An audit of second-trimester fetal anomaly scans based on a novel image-scoring method in the Southwest region of the Netherlands

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ABSTRACT

Objective: Since 2007 the second trimester fetal anomaly scan is offered to all pregnant women as part of the national prenatal screening programme in the Netherlands. Dutch population-based screening programmes have in general a well described system to achieve quality assurance. Due to the absence of an uniform system monitoring the actual performance of the fetal anomaly scan in 2012, we developed a standardised image-scoring method. The aim of this study was to evaluate the scanning performance of all sonographers in the southwestern region of the Netherlands using this image-scoring method.

Methods: Each sonographer is requested to set up a digital portfolio. A portfolio consists of five logbooks from five different pregnant women, each containing 25 fetal anatomical structures and six biometric measures of randomly selected fetal anomaly scans.

Results: During the study period, 425 logbooks of 85 sonographers were assessed as part of the audit process. Seventy-three out of 85 sonographers (86%) met the criteria in the primary audit and twelve sonographers required an individual hands-on training. A successful assessment was achieved for eleven sonographers in the re-audit and one sonographer ceased her contract. Moreover, 2.1% of the required images were not digitally stored and could therefore not be reviewed.

Conclusions: Quality assessment using the image-scoring method demonstrated that the majority of sonographers met the expectations of the audit process but those who had subpar performance met expectations after re-training.

INTRODUCTION

In 2007, a nationwide prenatal screening programme was introduced in the Netherlands for Down syndrome risk assessment in the first trimester of pregnancy and the detection of fetal structural anomalies in the second trimester of pregnancy. This programme is supported by a legislative framework, the Population Screening Act and perpetuates equal access for any pregnant woman to these screening entities. Its main goal is to enable pregnant women to make well informed reproductive choices.

Dutch population-based screening programmes have in general a well described system to achieve quality assurance, including accreditation requirements, quality assurance standards and quality control guidelines.[1, 2] National quality standards for the Down syndrome screening programme were available in June 2012 and have been implemented in the audit program to assess the quality of the individual sonographer for the nuchal translucency measurement.[3]

Despite the fact that general requirements for individual sonographers, such as attending CME (continuing medical education) activities and minimum number of scans were already described and incorporated, a uniform system monitoring the actual performance of the second trimester fetal anomaly scan was lacking.

Guidelines for the performance of the second trimester fetal anomaly scan , further referred to as 'anomaly scan' are issued by several international[4,5] and national organisations.[6] All guidelines emphasize the need for documentation of ultrasound examinations and their importance for quality assurance.

Scoring methods of the anomaly scan[7-9] and the fetal cardiac scan[10], based on fetal images were developed and are an objective and reproducible tool to assess the quality of ultrasound examinations. Recently a new scale for assessment of obstetric ultrasound competence, the Objective Structured Assessment of Ultrasound Skills (OSAUS) has been described by Tolsgaard *et al.*[11] Until now, such scoring systems were never applied to large groups of sonographers and only delineated a proof of principle.

The aim of this study was to evaluate a newly developed score-based audit method for quality assessment[9] of the second trimester anomaly scan and to evaluate the scanning performance of all sonographers in the southwest region of the Netherlands.

MATERIALS AND METHODS

The Dutch prenatal screening programme on fetal anomalies is a programme that is delegated to eight Regional Organisations and is coordinated by the National Institute of Public Health and Environment (RIVM). The Regional Organisation is among other things responsible for the quality control of the screening programme and auditing is

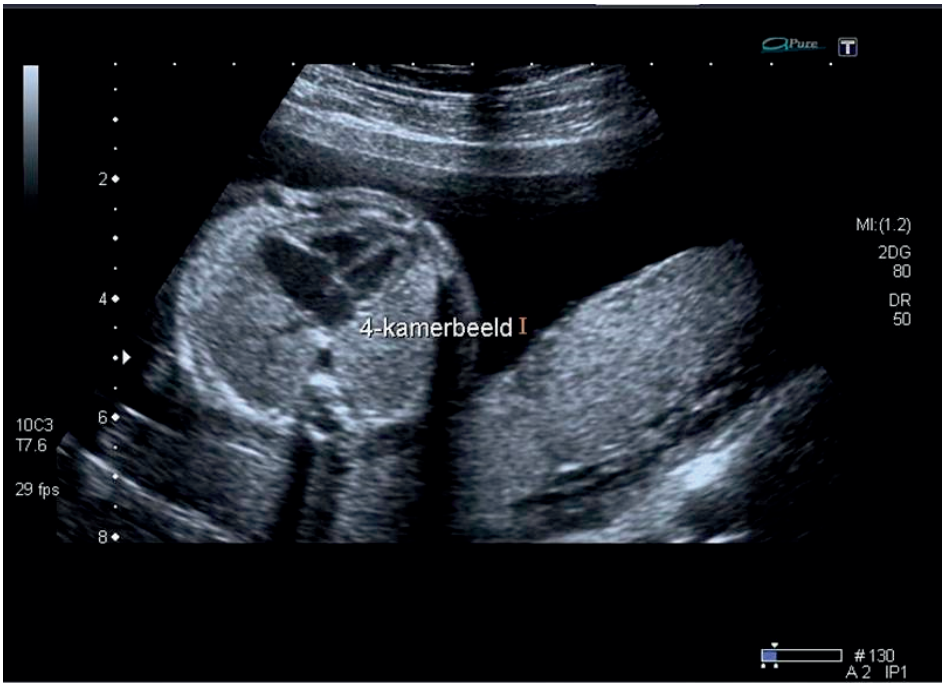
one of its quality instruments. All sonographers within the screening programme are properly trained in certified institutes. Sonographers only may perform anomaly scans when they have a quality agreement with the Regional Organisation. Certification, ongoing training and being subject to auditing are essential conditions to maintain their contract. In addition to the cost of the anomaly scan, ten percent of the reimbursement is charged and allocated to the Regional Organisation to enable execution of the prenatal screening program.

A score-based audit method for quality assessment of the anomaly scan was developed and briefly described in a national journal [9]. For each sonographer working in a screening unit, five recent cases preceding the actual audit were randomly selected by the audit team from the national prenatal screening database 'Peridos'. Data are provided by healthcare professionals involved in prenatal screening (contracted midwives, sonographers and obstetricians), all of whom are connected with Peridos. Cases were limited to singleton pregnancies and did not reveal any anomalies on the scan. All ultrasound equipment met the national quality requirements. During the audit individual data from each sonographer, such as number of scans per year, sonographic experience and working environment (kind of organisation, number of sonographers) were collected. According to the national guidelines, sonographers with less than two years of experience ('new') should perform more than 250 anomaly scans per year and others ('experienced') should perform more than 150 anomaly scans per year.

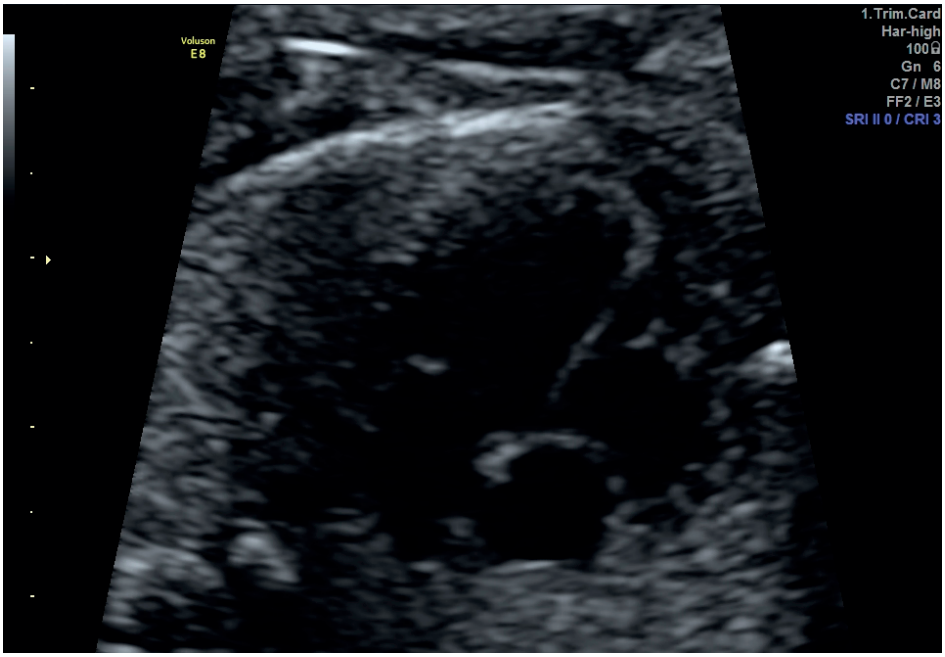
A sonographic digital portfolio consists of five logbooks, from five different pregnant women, each containing 25 anatomical structures and six biometric measures that should be recorded and evaluated during an anomaly scan, according to the Dutch Society of Obstetrics and Gynecology (NVOG).[6] The required images represent the structures and biometric measurements assessed in the fetal anatomical survey described by International Society of Ultrasound in Obstetrics and Gynecology (ISUOG), with the addition of the outflow tracts of the heart and the anterior – posterior inner to inner measurement of both renal pelvis.[4] For each anatomical structure one point for the correct plane and one point for the proper magnification can be obtained. A fetal structure should be depicted in a full-screen view, meaning that at least two-third of the monitor is occupied by the area of interest (Figure 7.1). In the Netherlands fetal biometry is assessed as described by Verburg et al. (2008).[12] For six biometrical images one point can be obtained for a correct calliper position. Images that are missing from the logbook will be classified as 'absent' and scored zero points. The maximum score is 56 points for each logbook (25 x 2 + 6). For this study a threshold score of 42 out of 56, corresponding to 75% of the total score was used to discriminate between an adequate and an inadequate score. Next to the evaluation of the above mentioned fetal structures and biometrical measurements, an annotation on the ultrasound image to distinguish right from left for kidneys and extremities was documented.

Figure 7.1 Four-chamber view showing inadequate magnification (A) and adequate magnification (full-screen view) (B).

A



B



The image-scoring is performed by a team consisting of four experienced sonographers from the division of Prenatal Medicine of the Erasmus Medical Centre, Rotterdam (T.C.O., M.H. and E.S.) or the department of Obstetrics and Gynecology of the Reinier de Graaf Hospital, Delft (C.R.). All five logbooks are reviewed, and the three best scoring logbooks will be selected for the final assessment. All selected logbooks should have an adequate score for a successful performance. For every rejected image (plane, magnification and placement of the callipers) a written explanation is provided and during the visit to the ultrasound practice, feedback on the performance based on these scores is given to the individual sonographer. When a portfolio is scored as 'inadequate', the portfolio is subject to a second opinion by the most experienced reviewer (T.C.O.). This reviewer has more than 30 years of experience in performing fetal medicine scans in a tertiary centre. To obtain inter-observer variability, twelve logbooks, each consisting of 25 images were selected randomly and were independently assessed by all four reviewers.

Sonographers with an unsuccessful final assessment should attend a hands-on training provided by the Erasmus Medical Centre or other qualified training institute. Following the hands-on training a re-audit will be performed according to conditions as described above. If the re-audit is unsuccessful again, the Regional Organisation has the ability to dissolve the contract.

Portfolios were obtained and assessed from October 2012 to March 2015. During this period, the whole audit cycle of all participating centres in the Southwest region of the Netherlands was completed.

Inter-observer variability was assessed by calculating intra-class correlation on the logbook scores of the four reviewers. The Wilcoxon test was used to compare individual scores (fetal and biometric measures) and the total audit score between the primary audit and the re-audit. We estimated the association of the total audit score with all studied variables (characteristics of individual sonographers and organisations) as adjusted unstandardized regression coefficients (B) with 95% confidence interval using multiple linear regression analysis. For data analysis SPSS (version 21, Chicago, IL, USA) was used. For all tests, a value of $p<0.05$ was considered as statistically significant.

RESULTS

During the study period, 85 sonographers participated and 425 logbooks were assessed as part of the audit procedure. Since three out of five portfolios were selected for the final assessment, the results of 255 portfolios were analysed. The characteristics of the audited sonographers are shown in Table 1. Most of the sonographers (57%) worked in a medium size practice consisting of three to seven sonographers, 14% worked in

Table 7.1 Baseline characteristics of the individual sonographers and organisation

	Audited sonographers n (%)
Setting	
Hospital	33 (39%)
Independent ultrasound practice	43 (50%)
Independent midwifery practice with ultrasound facilities	9 (11%)
Number of sonographers within an ultrasound practise	
1-2 sonographers	12 (14%)
3-7 sonographers	48 (57%)
>7 sonographers'	25 (29%)
Sonographic experience	
Experienced	63 (74%)
New	22 (26%)
Accomplished the annual number of scans per year	
Yes	60 (71%)
No	25 (29%)
Audit period	
1 (Oct 2012 – Sept 2013	27 (32%)
2 (Oct 2013- Sept 2014)	37 (43%)
3 (Oct 2014 - April 2015)	21 (25%)

a smaller practice and 29% worked in a large ultrasound practice. From the audited sonographers, 74% had more than two years of experience in obstetric ultrasound and 71% of them yielded the goal of the annual number of scans required (Table 7.1).

An overview of the evaluated anatomical structures and biometric measurements are depicted in Table 7.2. Missing results occurred in approximately 0.25% (36/14,280) of the items because the reviewer had forgotten to document their score. The intra-class correlation was 0.974 (95% CI: 0.936 - 0.991) indicating that the inter-observer variability of the scoring method between the four reviewers was excellent. The head circumference and femur length were correctly measured in 94.5% (240/254) and 94.7% (233/246), respectively. Callipers for abdominal circumference were correctly placed in 86.6% (214/247). For the correct anatomical plane the best scoring structure was the bladder (94.5% (241/255)) and the worst scoring structure was the sagittal view of the fetal profile (75.5% (193/255)). For the correct magnification the best scoring structure was the axial and suboccipitobregmatic view of the fetal head (93.3% (238/255)) and the poorest scoring structure was the four chamber view of the fetal heart (78.4% (200/255)). All images of fetal head, brain, spine, four chamber view of

Table 7.2 Ultrasound evaluation of fetal structures and biometric measurement. **Ultrasound evaluation of fetal structures and biometric measurement**

	Plane		Magnification			Placement callipers		
Total n = 255	Adequate	Inadequate	Adequate	Inadequate	Absent	Adequate	Inadequate	Absent
Central Nervous System								
Axial view head	237 (92.9%)	18 (7.1%)	238 (93.3%)	17 (6.7%)	-	215 (84.6%) *	39 (15.4%)	-
Suboccipitobregmatic view	234 (91.8%)	21 (8.2%)	238 (93.3%)	17 (6.7)	-	247 (97.2%) *	7 (2.8%)	-
Spine	217 (85.1%)	38 (14.9%)	237 (92.9%)	18 (7.1%)	-	-	-	-
Face								
Sagittal view profile	193 (75.7%)	45 (17.6%)	209 (82.0%)	29 (11.3%)	17 (6.7%)	-	-	-
Orbital diameters	234 (91.8%)	8 (3.1%)	231 (90.6%)	11 (4.3%)	13 (5.1%)	-	-	-
Coronal view nose, lips and chin	219 (85.9%)	34 (13.3%)	236 (92.5%)	17 (6.7%)	2 (0.8%)	-	-	-
Thorax								
Shape and echogenicity lungs	213 (83.5%)	36 (14.1%)	217 (85.1%)	32 (12.5%)	6 (2.4%)	-	-	-
Diaphragm	200 (78.4%)	50 (19.6%)	216 (84.7%)	34 (13.3%)	5 (2.0%)	-	-	-
Four chamber view	223 (87.4%)	32 (12.5%)	200 (78.4%)	55 (21.6%)	-	-	-	-
Heart: left outflow tract	223 (87.4%)	31 (12.2%)	211 (82.7%)	43 (16.9%)	1 (0.4%)	-	-	-
Heart: right outflow tract	223 (87.5%)	29 (11.4%)	220 (86.3%)	32 (12.5%)	3 (1.2%)	-	-	-
Heart: three vessel view	237 (92.9%)	17 (6.7%)	222 (87.1%)	32 (12.5%)	1 (0.4%)	-	-	-

Table 7.2 Ultrasound evaluation of fetal structures and biometric measurement. **Ultrasound evaluation of fetal structures and biometric measurement (continued)**

	Plane		Magnification			Placement callipers		
Total n = 255	Adequate	Inadequate	Adequate	Inadequate	Absent	Adequate	Inadequate	Absent
Abdomen								
Abdominal circumference	230 (90.6%) *	24 (9.4%)	234 (92.9%)†	18 (7.1%)	-	214 (86.6%) ‡	33 (13.4%)	-
Abdominal wall	221 (87.0%) *	28 (11.0%)	216 (85.0%)*	33 (13.0%)	5 (2.0%)	-		-
Bowels	210 (82.4%)	24 (9.4%)	212 (83. 2%)	22 (8.6%)	21 (8.2%)	-		-
Kidney left	227 (89.0%)	28 (11.0%)	220 (86.3%)	35 (13.7%)	-	166 (65.9%) †	86 (34.1%)	-
Kidney right	210 (82.3%)	43 (16.9%)	212 (83.1%)	41 (16.1%)	2 (0.8%)	154 (61.1%) †	97 (38.5%)	1 (0.4%)
Bladder	241 (94.5%)	9 (3.5%)	222 (87.0%)	28 (11.0%)	5 (2.0%)	-	-	-
Extremities								
Femur	238 (93.3%)	14 (5.5%)	229 (89.8%)	23 (9.0%)	3 (1.2%)	233 (94.7%) §	10 (4.1%)	3 (1.2%)
Left leg and foot	202 (79.2%)	44 (17.3%)	226 (88.6%)	20 (7.9%)	9 (3.5%)	-	-	-
Right leg and foot	204 (80.0%)	43 (16.9%)	229 (89.8%)	18 (7.1%)	8 (3.1%)	-	-	-
Left arm and hand	229 (89.8%)	18 (7.1%)	229 (89.8%)	17 (6.7%)	9 (3.5%)	-	-	-
Right arm and hand	220 (86.3%)	24 (9.4%)	229 (89.8%)	15 (5.9%)	11 (4.3%)	-	-	-
Umbilical cord	240 (94.5%)*	12 (4.7%)	237 (92.9%)	16 (6.3%)	2 (0.8%)	-	-	-
Relationship between placenta and internal cervical os	199 (78.0%)	42 (16.5%)	226 (88.6%)	15 (5.9%)	14 (5.5%)	-	-	-

*= 1 missing, † = 3 missing, ‡ = 8 missing, § = 9 missing.

the heart and one kidney were present in the portfolios. Of all other required images between 0.8% (umbilical cord) and 8.2% (bowel echogenicity) had not been stored and could not be reviewed and scored zero points. Overall, 2.1% (136/6375) of the images were not stored.

In the primary audit 73 sonographers (86%) had a successful image quality assessment and twelve sonographers (14%) failed to meet the criterion of three adequate scores out of five portfolios and therefore had an unsuccessful image quality assessment. After the primary audit one sonographer ceased working as a sonographer, the remaining eleven sonographers participated in the re-audit after individual feedback and hands-on training. All of them had a successful final assessment. The total audit score of these eleven sonographers was significantly higher ($p < 0.001$) in the re-audit compared to the primary audit (Figure 7.2). A more detailed analysis for each evaluated fetal anatomical structures and biometric measurements in the primary and re-audit is presented in the supplementary table.

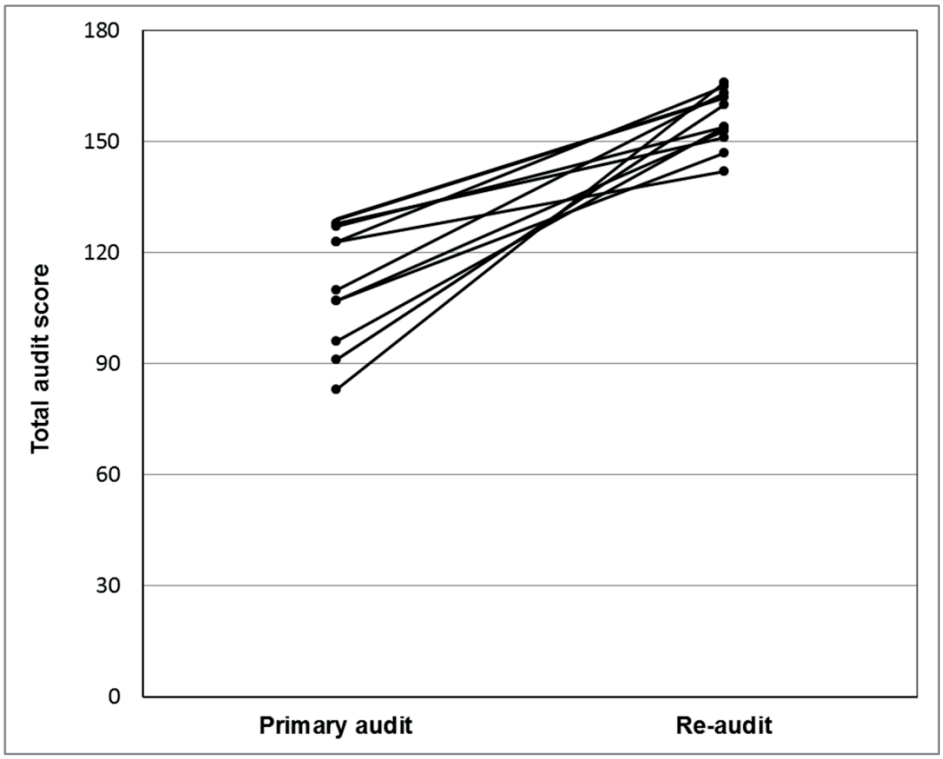


Figure 7.2 Individual sonographers' total audit score in the primary and re-audit of fetal ultrasound structures and biometric measurements.

Table 7.3 The association between total audit score and characteristics sonographers and organisation.

	Mean total audit score	Regression - coefficient (B)	p value	95%-CI
Setting				
Hospital	145	0.00		reference
Independent ultrasound practice	144	-5.62	0.31	-16.5 – 5.3
Independent midwifery practice with ultrasound facilities	147	12.67	0.09	-1.9 – 27.2
Number of sonographers within an ultrasound practise				
1-2 sonographers	130	0.00		reference
3-7 sonographers	145	21.4	0.001	8.8 – 34.0
>7 sonographers	151	26.9	< 0.001	12.2 – 41.6
Sonographic experience				
Experienced	144	0.00		reference
New	146	6.2	0.25	-4.4 – 16.7
Accomplished the annual number of scans per year				
Yes	147	0.00		reference
No	138	-14.0	0.009	-24.5 – -3.6
Audit period				
1	138	0.00		reference
2	148	11.0	0.04	0.6 – 21.5
3	148	6.8	0.23	-4.3 – 17.9

During the primary audit an annotation of the ultrasound image ('to depict right or left side') was present for kidneys in 142 out of 254 (56%) cases and for upper and lower extremities in 88 out of 245 (36%) cases. In the re-audit the percentages for an annotation on the ultrasound image were similar for the kidneys (73%; p = 0.07), but did improve for the upper (67%; p = 0.001) and lower extremities (70%; p < 0.001). The number of sonographers working within an ultrasound practice and fulfilment of required annual number of scans was positively associated with a higher total audit score after adjustment for all study variables (Table 7.3).

DISCUSSION

This study is the first published audit on the performance of the anomaly scan in the Netherlands since the beginning of the nationwide screening programme in 2007. This audit was conducted in southwestern region of the Netherlands consisting of both

highly urbanized and countryside areas. Seventy-three out of 85 sonographers met the audit criteria in the primary audit, and performance was largely similar considering the setting of the ultrasound unit, years of experience of the individual sonographer and the period of the audit. Sonographers who failed the first audit were subject to an individual hands-on training and succeeded in the re-audit, except for one sonographer, who ceased her contract.

The legislative framework for the nationwide prenatal screening programme mandates this programme and financing of the quality control system. Clear quality criteria were set and only sonographers meeting those criteria were legally permitted to perform anomaly scans by means of being contracted to a regional organisation. Auditing the individual sonographer on qualitative issues was commenced five years after starting the programme, implying that most sonographers had executed a substantial number of scans. Our study showed that the initial performance in our region was good (73/85; 86%) and could easily be improved to 100%.

Contracted sonographers were obliged to perform a minimum number of scans per year, but a substantial part of them (29%) did not meet this criterion. We demonstrated a significant correlation between number of scans executed per year and the total audit score, implying the relevance of setting a minimum number of scans, which is in line with an improvement in quality with increasing numbers of NT measurements.[13] Moreover, a recent study demonstrated that the level of experience and working volume of the sonographer performing the anomaly scan influence rates for revision and referral to a centre for prenatal diagnosis.[14]

A significant correlation between the individual performance and the number of sonographers in an ultrasound unit, in favour of large units was demonstrated. Larger units often have implemented internal quality control systems, that probably result in significantly better scores. A Cochrane Review on audit and feedback confirmed this observation.[15] It was suggested that feedback from a supervisor or colleague is shown to be more effective than from an outsider, that might explain why larger units perform better.[15]

Quality control of nuchal translucency measurements, based on an image-scoring method demonstrated that an implementation of an ongoing audit *itself* leads to an improvement of image quality.[16] It was shown before in the United States and Canada that a voluntary accreditation of ultrasound practices leads to an improvement of their quality of work.[17] The sonographers in our study compiled their own portfolio which resulted in awareness of image acceptability and lacking images. Previous studies showed that sonographer's own assessment of image acceptability facilitated quality improvement.[18, 19] Most sonographers with an inadequate score acknowledged the judgement by the auditor during audit visit. Realising that failing to continuously keep

adapting the magnification and the correct plane of a structure during the scan of a moving fetus results in storing of inadequate images.

Approximately 2.1% of the required images for the digital portfolio were not available for assessment. Both ISUOG[4] and NVOG[6] recommend permanent storing of all images and delineating the results and conclusions of the scan. A proper storage can help the sonographer to avoid litigation and to defend against it [20], as stated by the American College of Obstetrics and Gynecology (ACOG), 'Absence of visual image documentation eliminates the possibility of future review and weakens the defense against an allegation that an incomplete or inadequate study was performed'.[21, 22]

The incorrect placement of callipers for abdominal circumference in 13.4% of cases is a serious issue. Inaccurate fetal biometry measurements could result in growth estimation errors.[19, 23] Due to the audit sonographers became aware of the necessity to improve their accuracy both in fetal anatomical structures and fetal biometry.

After the introduction of the fetal anomaly scan in the Netherlands, detection rates of several anomalies, such as structural heart disease[24-26], cleft lip[27] and open spina bifida[28] have increased. However, a quality assessment study for the individual sonographer based on detection rates is not feasible since 2.3% of all pregnancies is affected with congenital anomalies.[29] During one year of scanning, sonographers may only encounter occasionally an abnormal finding, therefore, other methods are required to assess and maintain quality preferably supported by legislative framework.

This study had several strong points and limitations. We were able to use actual scans from the actual work situation and scans were randomly selected by the Regional Organisation. All sonographers in our region were obligated to participate in the quality assessment and this was not performed on voluntary basis. Although the quality standards were defined and communicated before starting the audit, the majority of the sonographers did not fully appreciate these new requirements of their practice. Only 38/87 (44%) of the sonographers had experience with image auditing due to nuchal translucency assessment but in that case sonographers may select their own images[30] contrary to our method were the audit team randomly selects the examinations.

A limitation of the study was that it took 2.5 years to complete the whole audit cycle. Sonographers evaluated at the end of the audit cycle could have been better informed about the audit method, although the audit score was not significantly dependent of the audit period. Secondly, we were unable to correlate the individual audit score with actual clinical performance because of the low prevalence of congenital anomalies. Another limitation was that we did not ask for annotations as a standard performance. Annotations can improve the interpretation of scans and increase the reliability of the image storage. Annotations are common practice in radiologic imaging.

CONCLUSION

In conclusion, we developed an objective score-based method for quality assessment of fetal images[9] and evaluated the scanning performance of the sonographers in the southwest region of the Netherlands, being the largest screening region in the Netherlands. Four out of five sonographers met the criteria in the primary audit and after an individual hands-on training all sonographers had a successful assessment. This quality assessment might make sonographers more aware of their performance.

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SUPPLEMENT

Supplementary table 7.1 Ultrasound Evaluation in Primary Audit and Re-audit of Fetal Structures and Biometry**upplementary table 1. Ultrasound Evaluation in Primary Audit and Re**

	Primary Audit (N = 33)								Re-audit (N = 33)							
	Plane		**Magnification**			**Placement Calipers**			**Plane**		**Magnification**			**Placement Calipers**		
	Adequate	*Inadequate*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Absent*
Central Nervous System																
Axial view head	29 (88%)	4 (12%)	28* (85%)	5 (15%)	-	21* (64%)	12 (36%)	-	28 (85%)	5 (15%)	33* (100%)	-	-	32* (97%)	1 (3%)	-
Suboccipitobregmatic view	28 (85%)	5 (15%)	27 (82%)	6 (18%)	-	31 (94%)	2 (6%)	-	30 (91%)	3 (9%)	31 (94%)	2 (6%)	-	31 (94%)	2 (6%)	-
Spine	25 (76%)	8 (24%)	22* (67%)	11 (33%)	-	-	-	-	23 (70%)	10 (10%)	32* (97%)	1 (3%)	-	-	-	-
Face																
Sagittal view profile	14* (42%)	12 (37%)	15* (46%)	11 (33%)	7 (21%)	-	-	-	25* (76%)	7 (21%)	31* (94%)	1 (3%)	1 (3%)	-	-	-
Orbital diameters	23* (70%)	4 (12%)	24* (73%)	3 (9%)	6 (18%)	-	-	-	32* (97%)	-	31* (94%)	1 (3%)	1 (3%)	-	-	-
Coronal view nose, lips and chin	24 (73%)	9 (27%)	29 (88%)	4 (12%)	-	-	-	-	30 (91%)	3 (9%)	31 (94%)	2 (6%)	-	-	-	-
Thorax																
Shape and echogenicity lungs	23* (70%)	7 (21%)	16* (49%)	14 (42%)	3 (9%)	-	-	-	30* (91%)	3 (9%)	32* (97%)	1 (3%)	-	-	-	-

Supplementary table 7.1 (continued)

	Primary Audit (N = 33)								Re-audit (N = 33)							
	Plane		**Magnification**			**Placement Calipers**			**Plane**		**Magnification**			**Placement Calipers**		
	Adequate	*Inadequate*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Absent*
Diaphragm	28 (85%)	3 (6%)	14* (42%)	16 (49%)	3 (9%)	-	-	-	31 (94%)	3 (6%)	32* (97%)	1 (3%)	-	-	-	-
Four chamber view	24 (73%)	9 (27%)	19* (58%)	14 (42%)	-	-	-	-	28 (85%)	5 (15%)	30* (91%)	3 (9%)	-	-	-	-
Heart: left outflow tract	28 (85%)	5 (15%)	20* (61%)	13 (39%)	-	-	-	-	30 (91%)	3 (9%)	31* (94%)	2 (6%)	-	-	-	-
Heart: right outflow tract	28 (85%)	5 (15%)	20* (61%)	13 (39%)	-	-	-	-	31 (97%)	1 (3%)	31* (94%)	2 (6%)	-	-	-	-
Heart: three vessel view	26 (79%)	7 (21%)	20* (61%)	13 (39%)	-	-	-	-	29 (88%)	4 (12%)	30* (91%)	3 (9%)	-	-	-	-
Abdomen																
Abdominal circumference	27 (82%)	6 (18%)	23* (70%)	10 (30%)	-	26 (84%) ‡	5 (16%)	-	28 (85%)	5 (15%)	33* (100%)	-	-	32 (97%)	1 (3%)	-
Abdominal wall	24* (75%) †	5 (16%)	15* (47%)†	14 (44%)	3 (9%)	-	-	-	32* (97%)	1 (3%)	33* (100%)	-	-	-	-	-
Bowels	19* (58%)	5 (15%)	16* (49%)	8 (24%)	9 (27%)	-	-	-	33* (100%)	0	33* (100%)	-	-	-	-	-
Kidney left	26 (79%)	7 (21%)	19* (58%)	14 (42%)	-	11* (34%) †	21 (66%)	-	31 (94%)	2 (6%)	32* (97%)	1 (3%)		24* (80%)§	6 (20%)	-

Supplementary table 7.1 (continued)

	Primary Audit (N = 33)								Re-audit (N = 33)							
	Plane		**Magnification**			**Placement Calipers**			**Plane**		**Magnification**			**Placement Calipers**		
	Adequate	*Inadequate*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Adequate*	*Inadequate*	*Absent*	*Adequate*	*Inadequate*	*Absent*
Kidney right	22 (67%)	10 (30%)	14* (42%)	18 (55%)	1 (3%)	9* (28%) †	23 (72%)	-	29 (88%)	4 (12%)	31* (94%)	2 (6%)	-	24* (80%)§	6 (20%)	-
Bladder	27* (82%)	2 (6%)	19* (58%)	10 (30%)	4 (12%)	-	-	-	32* (97%)	-	30* (91%)	2 (6%)	1 (3%)	-	-	-
Extremities																
Femur	28* (85%)	3 (9%)	20* (61%)	11 (33%)	2 (6%)	24 (80%)§	4 (13%)	2 (7%)	33* (100%)	-	32* (97%)	1 (3%)	-	28 (85%)	5 (15%)	-
Left leg and foot	20* (61%)	5 (15%)	18* (55%)	7 (21%)	8 (24%)	-	-	-	31* (94%)	2 (6%)	33* (100%)	-	-	-	-	-
Right leg and foot	18* (55%)	7 (21%)	20* (61%)	5 (15%)	8 (24%)	-	-	-	29* (88%)	4 (12%)	32* (97%)	1 (3%)	-	-	-	-
Left arm and hand	23* (70%)	3 (9%)	17* (52%)	8 (24%)	8 (24%)	-	-	-	31* (94%)	2 (6%)	32* (97%)	1 (3%)	-	-	-	-
Right arm and hand	21* (64%)	2 (6%)	19* (58%)	4 (12%)	10 (30%)	-	-	-	31* (94%)	2 (6%)	32* (97%)	1 (3%)	-	-	-	-
Umbilical cord	29 (88%)	3 (9%)	20* (61%)	12 (36%)	1 (3%)	-	-	-	32 (97%)	1 (3%)	33* (100%)	-	-	-	-	-
Relationship between placenta and internal cervical os	19* (58%)	8 (24%)	25* (76%)	2 (6%)	6 (18%)	-	-	-	32* (97%)	1 (3%)	32* (97%)	1 (3%)	-	-	-	-

[a]Statistically significant difference (P < .05) between primary and re-audit scores for plane, magnification, or placement calipers.
† = 1 missing, ‡ = 2 missing, § = 3 missing.