of fetal scalp electrode: a retrospective study. BJOG 2016;123(11):1797–803.

[5] Fick T, Woerdeman PA. Neonatal brain abscess development following fetal scalp electrode placement: a rare complication. Childs Nerv Syst 2022;38(1):199–202.

[6] Wilmink FA, Wilms FF, Heydanus R, Mol BWJ, Papatsonis DNM. Fetal complications after placement of an intrauterine pressure catheter: A report of two cases and review of the literature. J Maternal Fetal Neonatal Med 2008;21(12): 880–3.

[7] German Society of Gynecology and Obstetrics, (DGGG), Maternal Fetal Medicine Study Group, (AGMFM), German Society of Prenatal Medicine and Obstetrics, (DGPGM), German Society of Perinatal Medicine, (DGPM). S1-Guideline on the Use of CTG During Pregnancy and Labor: Long version - AWMF Registry No. 015/036. Geburtshilfe Frauenheilkd. 2014 -08;74(8):721-32.

[8] Dore S, Ehman WN. 396-Fetal Health Surveillance: Intrapartum Consensus Guideline. J Obstet Gynaecol Can 2020–03;42(3):316,348.e9..

[9] RANZCOG Clinical Guideline - Intrapartum Fetal Surveillance [Internet].; 2019 [updated 15 November; cited 15 November 2021]. Available from: https://ranzcog.edu.au/RANZCOG_SITE/media/RANZCOG-MEDIA/Women%27s%20Health/Statement%20and%20guidelines/Clinical-Obstetrics/IFS-Guideline-4thEdition-2019.pdf?ext=.pdf.

[10] ACOG Practice Bulletin No. 106: Intrapartum fetal heart rate monitoring: nomenclature, interpretation, and general management principles. Obstet Gynecol. 2009 -07;114(1):192-202.

[11] NICE Pathways - Fetal monitoring during labour [Internet].; 2021 [updated 19 August; cited 15 November 2021]. Available from: http://pathways.nice.org.uk/pathways/intrapartum-care.

[12] NVOG Richtlijn Intrapartum Foetale bewaking a terme [Internet].; 2015 [updated May; cited 15 November 2021]. Available from: https://www.nvog.nl/wp-content/uploads/2018/02/Foetale-bewaking-3.0-14-11-2013.pdf.

[13] Jørgensen JS, Weber T. Fetal scalp blood sampling in labor – a review. Acta Obstet Gynecol Scand 2014;93(6):548–55.

[14] Westerhuis MEMH, Porath MM, Becker JH, Van den akker ESA, Van beek ERIK, Van dessel HJHM, et al. Identification of cases with adverse neonatal outcome monitored by cardiotocography versus ST analysis: secondary analysis of a randomized trial. Acta Obstet Gynecol Scand 2012;91(7):830–7.

[15] Olofsson P, Ayres-de-Campos D, Kessler J, Tendal B, Yli BM, Devoe L. A critical appraisal of the evidence for using cardiotocography plus ECG ST interval analysis for fetal surveillance in labor. Part II: the meta-analyses. Acta Obstet Gynecol Scand 2014–06;93(6):571–88..

[16] Schuit E, Amer-Wahlin I, Ojala K, Vayssière C, Westerhuis, Michelle E. M. H., Maršál K, et al. Effectiveness of electronic fetal monitoring with additional ST analysis in vertex singleton pregnancies at >36 weeks of gestation: an individual participant data metaanalysis. Am J Obstet Gynecol. 2013 -03;208(3):187.e1,187.e13.

[17] Salmelin ANETTE, Wiklund INGELA, Bottinga ROGER, Brorsson BENGT, Ekmanordeberg GUNVOR, Grimfors EE, et al. Fetal monitoring with computerized ST analysis during labor: a systematic review and meta-analysis. Acta Obstet Gynecol Scand 2013;92(1):28–39.

[18] Potti S, Berghella V. ST waveform analysis versus cardiotocography alone for intrapartum fetal monitoring: a meta-analysis of randomized trials. Am J Perinatol 2012;29(08):657–64.

[19] Becker JH, Bax L, Amer-Wåhlin I, Ojala K, Vayssière C, Westerhuis MEMH, et al. ST analysis of the fetal electrocardiogram in intrapartum fetal monitoring: a meta-analysis. Obstet Gynecol 2012;119(1):145–54.

[20] Neilson JP. Fetal electrocardiogram (ECG) for fetal monitoring during labour. Cochrane Database Syst Rev. 2012 -04-18(4):CD000116.

[21] Frolova AI, Stout MJ, Carter EB, Macones GA, Cahill AG, Raghuraman N. Internal fetal and uterine monitoring in obese patients and maternal obstetrical outcomes. Am J Obstet Gynecol MFM 2021;3(1):100282.

[22] Harper LM, Shanks AL, Tuuli MG, Roehl KA, Cahill AG. The risks and benefits of internal monitors in laboring patients. American Journal of Obstetrics & Gynecology. 2013 /07/01;209(1):38.e1,38.e6.

[23] KNMG - Informed Consent. [Internet].; 2001 [cited 15 November 2021]. Available from: https://www.nvpc.nl/uploads/stand/63Richtlijn%20Informed%20Consent.pdf.

[24] Benton M, Salter A, Simpson B, Wilkinson C, Turnbull D. A qualitative study of a sample of women participating in an Australian randomised controlled trial of intrapartum fetal surveillance. Midwifery 2020;83:102655.

[25] Vullings R, van Laar, Judith O. E. H. Non-invasive Fetal Electrocardiography for Intrapartum Cardiotocography. Front Pediatr. 2020;8:599049.

[26] Bakker PCAM, van Geijn HP. Uterine activity: implications for the condition of the fetus. J Perinat Med 2008;36(1):30–7.

[27] Frenken MWE, van der Woude DAA, Dieleman JP, Oei SG, van Laar JOEH. The association between uterine contraction frequency and fetal scalp pH in women with suspicious or pathological fetal heart rate tracings: A retrospective study. Eur J Obstet Gynecol Reprod Biol 2022;271:1–6.

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