

Knowledge, attitude and practices of obstetric care providers towards maternal red-blood-cell immunization during pregnancy

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Vox Sanguinis

Background and objectives A successful routine RBC alloantibody screening programme should not lead to unnecessary emotional burden during pregnancy due to inadequate counselling on the risk of severe haemolytic disease of the foetus and the newborn (HDFN). Rareness of this disease may result in insufficient knowledge and subsequent inadequate information transfer to women, diagnosed with RBC antibodies. We investigated the current knowledge, views and experiences of Dutch obstetric care providers regarding RBC alloimmunization during pregnancy.

Materials and methods We performed a quantitative cross-sectional study, using a structured digital questionnaire to measure knowledge, attitude and practices (KAP) regarding maternal RBC alloimmunization among Dutch obstetric care providers in 2016.

Results About 10% of obstetric care providers completed the questionnaire. A sufficient level of knowledge was found in 7% of all participants (N = 329). Knowledge about RhD immunisation and prophylaxis was sufficient in 60% of the responders. Knowledge gaps were found concerning the relevance of non-RhD RBC antibodies, the indications for giving extra RhD prophylaxis and the interpretation of laboratory test results. Healthcare providers estimated their own level of knowledge 'sufficient' (primary/secondary care) to 'good' (tertiary care), and all participants considered their professional role important within the screening programme.

Conclusion Dutch obstetric care providers showed a lack of knowledge regarding maternal RBC immunization. Awareness of the lack of knowledge is necessary to help obstetric care providers to be careful in giving information and even to decide to contact the expert centre before counselling the patient.

Key words: blood groups, haemolytic disease of the foetus and newborn, quality management, RBC antigens and antibodies.

Received: 3 September 2019,
revised 2 December 2019,
accepted 9 December 2019,
published online 29 December 2019

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Introduction

Haemolytic disease of the foetus and newborn (HDFN) is still a known cause of pregnancy complications. HDFN is caused by red-blood-cell (RBC) antibodies developed by the mother and transferred to the foetus [1–3]. Untreated HDFN may result in progressive fetal anaemia, hydrops,

neonatal icterus and even death [4,5]. Antibodies causing severe HDFN are mostly of the anti-Rh(D) type and less frequent of the anti-Kell (anti-K1) or anti-Rh(c) type. Severe HDFN is rarely caused by other Rh antibodies and only very rarely by non-Rh antibodies (Duffy, Kidd, or S) [3,6].

Preventive measures such as prenatal and postnatal RhD immunoglobulin prophylaxis, matched blood transfusions for Rh and K antigens to women of fertile age (<45 years) and routine prenatal screening for RBC antibodies, together with improvements in monitoring and therapeutic possibilities, have substantially reduced the risk on maternal alloimmunization and improved outcome of HDFN over the past decades [3,7–10].

Obstetric care providers nowadays only see a few immunized pregnant women during their career, due to the success of the maternal red-blood-cell alloimmunization prevention programme. This might result in insufficient knowledge, inadequate information transfer and substandard care to women who are diagnosed with RBC antibodies. In the Netherlands, approximately 180 000 pregnant women are year are entering the screening programme. Thanks to a well-organized obstetrical network with multiple safety nets during the process, the coverage of the national prevention programme is almost 100% [11]. The reference laboratories (Sanquin Diagnostics and BIBO Groningen) and the national expert centre for the management of alloimmunization in pregnancy (Leiden University Medical Center, LUMC) are at any time available for advising and consultation on the rare occasion of RBC alloimmunization.

Pregnancies complicated by the presence of maternal RBC antibodies are monitored by laboratory measurements, consisting of maternal serum testing for antibody levels (quantification of titre) and, in the Netherlands, the antibody-dependent cell-mediated cytotoxicity (ADCC) test [12,13]. If laboratory findings indicate that a pregnancy is at risk for development of HDFN, frequent monitoring is started with ultrasound and Doppler middle cerebral artery (MCA) peak systolic velocity (PSV) measurements, to reliably predict fetal anaemia [14,15]. If severe fetal anaemia develops, treatment with intrauterine transfusions (IUT) is started and/or preterm delivery is induced, usually followed by neonatal phototherapy and/or (exchange) transfusions [16,17].

A Dutch questionnaire survey in 2004, including 233 pregnant women with and without RBC alloimmunization, showed that women were moderately satisfied with the quantity and comprehensibility of information provided by their obstetric care provider [18]. Fifty to 70% of the women, particularly those with RBC antibodies, indicated that they needed more information, preferable orally, about the consequences of the RBC alloantibodies

for their child. Supportive written information (e.g. folders/hand-outs) was lacking, both prenatally and postnatally.

A more recent survey from the UK, performed in the London area, including 270 RhD-negative women, showed that their knowledge about the consequences of screening for RhD antibodies was limited; 30% of respondents needed more information, in particular via folders or diagrams and through midwives [19]. The authors concluded that midwives needed training on this topic. Wee *et al.* performed a study on knowledge and practices of RhD prophylaxis among gynaecologists, residents and obstetric care workers in Singapore. Only 49% appeared to have an adequate level of knowledge on this topic [20].

In the Netherlands, after adapting the national screening programme in 2011, training and e-learning were developed and offered. However, it is yet unclear what these refresher courses have brought. More insight in the current knowledge of Dutch obstetric care providers on this topic is needed, to identify gaps in knowledge and to develop strategies to meet these gaps.

The aim of this research was to investigate the current knowledge, views and experiences of Dutch obstetric care providers regarding RBC alloimmunization during pregnancy.

Methods

Aim/objectives

The aim of the present study was to measure knowledge, attitude and practices (KAP) regarding maternal RBC alloimmunization among Dutch obstetric care providers. More specifically, the objectives of this KAP study were as follows:

- (1) to investigate the knowledge of Dutch obstetric care providers about the prevention (strategies) and detection of RBC alloantibodies and identification and treatment of HDFN;
- (2) to explore the attitude of Dutch obstetric care providers towards the maternal RBC alloimmunization prevention programme.
- (3) to examine the practices of Dutch obstetric care providers in participating in the care for pregnant women with RBC alloimmunization and (risk for) HDFN.

Design

We designed a quantitative cross-sectional study design, using a structured digital questionnaire. The questionnaire was conducted in 2016.

Research population

Participants were midwives, obstetricians and general practitioners specialized in obstetrics. In the Netherlands, obstetric care providers are working in three echelons. The first echelon, primary care, is provided by midwives and general practitioners, working independently in home practices. The second echelon, secondary care, is the regional hospital and the third echelon, tertiary care, is the university hospital (with neonatal intensive care unit availability); in these latter two echelons, the obstetric care is provided by midwives and gynaecologists. Participants were invited through a personal mail or mass mail.

Questionnaire

The questionnaire was developed by a medical student (CW), being supervised by a PhD student/midwife (YS) and a PhD/midwife (JK). To reduce the influence of the knowledge questions on the attitude and practice questions, we first posed the attitude and practical questions. No validated questionnaire was available. We were advised by an expert on questionnaires of the department of Medical Decision Making of the LUMC and by an expert of the education and training Directorate of the LUMC. Additionally, we compared questionnaires with [21–23]. Knowledge of the care providers was examined using vignettes, whereby the respondents had to apply their available knowledge [24]. An expert panel (including obstetricians specialized in fetal therapy, midwives and a laboratory specialist) reviewed the items on content and face validity. Finally, we used a checklist designed by the Dutch Interfaculty Center for Teacher Training, Educational Development and Training (ICLON) (Leiden University).

Measurements

Professional background

Questions about professional background, such as ‘In which echelon are you working (primary, secondary, tertiary care)?’, year of graduation, work experience (years), prior experienced a pregnancy complicated with maternal RBC alloimmunization (yes/no), prior experienced a foetus or newborn with haemolytic disease (yes/no), number of deliveries of practice/hospital, latest e-learning (2011, provided by the Dutch National Institute for Public Health and the Environment) done (yes/no) and latest training on this topic (year). The variable ‘year of graduation’ was categorized as follows: ≤ 1998 , 1999–2011 and > 2011 . These time sets were based on the introduction the routine first trimester screening in 1998, the introduction of the foetal RhD typing and third trimester screening of Rhc-negative pregnant women in 2011.

Knowledge

To test the knowledge about maternal RBC alloimmunization, we used vignettes, case descriptions with questions like ‘What information do you give your patient?’ ‘What is the right policy in this case?’ etc. There were seven vignettes, the domains were as follows: screening and prevention of RhD immunization (two questions), Rhc immunization (two questions), K immunization (two questions), risk factors for RhD immunization and indications for extra RhD immunoglobulin prophylaxis (four questions primary caregivers, five questions secondary and tertiary caregivers), laboratory testing for monitoring alloimmunized pregnant women (four questions), monitoring and treatment of pregnancy with an increased risk of HDFN (only secondary and tertiary care, two questions), follow-up of neonate with or without increased risk for hyperbilirubinaemia (two questions). In total, there were 16 questions to be answered by the primary caregivers and 19 questions for the secondary and tertiary caregivers.

The attitude part consisted of 13 items. *The attitude towards professional role* consisted four items: the participants indicated the importance of their own role in the whole process of screening, diagnosis and treatment of maternal alloimmunization and HDFN. They indicated if they have enough time per patient to well inform them, if they find it their job to well inform them and if they feel that this improves the level of care. *The attitude towards competences* consisted five items: participants rated their competences in providing information on the several fragments of this topic and their competences to accompany pregnant women with RBC antibodies and/risk of HDFN. *The attitude towards self-assessment of level of knowledge* consisted four items: The participants assessed their own level of knowledge and their satisfaction with it. All items were measured at a five-point Likert scale (1–5, Completely agree-strongly disagree).

The practices part contained five items in which the participants valued the necessity, importance and intention to improve their knowledge and to attend a training. Furthermore, the participants were asked to indicate how often they provide information about the purpose and possible outcomes of the screening programme, just before the blood test was taken. All items were measured at a five-point Likert scale (1–5, good-poor or completely agree-strongly disagree or always never).

Data collection

The questionnaire was made with NetQ version 2014.Q3. The questionnaire was spread in July 2016 and after two reminders, closed for analysis. Data analysis was done in SPSS version 23 (SPSS, Inc.).

Data analysis

On the knowledge questions, the maximum score for primary care was 16 points and for the secondary and tertiary care 19 points. Following the study of Wee *et al.* and after discussion with the expert panel, it was decided that a score of 80% is considered to be a sufficient level of knowledge.

Dichotomous outcomes were described as numbers and percentages, normally distributed continuous variables were described as means and standard deviations, and non-normally distributed continuous variables as median and range. Differences between primary, secondary and tertiary care were tested univariably. All variables with a *P*-value less than 0.20 were included in a multivariable logistic regression analysis to assess the association between those variables and the level of knowledge. We intended to add variables with a significant (*P* < 0.05) association in a regression analysis in a prediction model that predicted level of knowledge of alloimmunization.

Ethical considerations

Approval of the Medical Advisory Council of the LUMC was not necessary according to the rules published by the Central Committee on Research involving Human Subjects (<http://www.ccmo.nl/nl/niet-wmo-onderzoek>). The study was approved by the Science Commission of the Department of Obstetrics.

Results

Response

A total of 402 obstetric healthcare providers opened the link to the questionnaire, 359 of which filled in the attitude/practices part completely and 329 completed the questionnaire (Fig. 1).

On 1 January 2016, approximately 3321 midwives were active, of them 8.2% (272/3321) filled in at least the attitude/practices part of the questionnaire. Of 66 registered general practitioners specialized in obstetrics, 12.1% filled in at least the attitude/practices part of the questionnaire (ref registration CHBB). In 2009, 842 actively practicing gynaecologists were registered, more recent data are not available, of whom 8.2% filled in the questionnaire at least partly (<https://nvl004.nivel.nl/nivel-2015/sites/default/files/bestanden/Rapport-de-arbeidsmarkt-voor-gynaecologen-in-Nederland.pdf>).

Background variables

Table 1 shows the background variables of the obstetric healthcare providers who filled in the questionnaire

completely (*n* = 329). From all participants, 54% graduated between 1999 and 2011. Most had less than 20 years of work experience. The average number of births supervised annually per clinic/practice was between 250 and 500 in the home practices (primary care); in secondary care, 54% of obstetric care providers attended 1000–2000 births annually and 35% more than 2000 births/year. In tertiary care, 59% of the care providers had supervised between 1000 and 2000 births/year. The chance of experiencing a case of maternal alloimmunization or of HDFN increased from primary to secondary care. Forty-two per cent of participants followed a training in RBC alloimmunization and prevention less than five years ago, 25% between 5–10 years ago or longer than 10 years ago. One fifth of obstetric healthcare providers did not know if or when the last training on this topic was attended. The 2011 e-learning was completed by 32% of all participants.

Knowledge

Table 2 shows the number of correct answers per question of primary, secondary and tertiary caregivers. The questions on the indications for RhD prophylaxis administered in pregnancy were correctly answered by 95% of primary care participants, compared with 15% and 6%, respectively, of the secondary and tertiary care participants. The question about the indication and quantity of RhD prophylaxis after caesarean section was significantly better answered by secondary and tertiary caregivers. The knowledge about indication for RhD prophylaxis in case of a spontaneous abortion (72%) as well the indication of RhD prophylaxis in case of an abortion with curettage was less frequently correctly answered by participants in primary care (43%). The indication for RhD prophylaxis in case of fetal demise was poorly answered; this question was only submitted to secondary and tertiary caregivers. The knowledge score of screening of RhD- and Rhc-negative women was over 80%, hence sufficient, in all echelons, but the purpose of the third trimester screening of Rhc negatives appeared to be often unclear. Less than 20% of all participants gave the correct answers to the question about purpose and policy in case of K immunization. In general, questions about laboratory monitoring were moderately to poorly answered. The score for questions about detection of HDFN prenatally or postnatally was in general sufficient. Only tertiary care participants had some difficulties with correctly answering a question about unexpected hyperbilirubinemia.

Level of total knowledge of participants

Table 3 shows how many participants from primary, secondary and tertiary care achieved a sufficient score on

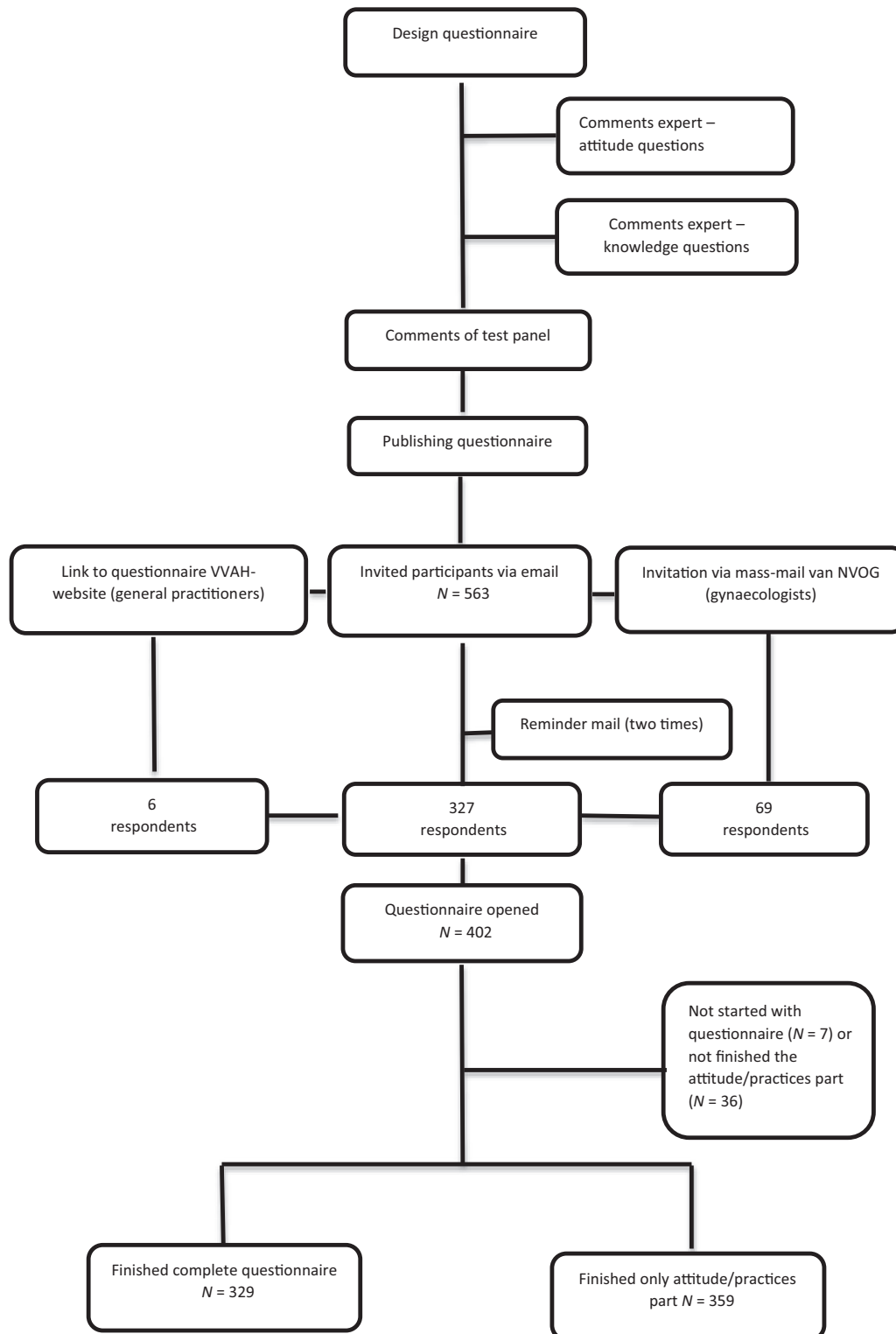


Fig. 1 Flowcharts of study design, distribution of the questionnaire and overview of the responders.

the test (defined as 13, respectively, 15 correctly answered questions in primary and secondary/tertiary care). Only 7% of all participants achieved a sufficient score. No

significant differences between the echelons were measured (Table S1). None of the background variables showed an association with the total test result with a *P*-

Table 1 Background variables of participants divided into three echelons: primary, secondary and tertiary care

	Primary care <i>n</i> = 252 <i>n</i> (%)	Secondary care <i>n</i> = 60 <i>n</i> (%)	Tertiary care <i>n</i> = 17 <i>n</i> (%)
Profession			
Midwife	246 (98)	7 (12)	1 (6)
General practitioner	6 (2)	0	0
Gynaecologist	0	53 (88)	16 (94)
Graduation year			
Until 1998	66 (26)	12 (20.0)	2 (12)
1999–2011	144 (57)	27 (45)	8 (47)
>2011	42 (17)	21 (35)	7 (41)
Work experience			
0–10 year(s)	116 (46)	22 (37)	2 (12)
11–20 years	89 (35)	23 (38)	11 (65)
21–30 years	33 (13)	15 (25)	3 (18)
31–50 years	14 (6)	0	1 (6)
Average number of births attended			
<250	130 (52)	0	0
251–500	105 (42)	0	0
501–750	13 (5)	1 (2)	0
751–1000	2 (1)	2 (3)	0
1001–1500	2 (1)	3 (5)	10 (59)
1501–2000	0	20 (33)	3 (18)
>2000	0	13 (22)	4 (24)
Experienced a foetus or newborn with haemolytic disease?			
Yes	53 (21)	21 (35)	15 (88)
Experienced a pregnancy complicated with RBC antibodies?			
Yes	171 (68)	44 (73)	17 (100)
Last training about alloimmunized pregnant women			
<5 years ago	102 (41)	56 (93)	12 (71)
5–10 years ago	45 (18)	24 (40)	2 (12)
>10 years ago	18 (7)	12 (20)	2 (12)
Unknown	87 (35)	3 (5)	1 (6)
Latest (2011) followed e-learning provided by the RIVM^a?			
Yes	92 (37)	21 (35)	5 (29)
No	113 (45)	10 (17)	11 (65)
Unknown	47 (19)	34 (57)	1 (6)

^aRIVM National Institute Public Health and Environment: E-learning - Prenatal screening infectious diseases and erythrocyte antibodies. The Hague, the Netherlands, 2014. <https://www.rivm.nl/bloedonderzoek-zwangersen/voor-professionals/bijscholing/e-learning-psie>

value < 0.20 (Table S2). When the cut-off was lowered from 80% to 60% or 70%, 35%, respectively, 21% of all participants had a sufficient score.

Attitude and practices

Table 4 shows the median scores on self-assessed attitude and practices per question per echelon (*N* = 359). For several domains a Cronbach's alpha was calculated, showing that only the domain 'Attitude to competences' turned

out to be 0.84, while the other domains were between 0.24 and 0.49 (respectively 'practices' and 'knowledge').

The tertiary healthcare providers estimated their own level of knowledge significantly higher (median score 'good') than primary care and secondary care (median score 'sufficient'). The tertiary care participants were more satisfied with their own level of knowledge and found it less necessary to participate in trainings than participants of primary and secondary care. The tertiary care participants considered their role within the screening programme and treatment of RBC immunization and HDFN less important. The primary care participants considered themselves less capable in the care of pregnant women with RBC alloimmunization without signs of fetal anaemia. All participants considered it their task to well inform pregnant women about the prevention programme. The opinion about time available to well inform pregnant women about the prevention programme was significantly different between echelons, varying from surely enough time (tertiary care) to neutral (secondary care).

Primary care providers felt themselves significantly less competent (median score 'partly agree' vs. 'completely agree') in providing information about the development of RBC antibodies during pregnancy and in explaining the blood test results to women with newly identified RBC antibodies, as well as on possible risk of HDFN. The secondary care providers explained significantly less frequent to the patient (median score 'often' vs 'always') that the routine first trimester screening includes the ABO blood group, Rhesus-D antigen typing and presence of RBC antibodies.

Discussion

In this nationwide study with 329 participants, only 7% of obstetric care providers appeared to have sufficient knowledge of all aspects of maternal RBC alloimmunization, needed to provide sufficient support and counselling during pregnancy. The participants of the tertiary care were more satisfied with their own knowledge on the subject than the participants of primary and secondary care and also judged it to be less necessary to follow an additional in-service training on management of maternal RBC alloimmunization. All echelons considered themselves important within the process of detection and treatment of RBC alloimmunization and HDFN.

Strength and weaknesses

For each professional group, the response was approximately 10% of the total number of active care providers. The response may have been negatively influenced by the

Table 2 Correctly answered questions by participants of primary, secondary or tertiary care

Question Correct	Primary care	Secondary care	Tertiary care	P-value*
	n = 252 n (%)	n = 60 n (%)	n = 17 n (%)	
1a Screening policy RhD negatives	244 (97)	60 (100)	17 (100)	0.286
1b Antenatal RhD prophylaxis	231 (96)	9 (15)	1 (6)	<0.001
1c RhD prophylaxis policy caesarean	16 (6)	35 (58)	11 (65)	<0.001
1d RhD prophylaxis policy abortion (9 weeks)	229 (91)	53 (88)	14 (82)	0.473
1e RhD prophylaxis policy abortion (12 weeks)	181 (72)	57 (95)	15 (88)	<0.001
1f RhD prophylaxis policy abortion + curettage (12 weeks)	109 (43)	56 (93)	16 (94)	<0.001
2a Screening policy Rhc negatives	252 (100)	60 (100)	17 (100)	-
2b Purpose third trimester screening Rhc negatives	52 (21)	18 (30)	4 (24)	0.294
3a Screening policy K immunization	48 (19)	6 (10)	3 (18)	0.250
3b Follow-up K immunization	22 (9)	11 (18)	3 (18)	0.067
4a RhD prophylaxis policy fetal demise	-	34 (57)	8 (47)	0.483
5a Risk HDFN ADCC test 10%/ titre 1:8	74 (29)	27 (45)	8 (47)	0.031
5b Policy ADCC test 10%/ titre 1:8	106 (42)	8 (13)	2 (12)	<0.001
5c Risk HDFN ADCC test 35%/ titre 1:16	78 (31)	23 (38)	12 (71)	0.003
5d Policy ADCC test 35%/ titre 1:16	168 (67)	34 (57)	14 (83)	0.113
5e Doppler monitoring to detect fetal anaemia	-	57 (95)	16 (94)	<0.001
5f Frequency of doppler monitoring	-	48 (80)	15 (88)	<0.001
6a follow-up neonate with negative RBC screening	239 (95)	53 (88)	16 (94)	0.179
7a Cause hyperbilirubinaemia neonate and negative third trimester screening	198 (79)	42 (70)	9 (53)	0.031

*Comparing primary, secondary and tertiary care (or secondary and tertiary care when restricted question); Pearson's chi-square test, Fisher's exact with expected value < 5 in 1 or more cells.

Table 3 Total test result of participants shown as sufficient with cut-off at 80% correctly answered questions

	Sufficient	
	N	%
Primary care	19	7.5%
Secondary care	3	5.0%
Tertiary care	1	5.9%
P-value*	0.843	

*Comparing primary, secondary and tertiary care; Pearson's chi-square test, Fisher's Exact with expected value < 5 in 1 of more cells.

length of the questionnaire and by sending it around in the summer period. In our opinion, this relatively low response is sufficient to at least have an impression of the level of knowledge. However, selective response of care providers who have an affinity with the subject may have resulted in an overestimation of the level of knowledge and a too optimistic assessment of the attitude.

Previous findings and interpretation

Our estimation was that at least half of the obstetric care providers should have sufficient knowledge about RBC alloimmunization, defined as answering 80% of all

questions correctly [20]. This cut-off value was also used in a study from Singapore, exploring the knowledge about RhD immunization and prophylaxis. Our study included questions on all aspects of the screening programme, whereas the Singapore study focused on prevention of RhD immunization. Also in our study, 60% of the questions about RhD screening and prophylaxis were correctly answered. The knowledge gaps we found concerned mainly aspects of non-RhD RBC antibodies, the indications for administering extra RhIg and the interpretation of ADCC and antibody titre results. This probably does not mean that mistakes are made in the care for pregnant women with RBC alloimmunization [3,7,16,25]. A lack of active knowledge may be explained by the fact that the care provider receives necessary information about the follow-up policy and if necessary advice to consult the expert centre at LUMC, via the laboratory report from the reference laboratories. The finding that obstetric care providers are often not aware of their own low level of knowledge is not only remarkable but also worrisome, as self-knowledge and introspection are essential to warrant an adequate level of care. Presumably, lack of knowledge has consequences for the adequate counselling and understanding of this complex matter by patients. It therefore may explain the moderate satisfaction of pregnant women with the content and comprehensibility of

Table 4 Overview of median scores on the attitude and practices questions divided in primary, secondary and tertiary care

	Primary care (<i>n</i> = 270) Median (P25–P75)	Secondary care (<i>n</i> = 70) Median (P25–P75)	Tertiary care (<i>n</i> = 19) Median (P25–P75)	<i>P</i> -value*
Attitude towards professional role				
I am important within the trajectory of detection and treatment of RBC alloimmunization and HDFN	1 (1–2)	2 (1–2)	2 (1–2)	<0.001
It is my job to well inform the pregnant women about the goal of the RBC screening	1 (1–1)	1 (1–1)	1 (1–1.75)	0.322
Providing information about the prevention programme alloimmunization improves the level of care	1 (1–2)	1 (1–2)	1 (1–2)	0.694
The time per pregnant women is sufficient to well inform the pregnant women about the goal of the RBC screening programme	2 (1–4)	3 (2–4)	1.5 (1–3.75)	0.011
Attitude towards competences				
I am competent in explaining the meaning of the titre and ADCC result to pregnant women with RBC antibodies	2 (2–3)	1 (1–2)	1 (1–1.75)	<0.001
I am competent to accompany a pregnant woman with RBC antibodies without any signs of haemolytic disease of the foetus	2 (1–3)	1 (1–1)	1 (1–1)	<0.001
I am competent to provide information about alloimmunization during pregnancy	2 (1–2)	1 (1–2)	1 (1–1.75)	0.003
I am competent in explaining the blood test result to pregnant women for whom RBC antibodies have been found	2 (1–2)	1 (1–1.5)	1 (1–1)	<0.001
I feel competent to provide information about the possible risk of haemolytic disease due to RBC antibodies during pregnancy	2 (1–2)	1 (1–2)	1 (1–1.75)	<0.001
Attitude towards self-assessment of level of knowledge				
My knowledge about alloimmunization is: ^a	3 (3–3)	3 (2–3)	2 (1–3)	<0.001
It is necessary to extent my knowledge about alloimmunization	2 (2–3)	2 (2–3)	4 (2.25–5)	0.027
My plan is to extent my knowledge about alloimmunization	2 (2–3)	2 (2–3)	4 (3–5)	0.126
I'm satisfied with my level of knowledge	3 (2–3)	3 (1–3)	2 (1–2)	0.044
Practices followed courses, actual information provided and intention or need for training				
I would attend a training/course on providing information	2 (1–2.25)	2 (1–2.5)	2.5 (2–3)	0.007
I find it important to follow a training/course about RBC alloimmunization	2 (1–2)	1 (1–3)	2 (1.25–3)	0.363
Attending the e-learning about prevention and detection of RBC alloimmunization was useful/relevant ^b (primary care <i>n</i> = 149, secondary care <i>n</i> = 17, tertiary care <i>n</i> = 8)	1 (1–2)	1 (1–2)	1 (1–1)	0.207
Before the first trimester screening I explain that the blood test contains the ABO and RhD blood group and RBC antibodies ^c	1 (1–1)	2 (1–3)	1 (1–2)	<0.001
Before the first trimester screening I explain the possible test results and the risk of RBC antibodies during pregnancy ^c	3.5 (3–4)	4 (3–4.5)	3 (2–4.75)	0.329

1 = Completely agree, 2 = partly agree, 3 = neutral, 4 = partly disagree, 5 = strongly disagree.

^a1 = very good, 2 = good, 3 = sufficient, 4 = insufficient, 5 = poor.

^bRespondents who did not follow the e-learning were excluded.

^c1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never.

*Differences between primary, secondary and tertiary care were tested using Kruskal–Wallis test.

information they receive on this condition, as we previously showed [18]. Poorly provided information after detection of RBC antibodies or during follow-up can influence the emotional pregnancy experience of women. From the evaluation of similar situations, like informing parents about a positive test result for any of the diseases

tested during the newborn screening, Moody *et al* (2017) advised to arrange direct face-to-face contact between the specialist team and the family, continued support and the availability of accessible condition specific information. Various studies about parents' recommendations how to inform them about a positive newborn screening

result suggest that it is important to offer realistic reassurance and hope, to address and support parents through the moments of anxiety and to keep the content simple, clear and actionable [26–29].

In our study, the obstetric care providers considered it important to provide information about the national screening programme and also found their own professional role important within the process of detection and treatment of RBC alloimmunization and HDFN. This positive attitude can form the basis to fill the knowledge gaps by a targeted e-learning based training or by up-to-date information on the web. Awareness of giving the patient news that can cause anxiety already helps to respond more adequately on emotions and socio-psychological aspects of the message, thus diminishing stress and anxiety in the pregnant woman [30].

Conclusion

Awareness of the lack of knowledge is necessary to help obstetric care providers to be careful in giving information and even to decide to contact the expert centre before counselling the patient.

References

- 1 Klein HG, Anstee DJ. Haemolytic disease of the fetus and the newborn; in Klein HG, Anstee DJ (eds): *Mollison's blood transfusion in clinical Medicine*. Hoboken, Blackwell Science, Ltd, 2012:499–548.
- 2 de Haas M, Thurik FF, Koelewijn JM, et al.: Haemolytic disease of the fetus and newborn. *Vox Sang* 2015; 109:99–113
- 3 Koelewijn JM, Vrijkotte TGM, van der Schoot CE, et al.: Effect of screening for red cell antibodies, other than anti-D, to detect hemolytic disease of the fetus and newborn: a population study in the Netherlands. *Transfusion* 2008; 48:941–52
- 4 Watchko J, Tiribelli C: Bilirubin-induced neurologic damage—mechanisms and management approaches. *N Engl J Med* 2013; 369:2021–30
- 5 Bhutani VKZA, Blencowe H, Khanna R, et al., et al.: Neonatal hyperbilirubinaemia and Rhesus disease of the newborn: incidence and impairment estimates for 2010 at regional and global levels. *Pediatr Res* 2013; 74:86–100
- 6 Moise KJ: Fetal anemia due to non-Rhesus-D red-cell alloimmunization; Seminars in fetal and neonatal medicine. *Perinat Haematol* 2008; 13: 207–14
- 7 Koelewijn JM, de Haas M, Vrijkotte TGM, et al.: One single dose of 200 µg of antenatal RhIG halves the risk of anti-D immunization and hemolytic disease of the fetus and newborn in the next pregnancy. *Transfusion* 2008; 48:1721–9
- 8 Gottstein RCR: Systematic review of intravenous immunoglobulin in haemolytic disease of the newborn. *Arch Dis Child Fetal Neonatal Ed* 2003; 88: F6–10
- 9 Slootweg YM, Koelewijn JM, van Kamp IL, et al.: Third trimester screening for alloimmunisation in Rhc-negative pregnant women: evaluation of the Dutch national screening programme. *BJOG* 2016; 123:955–63
- 10 CBO Central Guidance Agency: *Guideline Blood Transfusion*. Utrecht, the Netherlands, CBO Central Guidance Agency, 2011
- 11 RIVM National Institute Public Health and Environment: *Prenatal screening infectious diseases and erythrocyte antibodies*. the Hague, the Netherlands: RIVM National Institute Public Health and Environment, 2014
- 12 Oepkes D, van Kamp IL, Simon MJG, et al.: Clinical value of an antibody-dependent cell-mediated cytotoxicity assay in the management of Rh D alloimmunization. *Am J Obstet Gynecol* 2001; 184:1015–20
- 13 Slootweg YM, Lindenburg IT, Koelewijn JM, et al.: Predicting anti-Kell-mediated hemolytic disease of the fetus and newborn: diagnostic accuracy of laboratory management. *Am J Obstet Gynecol* 2018; 219:393.e1–393.e8
- 14 Oepkes D, Seaward PG, Vandenbussche FP, et al.: Doppler ultrasonography versus amniocentesis to predict fetal anemia. *N Engl J Med* 2006; 355:156–64
- 15 Illanes S, Soothill P: Management of red cell alloimmunisation in pregnancy: the non-invasive monitoring of the disease. *Prenat Diag* 2010; 30:668–73
- 16 Zwiens C, Lindenburg ITM, Klumper FJ, et al.: Complications of intrauterine intravascular blood transfusion: lessons learned after 1678 procedures.

- Ultrasound Obstetr Gynecol* 2017; 50:180–6
- 17 Zwiars C, van Kamp I, Oepkes D, *et al.*: Intrauterine transfusion and non-invasive treatment options for hemolytic disease of the fetus and newborn - review on current management and outcome. *Exp Rev Hematol* 2017; 10:337–44
 - 18 Koelewijn JM, Vrijkotte TGM, de Haas M, *et al.*: Women's attitude towards prenatal screening for red blood cell antibodies, other than RhD. *BMC Pregnancy Childbirth* 2008; 8:49
 - 19 Oxenford K, Silcock C, Hill M, *et al.*: Routine testing of fetal Rhesus D status in Rhesus D negative women using cell-free fetal DNA: an investigation into the preferences and information needs of women. *Prenat Diag* 2013; 33:688–94
 - 20 Wee WW, Kanagalingam D: The use of anti-D immunoglobulins for rhesus prophylaxis: audit on knowledge and practices among obstetricians. *Singapore Med J* 2009; 50:1054–7.
 - 21 Légaré FBF, Freitas A, Jacques A, *et al.*: Development of a simple 12-item theory-based instrument to assess the impact of continuing professional development on clinical behavioral intentions. *PLoS ONE* 2014; 9:e91013
 - 22 Verweij EJ: Prenatale screening en de non-invasieve prenatale test: hoe denken eerstelijns verloskundigen erover? (English translation: Prenatal screening and the non-invasive prenatal test: How do midwives think about it?). *Tijdschrift voor Verloskundigen* 2015; 1:16–20
 - 23 Coppenrath V, Filosa LA, Akselrod E, *et al.*: Adaptation and Validation of the Fresno Test of Competence in Evidence-Based Medicine in Doctor of Pharmacy Students. *Am J Pharm Educ* 2017; 81:106
 - 24 Christiane Atzmüller P: Experimental vignette studies in survey research. *Methodology* 2010; 6:128–38
 - 25 Ploeg CS Y, Oomen P, Vos K: Most important findings of national screening infection diseases and red blood cell immunisation in pregnancy of 2016. 2018-07-23, RIVM, National Institute for Public Health and the Environment, 2016.
 - 26 Moody L, Atkinson L, Kehal I, *et al.*: Healthcare professionals' and parents' experiences of the confirmatory testing period: a qualitative study of the UK expanded newborn screening pilot. *BMC Pediatr* 2017; 17:121
 - 27 Schmidt JL, Castellanos-Brown K, Childress S, *et al.*: The impact of false-positive newborn screening results on families: a qualitative study. *Genet Med* 2012; 14:76–80
 - 28 Farrell MH, Speiser J, Deuster L, *et al.*: Child health providers' precautionary discussion of emotions during communication about results of newborn genetic screening. *Arch Pediatr Adolesc Med* 2012; 166:62–7
 - 29 Salm N, Yetter E, Tluczek A: Informing parents about positive newborn screen results: parents' recommendations. *J Child Health Care* 2012; 16:367–81
 - 30 O'Brien ET, Quenby S, Lavender T: Women's views of high risk pregnancy under threat of preterm birth. *Sexual Reprod Healthc* 2010; 1:79–84

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1 Knowledge scores classified per level of obstetrical care.

Table S2 Univariate analysis of the association of background variables with the level of knowledge.