Obstetric audit: the Bradford way

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Abstract

Ultrasound is widely used as a screening tool in obstetrics with the aim of reducing maternal and foetal morbidity. However, to be effective it is recommended that scanning services follow standard protocols based on national guidelines and that scanning practice is audited to ensure consistency. Bradford has a multi-ethnic population with one of the highest rates of birth defects in the UK and it requires an effective foetal anomaly screening service. We implemented a rolling programme of audits of dating scans, foetal anomaly scans and growth scans carried out by sonographers in Bradford. All three categories of scan were audited using measurable parameters based on national guidelines. Following feedback and re-training to address issues identified, re-audits of dating and foetal anomaly scans were carried out. In both cases, sonographers being re-audited had a marked improvement in their practice. Analysis of foetal abnormality detection rates showed that as a department, we were reaching the nationally agreed detection rates for the Fetal Anomaly Screening Programme auditable conditions. Audit has been shown to be a useful and essential process in achieving consistent scanning practices and high quality images and measurements.

Keywords: Obstetric audit, foetal anomaly screening programme, foetal measurements

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Introduction

Ultrasound has been used successfully for several decades for the detection of specific foetal abnormalities. However, its value as a screening tool has been more difficult to demonstrate. A 1997 report by the Royal College of Obstetricians and Gynaecologists (RCOG) concluded that one of the reasons for its limited effectiveness as a screening tool was the lack of consistency in the way that screening was carried out.¹ In 2000, the RCOG published guidelines on ultrasound screening, which recommended a two-stage scan programme to include an initial dating scan (ideally before 15 weeks), followed by a 20-week anomaly scan.² The guidelines recommended that all scans be carefully documented and archived and that accurate record keeping be maintained. It also recommended that results should be audited with respect to the detection of foetal abnormalities.

In 2010, the Fetal Anomaly Screening Programme (FASP) published guidelines on the 18⁺₀ to 20⁺₆ weeks foetal anomaly scan.³ These nationally agreed guidelines are intended to form the basis of the ultrasound screening service in England and give guidance on service configuration, patient information and screening protocols. The report includes 12 standards against which screening services can audit and monitor their effectiveness. Arrangements are required to monitor local screening programmes with evidence of audit and accurate record taking for the

ultrasound scans performed. This includes a performance development review for each health professional involved in obstetric scanning. It was recognised that the practitioner was expected to manually manipulate and alter equipment settings in order to optimise the image obtained.

Recent RCOG guidance on the investigation and management of the small for gestational age (SGA) foetus recommends that all women should be assessed at booking for risk factors for a SGA foetus/neonate.⁴ Those who have a high risk factor are referred for serial ultrasound. Monitoring the abdominal circumference (AC) measurement and serial umbilical artery (UA) Doppler studies can confirm the diagnosis of a SGA foetus and it is extremely important that these measurements are performed accurately to assess the growth patterns in order to counsel and manage the patient appropriately.

Recent analysis of data from the Born in Bradford (BIB) study has shown that Bradford has one of the highest foetal abnormality rates in the country, due to its population and ethnicity.⁵ The research team from Bradford found from a study of 11,300 babies born in Bradford between 2007 and 2011, had an overall birth defect rate of about 3%, nearly double the national average. The largest ethnic groups looked at were Pakistani (45%) and White British (40%). In the Pakistani subgroup, 77% of babies born with birth defects were to parents in consanguineous marriages. In the White

British sub-group, 19% of babies with a birth defect were from mothers over the age of 34. One of the most common defects found in these babies were cardiac anomalies.

Nuchal translucency (NT) measurements are used as part of the screening protocol for Trisomy 21. FASP guidance on this measurement maintains that it is imperative that the ultrasound measurements are as accurate as possible in order to calculate and provide the patient with an accurate screening value.^{6,7} An NT screening programme was implemented at Bradford teaching Hospitals in October 2011. Bradford has the lowest uptake for this screening test, in the region of only 22%, and therefore has a higher rate of Downs babies being delivered that are not diagnosed antenatally.

We aimed to audit the quality of obstetric ultrasound services in Bradford against national guidelines. When introducing obstetric audit in Bradford, it was acknowledged that it was important to not only audit the quality of scans and reports, but to review the foetal anomalies being detected or missed antenatally at scan.

Methods

Three different audits were devised. These were: (i) a dating scan audit, (ii) a foetal anatomy scan (FNS) audit and (iii) a growth scan audit. The audits were implemented to ensure that sonographers were adhering to departmental obstetric guidelines, which were based on the FASP guidelines.³

They included assessments of image quality, the minimum number of images being recorded and measurements. The audit analysis data was then fed back to the staff and any issues highlighted. Any required changes in practice identified were implemented and the dating and FNS audits were repeated 6–12 months later. This audit cycle is illustrated in Figure 1.

Before the audit programme was implemented, a number of changes to the ultrasound service were put in place. These included the purchase of new equipment and the introduction of new local and national guidelines. All staff were informed of the new guidelines, and relevant training was provided. The changes are listed in Table 1.

The sonographers were informed of the audit process and how they were to be assessed. Each audit was performed retrospectively with only one audit in progress at any one time (except the NT audit which is performed each month). Each sonographer was requested to submit 10 scans to be audited for the dating and FNS audits. For the growth audit, 10 scans were randomly selected by the auditors. A time limit was allocated to ensure the 3 audits were performed in a 12-month period. Each audit was assessed by 2 senior sonographers with agreed objectives, aims and benchmarks. Time was allocated for each sonographer performing the audits.

An overall benchmark of 95% was agreed for image quality and accuracy of the measurements performed for

Figure 1 The audit cycle

Table 1 Changes implemented before commencing the audits

	Change	Outcome
Equipment	6 new high end ultrasound machines were purchased specifically for use in obstetric and NT scanning	Improved image quality
Obstetric ultrasound protocols	New guidelines were introduced based on local, FASP and NICE guidelines	Sonographers informed and agreed to scan by new protocols
Training	Sonographers were allocated time to complete required FASP e-learning modules and attend regional foetal cardiac training sessions. Sonographers were allocated some CPD time once a month	Sonographers updated their knowledge, skills and practice in relation to obstetric scans

Sonographer name:						
CRIS number/ Accession number	Image size correct Y/N	Correct section of foetus used Y/N	Caliper alignment correct Y/N	Good image quality Y/N	Foetal attitude correct Y/N	Correctly dated Y/N
Comments:						

Table 3 The foetal anatomy audit form

CRIS number:	Image present	Good image quality	Adequate image	Poor image
FL measurement				
HC measurement				
AC measurement				
Lips/nasal tip				
Measurement of the transcerebellar diameter				
Ventricular atrial (VA) measurement				
Measurement of the nuchal fold				
Sagittal view of cervical spine				
Sagittal thoracic spine views				
Sagittal lumbar and L/S views				
4-chamber heart view				
3-vessel view				
RVOT				
LVOT				

Figure 3 Head circumference image **Figure 4** Abdominal circumference image

Growth scan audit methodology

A growth/Doppler audit was implemented based on the FASP measurements, NICE guidelines^{4,8,9} and locally agreed guidelines. The aims of the growth scan audit were to ensure that the ultrasound protocols and guidelines were being adhered to and that all sonographers produced good measurements, images and reports (Figures 3, 4 and 5). A tick sheet was provided to audit the presence and quality of the required images as shown in Table 4. Umbilical artery Doppler images were required to show a correct scale and baseline, with a good quality trace (at least 3 peaks measured) and correct calliper placement.

Results

Dating scan audits

Dating scan audits were completed in years 2011 and 2012 (Tables 5 and 6). In the 2011 audit, 18 sonographers were audited, with scores ranging from 44% to 100%. 8/18 sonographers (44%) did not reach the required 95% benchmark. The main problems related to magnification and image quality. In some cases, average measurements were being

Figure 5 Femur length image

used instead of choosing the best CRL measurement and quoting this. The sonographer receiving a mark of 44% was measuring an incorrect CRL section and applying the callipers incorrectly. The sonographers receiving 44% and 66%

Table 4 The growth/Doppler assessment sheet

Sonographer name:	Date:		
CRIS number:			
	Image present Y/N	Good image quality Y/N (magnification, focus, gain)	Correctly measured Y/N (correct landmarks, calliper placement)
HC measurement			
AC measurement			
FL measurement			
AFI (cm)			
UA Doppler measurement PI and SD ratio			
Foetal stomach			N/A
Foetal bladder			N/A
Foetal diaphragm			N/A
Foetal kidneys			N/A
LS view uterus showing placental position/ internal OS/presentation of foetus			N/A
Comments:			
Report filled in correctly? Y/N			

Table 5 Results of the 2011 and 2012 dating scan audits on BRI sonographers

Sonographer	2012 score	2011 score
A	100%	100%
B	X	84%
C	95%	92.2%
D	100%	96%
E	X	84%
F	100%	100%
G	X	96%
H	100%	96%
I	97.2%	92%
J	100%	88%
K	100%	100%
L	96%	98%
M	98%	98%
N	100%	100%
O	X	44%
P	100%	100%
Q	96%	66%
R	100%	86%
T	100%	x
U	98%	x

X = sonographers no-longer working at Trust

were given some supervised sessions with a senior sonographer to help them improve their technique.

A total of 21 sonographers (16 BRI and 5 contracts) took part in the second audit (2012). Their scores ranged from 86% to 100%, with 14 scoring 100%. All 16 BRI sonographers and 4/5 contract sonographers reached the 95% benchmark, compared with 10/18 BRI sonographers in 2011. Of

Table 6 Results of the 2012 dating scan audit on contract sonographers

Sonographer	2012 score	2011 score
S	86%	N/A
V	100%	N/A
W	100%	N/A
X	100%	N/A
Y	100%	N/A

the 16 BRI sonographers, 14 were re-audits. Sonographer Q, who had had some supervised sessions to improve her image quality after the first audit, dramatically improved and gained 96% in the 2012 audit. One contract sonographer did not meet the required benchmark; this sonographer has had a supervised session to improve their practice.

The main issues identified in the dating audits were incorrect CRL magnification (3), incorrect CRL section (5), incorrectly positioned callipers (3) and poor image quality (4).

Incorrect section accounted for the largest number of errors (5/16). Previously, magnification accounted for the greatest number of errors. However, FASP criteria have now changed. Image quality problems included the use of too much overall gain and incorrectly positioned focus. Other issues included poor choice of image/section of the three obtained, slightly oblique CRL section and the use of an average measurement of the three rather than the best. The results were fed back to each individual and any problems addressed.

A good dating scan is essential when used in conjunction with NT screening. From recent data, Bradford has one of the best NT screening results from Down's Syndrome Screening Quality Assurance Support Service (DQASS) in

Table 7 Results of the 2012 and 2013 FNS audits on BRI sonographers. The table shows the scores attained by each sonographer for image quality and images present. It also indicates whether the sonographer has improved their practice between audits

BRI sonographer	2012 % images present	2013 % images present	Improved? Images present	2012 % of images diagnostic	2013 % of images diagnostic	Improved? Images diagnostic
A	x	100%	n/a	x	99.2%	n/a
B	100%	100%	same	96.9%	100%	yes
C	99%	100%	yes	96.9%	100%	yes
D	100%	100%	same	95.4%	100%	yes
E	X	100%	n/a	X	96.2%	n/a
F	X	97.6%	n/a	X	96.2%	n/a
G	100%	100%	same	95.4%	100%	yes
H	97%	100%	yes	90%	99.2%	yes
I	99%	100%	yes	96.1%	99.2%	yes
J	100%	100%	same	94.6%	98.3%	yes
K	99%	100%	yes	90.7%	99.2%	yes
L	X	100%	n/a	X	100%	n/a
M	99%	100%	yes	90.7%	99.2%	yes
N	98%	100%	yes	93.1%	99.2%	yes
O	X	100%	n/a	X	93.9%	n/a
P	100%	100%	same	97.7%	92%	no
Q	98%	100%	yes	96.1%	100%	yes
R	99%	100%	yes	91.5%	100%	yes
S	100%	99.1%	no	93.1%	98.3%	yes
T	91%	100%	yes	86.9%	97.7%	yes

the region and this is with low uptake numbers for screening.

Foetal normality scan audits

FNS audits were carried out in 2012 and 2013. The outcomes of these are summarised in Tables 7 and 8. In 2012, 15 sonographers were audited, of whom 6 (40%) reached the 100% required benchmark for images being present and 7 (46%) reached the required benchmark for image quality. The main issues identified from this audit were poor sagittal spine views and inaccurate measurement of the cerebellum. One sonographer did not measure the cerebellum in all 10 scans. In addition, sonographers were measuring the ventricular atrium (VA) at different points. FASP guidelines indicate VA should be measured at its widest point through the choroid plexus (CP), whereas other literature suggests measurement behind the CP. Some agreement is needed here. Regardless of where the measurement was taken, the callipers were positioned accurately on the ventricle walls by everyone taking part in the audit. Generally, the heart views were of a good quality.

In the 2013 audit, 23 sonographers were assessed. Of these, 3 sonographers were contract workers and had not been audited in 2012, 3 sonographers were new to the department and 2 were newly qualified sonographers but had trained in Bradford. The outcomes of this audit are also shown in Tables 7 and 8. Scores for the presence and diagnostic quality of images were 97.6–100% and 92–100%, respectively. 3/23 sonographers (13%) did not quite reach the 100% benchmark for images present and 3/23

sonographers (13%) did not reach the 95% benchmark for images of diagnostic quality. All sonographers who had participated in the first audit, apart from one, had improved on their previous results.

Sonographer P, who was previously audited but failed to reach the benchmark for image quality in the second audit, was incorrectly measuring the nuchal fold (in our trust we measure the nuchal fold at the FNS scan). On the previous audit, the nuchal fold had been measured correctly. This sonographer was informed of the error and subsequent FNS scans have been audited to ensure that the nuchal fold is being measured correctly. Sonographers F and O did not reach the required benchmarks for the minimum number of required images and for image quality respectively, but both were new to the Trust. All new sonographers have supervised induction scanning sessions before scanning independently, to ensure that they can competently use the equipment and understand the protocols.

Sonographer W was a contract worker whose main issues were the foetal cardiac views. This had been recognised whilst the audit was on-going and a foetal cardiac training session was arranged to improve their technique and practice. Another issue identified in the 2013 audit was that the sagittal cervical and lumbar sacral spine views were often oblique or did not demonstrate the skin surface well.

Growth audits

The growth audit involved 22 sonographers, all of whom obtained the required overall benchmark of 95% or more. The outcomes are shown in Table 9. Sonographers 8 and 21,

Table 8 Results of the 2013 FNS audits on contract sonographers

Contract sonographer	Cases assessed	Images present (%)	Image quality (% good, acceptable, undiagnostic)				% of diagnostic quality	Both benchmarks reached?
W	10	129/130	99.2%	82.3%	11.5%	6.1%	93.9%	no
X	7	91/91	100%	83.5%	12.1%	4.3%	95.7%	yes
Z	10	130/130	100%	81.5%	13.8%	3%	97%	yes

Table 9 Results of the growth audit, showing sonographer scores in the three areas audited and the overall percentage each sonographer attained

BRI sonographer	Score for each case: image present	Score for each case: correctly measured/calliper placement	Score for each case: correct landmarks	Overall percentage
1	100	50	50	200/200 = 100%
2	100	50	50	200/200 = 100%
3	100	50	50	200/200 = 100%
4	100	49	50	199/200 = 99.5%
5	100	49	49	198//200 = 99%
6	100	48	50	198/200 = 99%
7	98	47	50	195/200 = 97.5%
8	94	46	49	189/200 = 95%
9	100	46	49	195/200 = 97.5%
10	100	50	50	200/200 = 100%
11	100	50	50	200/200 = 100%
12	100	50	50	200/200 = 100%
13	99	49	50	198/200 = 99%
14	100	50	49	199/200 = 99.5%
15	100	48	49	197/200 = 98.5%
16	100	47	49	196/200 = 98%
17	99	50	50	199/200 = 99.5%
18	100	47	49	196/200 = 98%
19	98	49	45	192/200 = 96%
Contract sonographer	Score for each case: image present	Score for each case: correctly measured/calliper placement	Score for each case: correct landmarks	Overall percentage
20	100	50	45	195/200 = 97.5%
21	98	44	49	191/200 = 95.5%
22	98	45	49	192/200 = 96%

who obtained benchmarks of 95% and 95.5%, were already aware of the areas they needed to improve on, such as image quality and choosing accurate presets. These errors had been identified whilst the audit was being performed.

Issues identified included the use by many sonographers of average measurements instead of the most accurate measurement recorded. It has been highlighted to sonographers that they need to review their images of measurements first and then select the best measurement taken. Image quality issues included the use of incorrect landmarks for the head circumference (HC) measurement; sonographers tended to measure the HC with the thalamus as a landmark, which was the old standard of practice. A common finding was unsatisfactory femur length (FL)

image quality. Depth, magnification, sector width and zoom were often not fully utilised when imaging the FL.

The results revealed that protocols were not being adhered to in some cases. The most common finding was there were only two AC measurements taken instead of three. Some incorrect umbilical artery Doppler measurements were quoted in the scan reports. This error occurred as some sonographers were using auto-trace. Once an auto-trace had been calculated, the sonographer did not ensure that the callipers had been correctly placed on the trace obtained. This was highlighted early on in the audit and involved the same two scanning machines. As this could have potentially altered the patient's management, all sonographers were informed of this error immediately.

Table 10 Foetal anomaly detection rate for Bradford Teaching Hospitals NHS Foundation Trust

Conditions	National detection rate target	Bradford detection rate, 2010–2011	Bradford detection rate (antenatal), 2011–2012	Bradford detection rate at 20-week scan, 2011–2012	Notes 2011–2012
Anencephaly	98%	100%	100%	100%	
Open Spina Bifida	90%	100%	100%	85.7%	7 cases in total: - 6 detected at or before 20-week scan - 1 case detected at 22 + 1
Cleft palate	75%	80%	90.9%	62.5%	Of 8 clefts: - 5 detected at or before the 20-week scan - 2 were scanned in the 20-week period and scheduled for rescans before 23 weeks, at which point the cleft was detected
Cleft palate with cleft lip		100%			- in 1 case, the cleft was only detected postnatally, despite scan at 20 + 3
Detection rate overall		90%			
Diaphragmatic hernia	60%	100%	100%	85.7%	7 cases in total - 6 detected at or before 20-week scan - 1 case was first detected at 31 + 5 – scan at 20 + 1 did not detect DH
Gastroschisis	98%	100%	100%	100%	
Exomphalus	80%	100%	100%	100%	
Serious cardiac abnormalities	50%	66%	66.6%	33.3%	6 cases in total: - 2 detected at or before 20-week scan period - 2 cases scanned in 20-week period, and scheduled for rescan before 23 weeks – anomaly detected at rescan - 2 cases scanned in 20-week period and missed.
Bilateral renal agenesis	84%	100%	No cases	No cases	
Lethal skeletal dysplasia	60%	No cases	100%	100%	
Edwards syndrome		100%			
		Only 1 case			
Down's syndrome		Not calculated	Not calculated	Not calculated	Not calculated Part of NT screening programme

Foetal abnormality detection rate

All foetal anomalies found antenatally at scan or at delivery were reported to YHCAR and documented. At the end of each year, the data were collated and a foetal abnormality detection rate was calculated for the auditable conditions (Table 10). This detection rate has shown that as a department, the majority of foetal anomalies prior to delivery are detected. In both the years calculated, 2011–2012 and 2010–2011, the nationally agreed detection rates for the auditable conditions were met. The data supplied by YHCAR have been used as a tool to review missed anomalies in the antenatal period and to assess how we can improve on our practice.

In year 2011–2012, the data were further assessed to review which anomalies were detected at or before the 20-week scan. It was noted that a spina bifida, 2 cleft lips and 2 serious cardiac defects were detected at the second FNS scan at 22w 6d. Most completion FNS scans are booked on patients with a high body mass index (BMI). A

diaphragmatic hernia was not detected at the routine 20-week FNS scan, but was found on a subsequent growth scan at 31w 5d as we routinely image and assess the diaphragm on growth scans. Reassuringly, our detection rate for serious cardiac foetal anomalies for both years was 66.6%. In year 2011–2012, all fetuses with anencephaly had been detected at the initial dating scan at around 12.5 weeks.

Data from YHCAR shows that Bradford reports more foetal anomalies than any other Trust in the region. This shows there is a good mechanism in place for reporting foetal anomalies found antenatally at scan.

Discussion

In Bradford, we have implemented a rolling programme of audit of the obstetric scanning service following recommendations of from FASP and NICE, using measurable audit parameters.³ Re-audit of dating scans and FNS scans

demonstrated that the audit process, with feedback, has improved sonographer practice. In the 2012 dating scan audit, 16/16 BRI sonographers reached the 95% benchmark, compared to just 10/18 in 2011. In the 2013 FNS audit, 18/20 BRI sonographers reached the 100% mark for images present and 19/20 reached the 95% mark for image quality compared to 6/15 and 7/15 respectively in 2012.

The audit programme identified a range of examples of poor adherence to scanning protocols, such as the use of inappropriate magnification, image section and caliper positioning. However, once identified, most of these practices have been corrected by retraining the individuals concerned. The audits highlight the importance of a rolling programme of continuous audits to ensure protocols are being adhered to and to maintain high standards of scanning. Audits can be a tool to help standardise the practice between different sonographers, which is helpful for training of ultrasound students and other medical personnel.

Sonographers have been made aware of the need to produce accurate measurements and images are of an acceptable quality. Images on PACS can be reviewed by other medical staff for MDT meetings or if foetal anomalies have been missed. If the scan report is correct and the images are of a good quality, rescans may be avoided and complaints or legal challenges easily answered.

Audits can also identify the need for changes in protocols. We have changed our protocols to reflect the lessons learned, e.g. on high risk pregnancies, if an anomaly scan is not complete on the second FNS scan, further attempts to complete the anatomy survey should be made on any further serial growth scans performed. This is particularly important on multiple pregnancies.

Comparison of foetal abnormality detection rates with national detection rate targets has shown that the Bradford obstetric scanning service exceeded the target detection rate for antenatal detection, although not all cases were detected at or before the 20-week scan. This has been reassuring to staff and enables patients to have the appropriate counselling and be given choices on further management of the pregnancy before delivery.

In addition to the measured improvements in practice, the attitude of sonographers to audit has changed. Some sonographers initially felt threatened by the process but now see it as a valuable tool and are now happy for scans to be randomly selected for audit rather than choosing themselves. The audit results are discussed at yearly appraisals and all sonographers see this as a positive approach. Sonographers who do not obtain the required benchmarks have a supportive action plan put in place to help them to meet the required standards. Audit has now been implemented on a rolling programme for all areas of ultrasound at Bradford.

The audits as described have some limitations. The FNS audit only included complete 20-week scans. The results would hence exclude many high BMI patients who are re-booked for a completion scan. Future audits need to be more focused, reviewing and assessing scans on high BMI patients or mini audits, reviewing the foetal spine views where issues have been highlighted.

Conclusion

Audit of obstetric ultrasound screening services is necessary to ensure that they are effective in reducing maternal morbidity. We have demonstrated that a rolling programme of audits, using criteria based on national guidelines, can lead to improvements in the quality and consistency of obstetric ultrasound services. Audit can identify shortcomings in ultrasound scanning and measurement techniques and lead to effective changes being implemented, resulting in improved patient care.

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