An audit of antenatal ultrasound scans from 22 hospitals in England and Wales during 2007

Report on behalf of the NHS Fetal Anomaly Screening Programme

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Contents

Main findings

22 hospitals participated in the audit, providing data on 5,858 scans, which were classified as routine (dating and anomaly) or non-routine (pre-dating, post-anomaly and between dating and anomaly).

Overall, 57% of scans were recorded as routine and 43% as non-routine. The proportion of non-routine scans varied from 29% to 54% between hospitals. In 6 of the 22 hospitals, non-routine scans accounted for the majority (>50%) of scans performed.

Routine scans

All hospitals participating in the audit had a policy of offering routine dating and anomaly scans; the majority performed them at the recommended gestations.

Dating scans – approximately 28% of all scans

- The overall median gestational age at the time of scan was 12 weeks. The median gestational age varied from 10 to 13 weeks across hospitals

- 77% of dating scans were performed within the recommended gestational age range of 10 weeks 0 days to 13 weeks 6 days

- 10% of all dating scans were performed before 10 weeks gestation, 13% were performed at 14 weeks or later

- 7% of dating scans failed to be completed within the scheduled appointment time and required a further appointment. This failure rate ranged from 0% to 17% across hospitals

- There was strong evidence of variation in failure rates between hospitals. Higher rates of failure were associated with early gestational age

- There was wide variation in times scheduled for dating scans (10-30 minutes)

Anomaly scans – approximately 30% of all scans

- The overall median gestational age at the time of scan was 20 weeks. The median gestational age varied from 19 to 22 weeks across hospitals

- 70% of anomaly scans were performed within the recommended gestational age range of 18 weeks 0 days to 20 weeks 6 days

- 1% of all anomaly scans were performed before 18 weeks gestation, 29% were performed at 21 weeks or later

- 13% of anomaly scans failed to be completed within the scheduled appointment time and required a further appointment. This failure rate ranged from 0% to 29% across hospitals

- There was strong evidence of variation in failure rates between hospitals. Higher rates of failure were associated with early gestational age and high BMI

- There was wide variation in times scheduled for anomaly scans (15-30 minutes)

Non-routine scans

Pre-dating scans – approximately 13% of all scans

- The overall median gestational age at the time of scan was 7 weeks. The median gestational age varied from 6 to 8 weeks across hospitals

- The most frequent reasons for referral related to possible miscarriage or ectopic pregnancy. These included indications of early pregnancy bleeding and pain

- The professionals performing the pre-dating scans considered the referral to be inappropriate in 10% of pre-dating scans. This accounts for 3% of all non-routine scans and 1% of all scans covered by the audit

Scans performed between the dating and anomaly scans – approximately 3% of all scans

This relatively small sample of scans (n=159) was excluded from further analysis.

Post-anomaly scans – approximately 27% of all scans

- The overall median gestational age at the time of scan was 33 weeks, varying from 30 to 36 weeks across hospitals

- Indications relating to small size were the most frequent reason for referral, followed by placental site localisation, twin pregnancy, confirmation of presentation, previous large or small baby, clinically suspected large for dates, diabetes and reassurance

- The most frequent interval between growth scans was 4 weeks

- The professionals performing the post-anomaly scans considered the referral to be inappropriate in 17% of post-anomaly scans. This accounts for 11% of all non-routine scans and 5% of all scans covered by the audit

Key messages

- Lowest failure rates for routine dating scans were associated with those performed between 11 weeks 0 days and 13 weeks 6 days gestation

- For women with a BMI of 30 or above, moving the routine anomaly scan nearer to 20 weeks is likely to reduce the number of failed scans

- In the absence of clinical indications in later pregnancy, a repeat scan for placental site should only be undertaken when the placenta covers the internal cervical os at the time of the routine anomaly scan and should not be carried out before 32 weeks unless there is an additional clinical indication such as vaginal bleeding or threatened premature labour

- Units should review the need for repeat fetal growth scans and ensure that if required, they are undertaken at an appropriate interval

- Scans to check fetal presentation should not be carried out before 36 weeks gestation in the absence of additional clinical indications such as threatened premature labour

- Units should aim to reduce all scan appointments to the most effective minimum

- Communication between referrer and sonographer should be optimised. This may be achieved by:

    (i)   the development of a national referral card

    (ii)   referrers reviewing the results of previous scans prior to making a further referral

1 Introduction

1.1 Background

The first report on antenatal ultrasound was published in 1958 by Donald and colleagues[1]. During the 30 years following this report, there has been a gradual and haphazard introduction of the technique into clinical practice in the UK. Several working parties have considered the clinical effectiveness of scans and what scans should be offered and when, both routinely and for specific clinical indications. In 1984, a Royal College of Obstetricians and Gynaecologists (RCOG) Working Party[2] suggested that a single routine scan at 16-18 weeks gestation might be beneficial. In 1991, an RCOG Study Group[3] recommended a routine "anomaly" scan between 18 and 20 weeks gestation. The 1997 RCOG Working Party on Ultrasound Screening for Fetal Abnormalities[4] reported that one of the problems with screening scans was the variable way in which they were conducted across the country. It was also reported that there were no clear guidelines as to what should, or should not, be examined. A supplementary report (2000)[5], produced by an RCOG Working Party that began in 1998, recommended that a two stage (routine dating and anomaly) ultrasound examination programme was acceptable. This is endorsed in the current (2008) National Institute for Health and Clinical Excellence (NICE) guidelines[6]. Furthermore, there is now an agreed policy for screening for fetal anomalies using ultrasound set out by the Department of Health through the UK National Screening Committee (UK NSC) and supported by the National Services Framework (NSF)[7] and NICE.

The UK NSC has the remit to receive and review evidence on screening. Advice on implementation is then provided to the Ministers of the four UK countries who decide whether screening should be implemented into the NHS. The remit to interpret this policy and provide a comprehensive service for England has been given to the NHS Fetal Anomaly Screening Programme (NHS FASP), who commissioned the work set out in this report.

There have been few surveys or national audits aimed at identifying which scans are offered in different hospitals across the country. A survey in 1995, from the RCOG/Royal College of Radiology (RCR)[8] indicated that at least three quarters of the country used the two stage (routine dating and anomaly) ultrasound examination. In 2002, a survey commissioned by the UK NSC[9], provided a snapshot of the ultrasound screening services in place in England and reported a variation in the types of scans offered by different hospitals. With regard to routine scans, it was found that 53% of hospitals offered dating scans, 97% anomaly scans and 1.5% a routine Doppler or third trimester scan. The performance of non-routine scans was not addressed in this particular survey.

Following the 2002 survey[9] and two national conferences arranged by the UK NSC for ultrasonographers, a discussion was held concerning the number and type of referrals for non-routine antenatal scans made to ultrasound units. This discussion covered points such as large variations in practice between hospitals regarding referrals, poor agreement on criteria for requesting an ultrasound scan and the issue that some referrals may be inappropriate. Coinciding with this discussion, a review in 2003, leading to a British Medical Ultrasound Society (BMUS) strategy document (Bates et al, 2003)[10], outlined the fact that, in the UK, increasing demand for all ultrasound services and inadequate resources has led to long waiting lists for ultrasound scans. Consequently, an audit to "map" the current national position regarding antenatal ultrasound referrals in England and Wales was proposed. This audit is therefore particularly timely, as demands on ultrasound units have increased with the introduction of nuchal translucency (NT) scanning.

1.2 Aims and objectives

This audit aims to identify whether there are differences in patterns of antenatal ultrasound referrals in a selected sample of hospitals in England and Wales in 2007, as well as addressing whether variation exists within and between hospitals.

How can this information inform improvement in the provision of antenatal ultrasound services?

The key objectives of this audit are:

- To determine areas where antenatal ultrasound referrals could be rationalised by attempting to state which referrals are considered appropriate

- To compare existing practices against current guidelines concerning the appropriateness of ultrasound scan referrals

- To identify areas for further research in order to set guidelines on making referrals

In order to achieve the objectives stated above, the following plan was developed:

- To categorise routine scans by type and explore:

  - Gestational age at the time of the scan

  - Time scheduled and time taken to perform the scan

  - Rate of failure to complete the scan within the scheduled appointment time

- To categorise non-routine referrals by type and explore:

  - Gestational age at the time of the scan

  - Source and reason for non-routine referral

- To investigate the workload composition within and between hospitals

- To highlight areas of significant variation in relation to existing referral recommendations

2 Methods

2.1 Forming the core study group and expert advisory panel

A core study group was set up to carry out the audit and analyse the results. The group comprised individuals from different backgrounds including antenatal ultrasonography, midwifery, statistics and prenatal genetics. A panel of experts was formed to advise the core group and to set guidelines. Their expertise encompassed obstetrics, fetal medicine, midwifery, general practice and perinatal epidemiology. Membership of the core and expert groups is detailed in Appendix 1.

2.2 Design

This audit was designed as a cross sectional survey covering every antenatal ultrasound scan in a selection of hospitals across England and Wales over a two to three week period.

2.3 Selection of participating hospitals

An audit based on a full census or random sample of hospitals was considered but rejected due to the associated increase in workload for those conducting the audit, as well as staff shortages affecting some hospitals. Instead, the sample of hospitals included in the audit was obtained by inviting those ultrasonographers attending the 2005 UK NSC Ultrasound conferences to volunteer their unit for inclusion. This approach allowed individual hospitals to assess the feasibility of participation. Interest was expressed by staff from 32 hospitals. After consideration of the number of potential scans, geography and feasibility of data collection, agreement to participate was given by 23 of the hospitals. Audit data were collected from 22 of these. The names of the participating hospitals are given in Appendix 2 and their locations are shown on the map in Figure 1. As can be seen from Figure 1, this sample covers many of the main population centres in England and Wales. Background information about each of the participating hospitals was obtained through questionnaires and telephone interviews with the designated sonographer from each hospital, who was responsible for overseeing the conduct of the audit. This information is summarised in Tables 1 and 2.
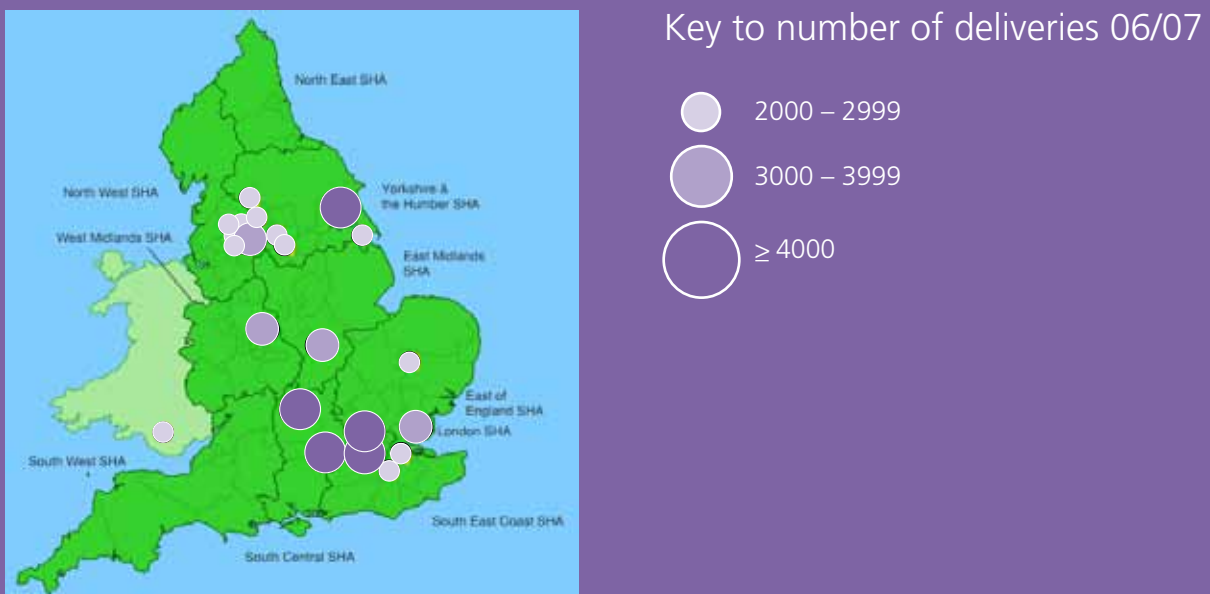

Key to number of deliveries 06/07

2000 – 2999

3000 – 3999

≥ 4000

Figure 1: Map of England and Wales showing locations of participating hospitals

Participating Hospital ID	Number of women delivered in 2006/2007*	Type of hospital	Number of questionnaires returned with information on the type of scan	Specialist clinics (EPAU, FMU, PND)† present in hospital / included (I) / excluded (Ex) from audit		Down's Syndrome screening (NHS) - 1st or 2nd trimester in place July '07	Audit period (days)
1	3,893	Tertiary	283	EPAU I	FMU I	1st	5
2	2,387**	Secondary	297	EPAU I		2nd	20
3	5,356	Secondary	267	EPAU I		2nd	15
4	3,625	Secondary	296	EPAU I		2nd	9
5	2,570	Secondary	272	EPAU I		2nd	10
6	3,390**	Secondary	273	EPAU I	FMU I	2nd	6
7	2,416	Secondary	226	EPAU I		2nd	18
8	2,398	Secondary	110	EPAU I	FMU Ex	1st	5
9	2,443	Secondary	114	EPAU I		2nd	5
10	4,235	Secondary	317	EPAU I		1st	5
11	3,732	Secondary	338	EPAU I		2nd	5
12	6,201	Tertiary	482	EPAU I	FMU Ex PND I	2nd	19
13	2,713	Secondary	297	EPAU Ex		2nd	10
14	3,100	Secondary	299	EPAU Ex		2nd	11
15	2,191	Secondary	266	EPAU Ex		2nd	14
16	2,313	Secondary	242	EPAU Ex		2nd	10
17	2,250	Secondary	310	EPAU Ex		2nd	14
18	4,547	Secondary	321	EPAU I	FMU I	1st	5
19	2,882	Secondary	300	EPAU I		2nd	11
20	2,896	Secondary	180	EPAU I		2nd	16
21	2,728	Secondary	180	EPAU I	FMU Ex	2nd	10
22	2,659	Secondary	188	EPAU I		2nd	10
Totals	70,925		5,858				

Table 1: Characteristics of the participating hospitals

* Data from Commission for Healthcare Audit and Inspection 2008 unless stated ** when numbers of deliveries supplied from individual hospitals
† EPAU: Early Pregnancy Assessment Unit, FMU: Fetal Medicine Unit, PND: Prenatal Diagnosis Unit (see Glossary for definitions)

2.4 Development of the audit questionnaire

Following meetings with the expert group, a questionnaire was developed to obtain information on referrals associated with antenatal ultrasound scans performed in each participating hospital during the proposed audit period. The aim was to include information on all antenatal scans within the hospital, including scans performed in antenatal clinics, ultrasound units, early pregnancy assessment units (EPAU), fetal medicine units (FMU) and prenatal diagnosis units (PND). Information on referrals requested prior to termination of pregnancy was excluded from the audit process.

In January 2007, a pilot study was carried out in three of the participating hospitals (ID numbers 4, 5 and 12). This was undertaken to assess the feasibility of data collection and to obtain feedback on the questionnaire and audit processes. Changes were made and a second pilot study was conducted in April 2007. On the basis of this and discussion with the expert group, further modifications were made and the questionnaire and study processes were finalised.

To address the aims of the audit, the questionnaire was designed to provide information covering three main areas; maternal characteristics, details of the current scan and details of any previous scans in the current pregnancy.

Participating Hospital ID	Protocol in place concerning referrals (Yes / No)	Routinely perform NT with dating scans (Yes / No)	Time (minutes) allocated for scans			
			Early Pregnancy	Dating	Anomaly	Growth
1	Yes	Yes	30	30	30	30
2	Yes	No	15	15	20	15
3	Yes	No	15	15	30	15
4	Yes	No	20	20	30	30
5	Yes	No	20	15	20	20
6	Yes	No	15	15	20	15
7	Yes	No	20	15	30	20
8	Yes	No	20	20	20	20
9	Missing data	No	10	10	30	20
10	Yes	Yes	15	15	20	15
11	Yes	No	20	10	20	15
12	Yes	No	20	15	30	15
13	Yes	No	15	15	15	15
14	Yes	No	10	10	20	10
15	Yes	No	10	10	20	10
16	Yes	No	15	15	20	20
17	Yes	No	20	10	20	20
18	Yes	Yes	15	20	15	15
19	No	No	20	20	25	20
20	Yes	No	15	15	30	15
21	Yes	No	20	20	20	20
22	Yes	No	20	15	20	20

Table 2: Background information on the participating hospitals

Maternal characteristics included first half of postcode, age, Body Mass Index (BMI) (or height and weight), whether the pregnancy was multiple and / or the result of In Vitro Fertilisation (IVF). Information was also collected on any previous pregnancies.

Information requested on the current scan covered; source of referral, person performing the scan, presence of other health professional, time allocated and time taken for the appointment and whether the referral was considered appropriate. These scans were categorised as either pre-dating, dating, between dating and anomaly, anomaly or post-anomaly. If the current scan was a routine dating or anomaly scan further information was requested on whether an NT scan was included with the dating scan, whether there had been previous appointments for the scan and whether the scan was completed successfully.

For non-routine scans, data on up to three reasons for referral were requested as well as whether the referral was due to a previous or current pregnancy problem. Information was also requested on the components of the scan. Equivalent information on the previous scan was obtained if such a scan had been performed in the same pregnancy. Summary details of the number and type of previous scans was also obtained.

Guidelines on how to fill in the questionnaire were printed with it and a telephone contact was given to the designated lead for any queries during the audit. The questionnaire and the instructions for its completion are given in Appendix 3.

2.5 Sample size and duration of the audit

It was considered important that the audit period covered complete weeks and complete cycles of workload to achieve a sufficiently large sample free from biases that might occur due to rota patterns or clinic schedules. For the audit, it was requested that hospitals cover all referring clinics and departments at least once to capture the full range of different referrals received by the ultrasound department. For example, some hospitals offer specific clinics for pregnant women with diabetes every week or fortnight. This resulted in some ultrasound departments running the audit for more than two weeks.

Given that the focus of the analysis was on descriptive measures and in particular comparison of proportions between hospitals, the sample size was determined to produce adequate precision in the estimated proportions. A sample size of 300 referrals per hospital was determined as a practical compromise between the burden of data collection and precision. This sample size gives estimated proportions with a standard error of less than 3%. In larger hospitals, 300 scans correspond to approximately one week's workload while in smaller hospitals this equates to approximately two weeks' workload.

2.6 Conduct of the Audit

Prior to the audit, guidance on completing the questionnaire was provided to each ultrasound department. A designated lead sonographer from each hospital was invited to attend a training session on conducting the audit. This training was cascaded down by the designated leads to the sonographers completing the questionnaires.

Questionnaires were sent to the designated lead sonographer in each hospital who oversaw training, distribution of the forms and return of the completed forms to the study centre. The audit was carried out at each hospital over a period of one to three weeks. Nineteen of the hospitals completed the audit in July 2007 and three in August 2007.

Following completion of the audit, the designated leads were asked to complete a further questionnaire in order to ascertain any differences in departmental protocol (such as time allocated for specific scan types) as well as the specific circumstances surrounding the running of the audit. They were also asked to estimate the proportion of scans performed during the audit period, for which a questionnaire was completed.

2.7 Data management

The participating hospitals sent their completed questionnaires to the National Programme Office of the NHS FASP, with the first received in July 2007 and the last in September 2007. Here, the number of questionnaires returned was recorded. They were then forwarded to a clinical audit manager who developed a database recording the questionnaire data.

A system of independent double data entry, overseen by a member of the core group, was used to minimise transcription errors[11]. This double entry was completed by CFEP UK Surveys, who estimated the error rate between the data entry personnel to be 0.82%. The questionnaire required free text answers in certain sections. These comments were transcribed by the data entry personnel and coded manually. These codes were discussed and agreed by the expert group.

All data entered from the questionnaires were anonymous; i.e. the women having the scan could not be identified: this precludes the possibility of obtaining follow up information on the women during the audit.

Since the conclusion of the data entry stage of the audit in the August of 2008, the questionnaires have been stored in the National Programme Centre of the NHS FASP.

2.8 Feedback to participating hospitals

The designated lead from each participating hospital will be given the opportunity to access their individual audit results. They will also be able to discuss these results with a member of the core study group.

2.9 Analysis of the data

An analysis plan was written and subsequently refined following consultation with the expert group. The analysis, which comprises mainly tabular and graphical summaries, was conducted using S-Plus[12]. Scan failure rates were analysed using logistic regression with hospital, gestational age, BMI, singleton/multiple pregnancy and scheduled appointment time as explanatory variables. Documented S-Plus functions were written for the analysis to ensure reproducibility of the results.

3 Results

3.1 Description of sample

Completed questionnaires were received from 22 hospitals; their characteristics are detailed in Table 1. The hospitals were classified by type as either tertiary (n=2) or secondary (n=20). In the hospitals taking part in the audit, there were a total of 70,925 deliveries (range 2,191 – 6,201) recorded in the year 1st April 2006 to 31st March 2007[13]. All of the hospitals had EPAUs and in all but five, scans performed in the EPAU were included in the audit. Six hospitals had FMUs; scans from three were included in the audit. Of the three hospitals whose FMU data was excluded, one provided data from a PND unit.

There was a total of 5,923 questionnaires returned of which 5,858 (99%) had information on scan type recorded. The number of questionnaires returned per hospital (and therefore scans performed during the audit) varied from 110 to 482.

It was requested that all routine and non-routine antenatal ultrasound scans were recorded (except for those relating to termination of pregnancy). In some cases, this was not achieved due to staff shortages or logistical obstacles, for example, flooding. In estimating the proportion of eligible scans included in the audit, the lead sonographers reported the following:

- 7 of the 22 hospitals included all eligible scans

- 11 included between 80% and 95%

- 2 included 75%

- 2 included 50% (both excluded the EPAU)

Eighteen of the 22 hospitals had primarily a second trimester screening policy for Down's syndrome and three included a first trimester NT scan in their policy. Routine dating and anomaly scans were offered in all hospitals.

Table 2 reports, for each hospital, the existence of protocols regarding referrals and routine performance of NT scans, together with times allocated for different scan types. The time allocated for a scan varied between hospitals; from 10 to 30 minutes for early pregnancy scans, dating scans (+/- NT scan) and growth scans, while allocated appointment times for anomaly scans varied from 15 to 30 minutes.

Background information on maternal characteristics was recorded in order to aid the explanation of variations in the results of the audit. This information, together with data concerning the person performing the scan, the source of referral and whether the referral was considered appropriate are provided in Appendix 4. The daily counts of questionnaires completed (and thus scans performed in the audit), are also shown in Appendix 4.

3.2 Scan performed at time of audit – "Today's scan"

Of the 5,858 scans recorded during the audit period 3,354 (57%) were classified as routine (1,623 dating scans; 1,731 anomaly scans) and 2,504 (43%) as non-routine. Table 3 shows the total number (and percentage) of scans performed in each hospital during the audit period by type of scan; routine (dating / anomaly) or non routine (pre-dating / between dating and anomaly / post anomaly).

Figure 2 shows the approximate overall percentage of scans by type. Dating scans accounted for 28% of all scans while 30% were anomaly scans. Pre-dating scans made up 13%, between dating and anomaly scans 3% and post-anomaly scans 27%.

Figure 3a shows the proportion of scans undertaken in each hospital, which were classified as routine. Further subdivision by routine scan type is also shown. The results are ordered by the magnitude of the proportions. Figure 3b presents the equivalent information for non-routine scans. The hospitals are given in the same order as in Figure 3a. The proportion of scans that were non-routine varied from 29% to 54% across hospitals. In 6 of the 22 hospitals, non-routine scans accounted for more than 50% of scans performed.

Participating Hospital ID	Routine scans						Non-routine scans								All scans
	Dating		Anomaly		Overall		Pre-dating		Between dating and anomaly		Post-anomaly		Overall		Total
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n
1	70	(25)	60	(21)	130	(46)	63	(22)	6	(2)	84	(30)	153	(54)	283
2	60	(20)	106	(36)	166	(56)	34	(11)	7	(2)	90	(30)	131	(44)	297
3	111	(42)	58	(22)	169	(63)	73	(27)	8	(3)	17	(6)	98	(37)	267
4	97	(33)	108	(36)	205	(69)	33	(11)	5	(2)	53	(18)	91	(31)	296
5	95	(35)	91	(33)	186	(68)	21	(8)	12	(4)	53	(19)	86	(32)	272
6	52	(19)	80	(29)	132	(48)	52	(19)	4	(1)	85	(31)	141	(52)	273
7	51	(23)	72	(32)	123	(54)	19	(8)	7	(3)	77	(34)	103	(46)	226
8	24	(22)	30	(27)	54	(49)	16	(15)	3	(3)	37	(34)	56	(51)	110
9	36	(32)	27	(24)	63	(55)	11	(10)	1	(1)	39	(34)	51	(45)	114
10	80	(25)	77	(24)	157	(50)	56	(18)	12	(4)	92	(29)	160	(50)	317
11	82	(24)	75	(22)	157	(46)	31	(9)	6	(2)	144	(43)	181	(54)	338
12	108	(22)	177	(37)	285	(59)	72	(15)	13	(3)	112	(23)	197	(41)	482
13	104	(35)	80	(27)	184	(62)	63	(21)	8	(3)	42	(14)	113	(38)	297
14	62	(21)	77	(26)	139	(46)	25	(8)	17	(6)	118	(39)	160	(54)	299
15	80	(30)	76	(29)	156	(59)	8	(3)	5	(2)	97	(36)	110	(41)	266
16	76	(31)	77	(32)	153	(63)	31	(13)	4	(2)	54	(22)	89	(37)	242
17	92	(30)	87	(28)	179	(58)	40	(13)	8	(3)	83	(27)	131	(42)	310
18	91	(28)	92	(29)	183	(57)	58	(18)	8	(2)	72	(22)	138	(43)	321
19	110	(37)	85	(28)	195	(65)	31	(10)	4	(1)	70	(23)	105	(35)	300
20	36	(20)	74	(41)	110	(61)	3	(2)	6	(3)	61	(34)	70	(39)	180
21	41	(23)	54	(30)	95	(53)	17	(9)	8	(4)	60	(33)	85	(47)	180
22	65	(35)	68	(36)	133	(71)	15	(8)	7	(4)	33	(18)	55	(29)	188
Totals	1623	(28)	1731	(30)	3354	(57)	772	(13)	159	(3)	1573	(27)	2504	(43)	5858

Table 3: Description of sample
Total number (and percentage) of scans performed in each hospital during the audit period, by type of scan

Row percentages may not sum to 100 due to rounding.
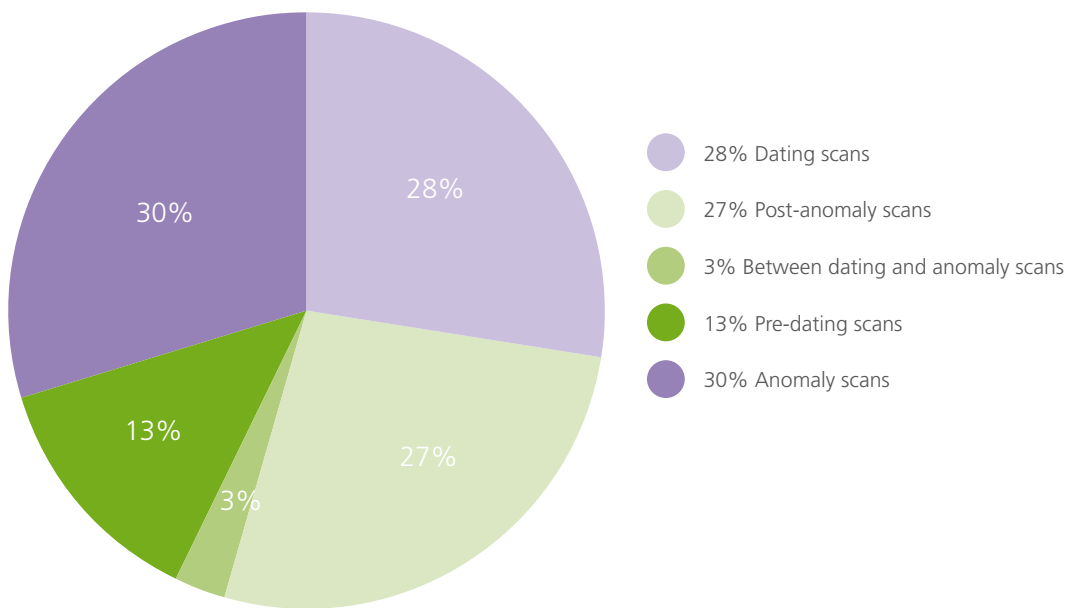
- 28% Dating scans
- 27% Post-anomaly scans
- 3% Between dating and anomaly scans
- 13% Pre-dating scans
- 30% Anomaly scans

Figure 2: Composition of workload (approximate percentage of scans) by type of scan for all participating hospitals
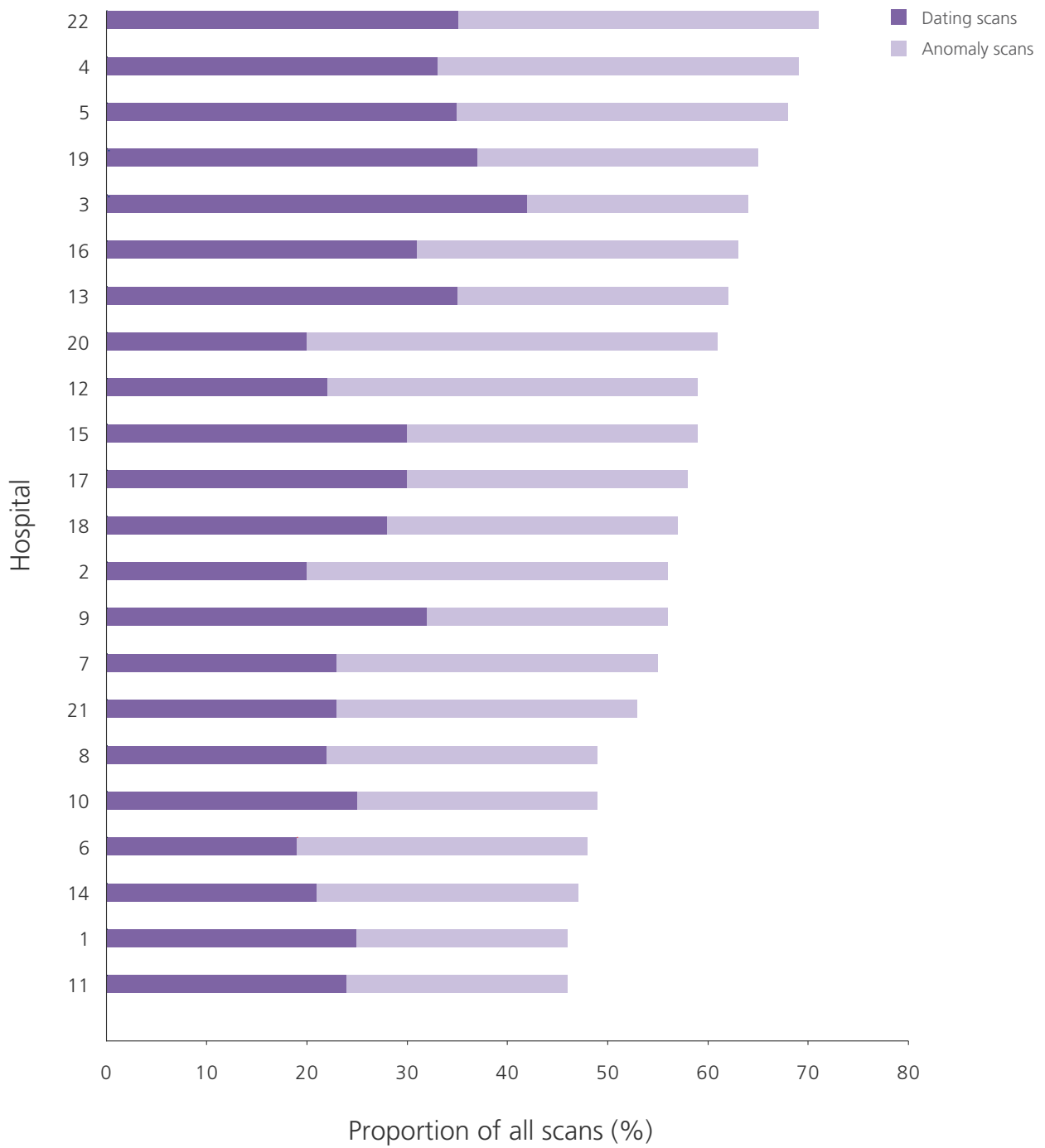
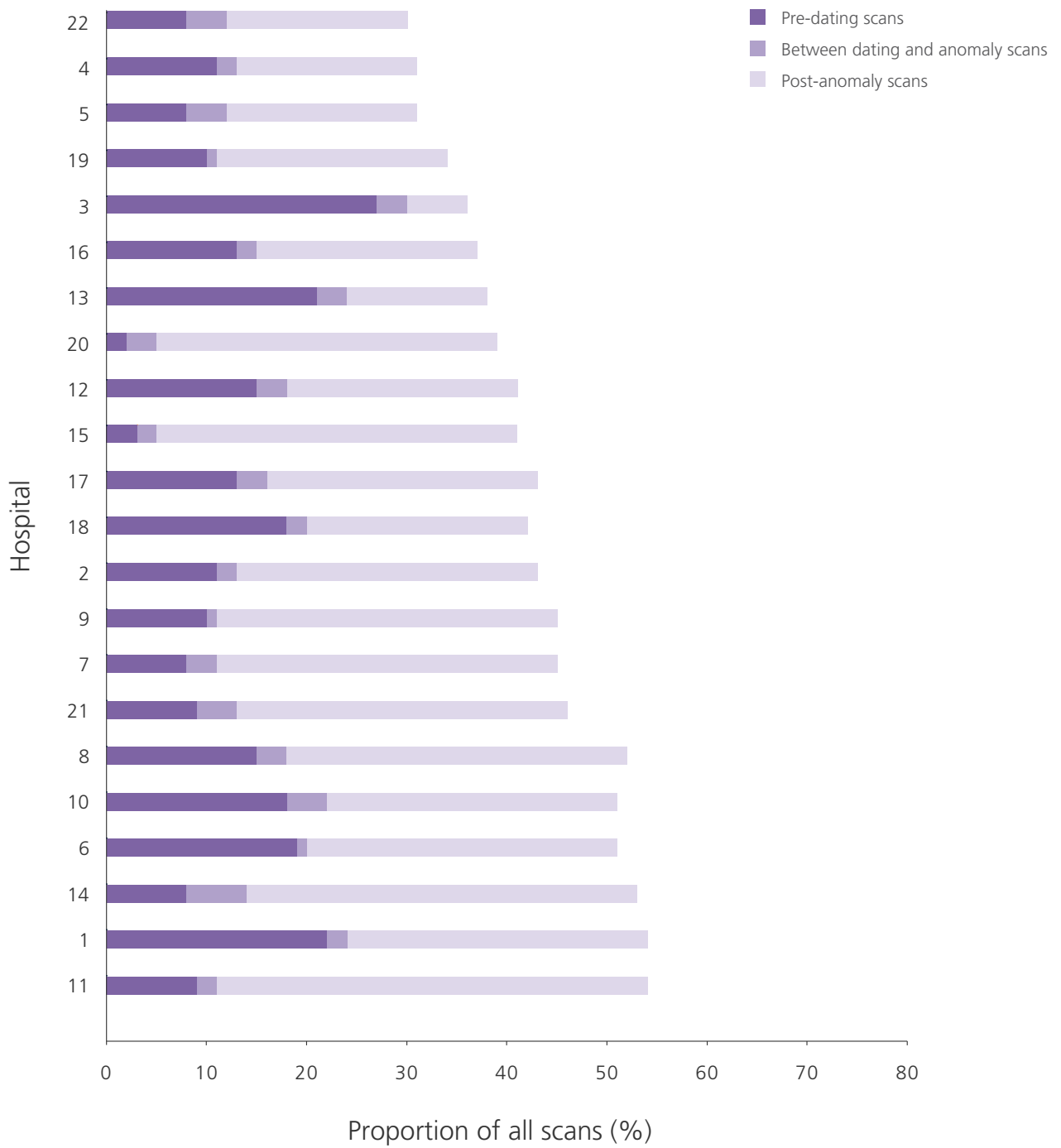*Figure 3a: Contribution to workload of routine scans for each of the participating hospitals*

Figure 3b: Contribution to workload of non-routine scans for each of the participating hospitals

3.3 Routine scans

Across hospitals, the breakdown of routine scans varied from 66% dating-34% anomaly to 33% dating-67% anomaly.

3.3.1 Dating scans: n = 1,623 (28% (range 19-42%) of all scans)

Gestational age at the time of dating scan by hospital is shown in Figure 4 while Table 4 summarises some features of dating scans.

The overall median gestational age at dating scan was 12 weeks and the medians ranged from 10 to 13 weeks across hospitals. NICE recommended gestational age limits for dating scans are 10 weeks 0 days to 13 weeks 6 days. Overall, 23% of scans were performed outside this range; 10% prior to 10 weeks (range 0-38%) and 13% at 14 weeks or later (range 0-40%). Three hospitals include a routine NT scan as part of their Down's syndrome screening policy. These hospitals (1, 10 and 18) performed an NT scan with the dating scan in 71%, 88% and 73% of appointments respectively. The remaining hospitals performed an NT scan with, at most, 5% of dating scans.

Overall 7% of the dating scans could not be completed in one appointment; this failure rate ranged from 0% to 17% across hospitals. Failure to complete dating scans was significantly associated with both hospital (P<0.0001) and gestational age (P<0.0001). Excluding missing data and scans for which gestational age was reported as 0, the overall failure rate of dating scans performed before 11 weeks was 16% (46/279) compared to 4% (48/1164) for scans performed at 11 weeks or later. Of the three hospitals routinely performing NT scans, the proportion of failures was 78% (14/18) for scans performed before 11 weeks and 5% (11/217) for scans performed at 11 weeks or later. For hospitals not including NT scans, the failure rates were 12% and 4% respectively.

Allowing for differences between hospitals and gestational ages, the failure rate varied significantly between singleton and multiple pregnancies (P = 0.02). The failure rate for multiple pregnancies was 10% (34/334) compared to 7% (87/1289) for singleton pregnancies. BMI was not a significant factor in influencing failure rates of dating scans.

These results show that most failures of dating scans are due to the woman being scanned too early in pregnancy. Each hospital has different guidelines or protocols regarding making a repeat appointment for a scan performed too early in pregnancy for an accurate assessment of dates. In most hospitals the recommended gestation for a dating scan is between 10 and 14 weeks, however if a women attends earlier in pregnancy, but is more than seven weeks gestation (or eight in some hospitals) the dating scan is not repeated.
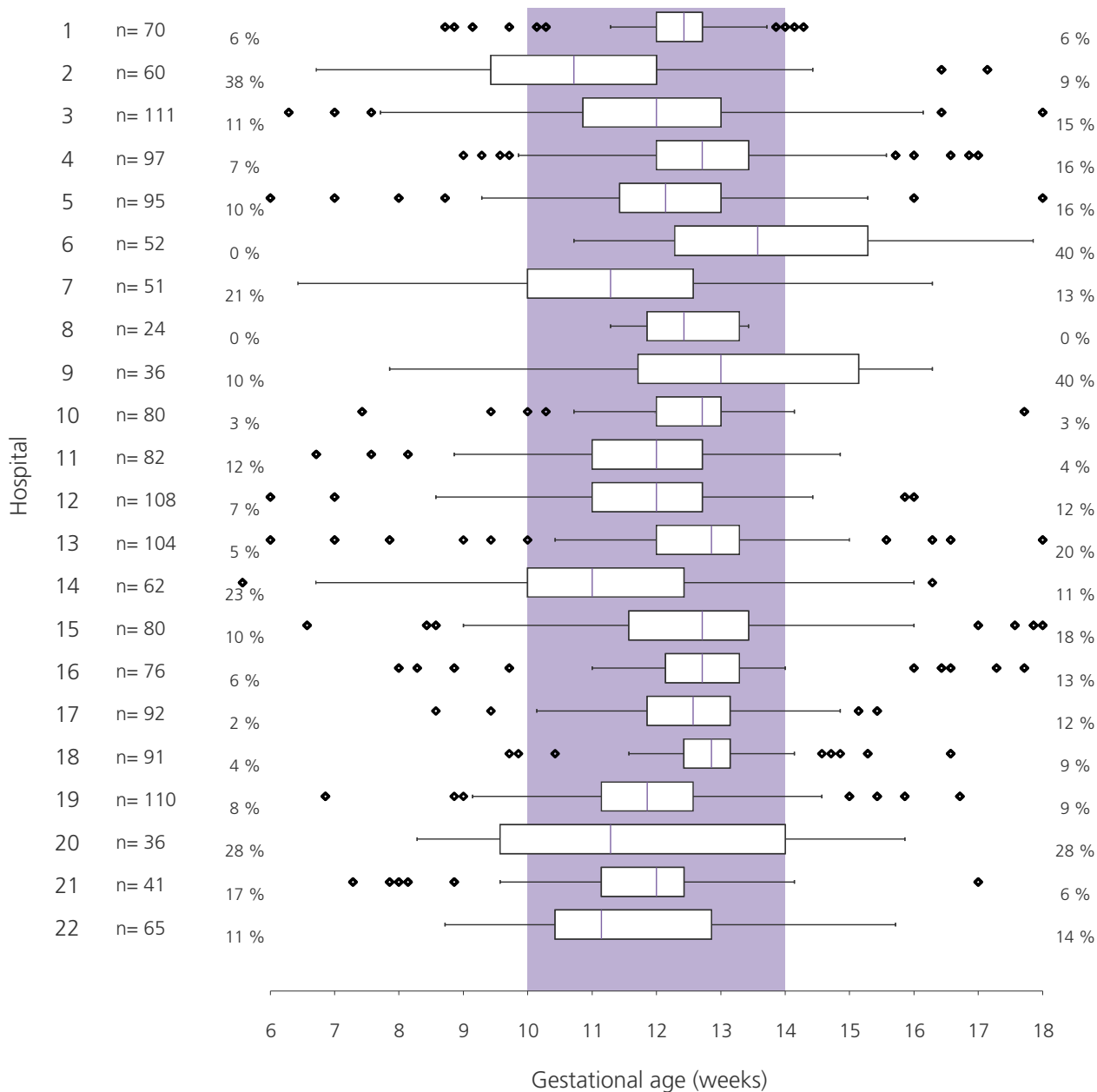
Figure 4: Box plots of gestational age at dating scan, by hospital

The recommended gestational age range for completing a dating scan is highlighted and the proportion (%) of scans performed outside this range is given for each hospital; n is the total number of dating scans performed by the individual hospitals; the box contains the middle 50% of the data, with a line at the median. The whiskers show the range of values within 1.5*IQR (Interquartile range) of the quartiles and any data values beyond this range are indicated by a point

Participating Hospital ID	Number of dating scans covered by the audit	% failures	Gestational age in weeks		Scans performed at < 10 weeks		Scans performed at ≥14 weeks	
			Median	(5th, 95th)	n	(%)	n	(%)
1	70	9	12	(9, 13)	4	(6)	4	(6)
2	60	7	10	(8, 14)	22	(38)	5	(9)
3	111	0	12	(8, 17)	12	(11)	16	(15)
4	97	2	12	(9, 15)	6	(7)	15	(16)
5	95	4	12	(8, 19)	9	(10)	15	(16)
6	52	17	13	(10, 21)	0	(0)	12	(40)
7	51	12	11	(7, 14)	10	(21)	6	(13)
8	24	17	12	(11, 13)	0	(0)	0	(0)
9	36	11	13	(9, 16)	3	(10)	12	(40)
10	80	8	12	(10, 13)	2	(3)	2	(3)
11	82	13	12	(8, 13)	9	(12)	3	(4)
12	108	2	12	(9, 14)	6	(7)	10	(12)
13	104	7	12	(9, 20)	5	(5)	19	(20)
14	62	5	11	(7, 15)	14	(23)	7	(11)
15	80	12	12	(9, 17)	7	(10)	13	(18)
16	76	9	12	(10, 17)	4	(6)	9	(13)
17	92	2	12	(10, 14)	2	(2)	10	(12)
18	91	14	12	(10, 14)	4	(4)	8	(9)
19	110	11	11	(9, 14)	6	(8)	7	(9)
20	36	8	11	(8, 15)	5	(28)	5	(28)
21	41	7	12	(7, 13)	6	(17)	2	(6)
22	65	5	11	(9, 14)	7	(11)	9	(14)
Totals	1623	7	12	(9, 16)	143	(10)	189	(13)

Table 4: Characteristics of dating scans

Proportions of dating scans that failed to be completed in the appointment covered by the audit, median and 5% and 95% quantiles for gestation and proportion of scans performed outside the recommended gestational age range. Those hospitals that routinely perform NT with dating scans are highlighted

3.3.2 Anomaly scans: n = 1,731 (30% (range 21-41%) of all scans)

Gestational age at the time of anomaly scan by hospital is shown in Figure 5 while Table 5 summarises some features of anomaly scans.

The overall median gestational age at anomaly scan was 20 weeks and the medians ranged from 19 to 22 weeks across hospitals. NICE recommended gestational age limits for anomaly scans are 18 weeks 0 days to 20 weeks 6 days. Overall, 30% of scans were performed outside this range; 29% at 21 weeks or later (range 7-90%) and 1% (range 0-4%, n=9) prior to 18 weeks; 3 of which had not had a dating scan.

Overall 13% of anomaly scans could not be completed in one appointment; this failure rate ranged from 0% to 29% across hospitals. Failure to complete anomaly scans was significantly associated with both hospital (P<0.0001) and gestational age (P<0.0001). Excluding missing data, the overall failure rate of anomaly scans performed between 18 and 21 weeks gestation (inclusive) was 10% (123/1,276), compared to 56% (5/9) for scans performed earlier than 18 weeks and 9% (39/413) for scans performed after 21 weeks. Allowing for differences between gestational age and hospitals, failures were significantly associated with BMI (P<0.0001). Overall failure rates were 10% (123/1,222) for women with BMI less than 30, 20% (48/238) for those with a BMI between 30 and 35 and 24% (18/74) for women with BMI over 35. Allowing for differences between hospitals and BMI, failed scans took significantly longer to perform than successful scans. The median and (5th, 95th quantiles) for time taken to perform an anomaly scan were 25 minutes (13, 45 minutes) for those scans that failed, compared to 20 minutes (12, 35 minutes) for successful scans.
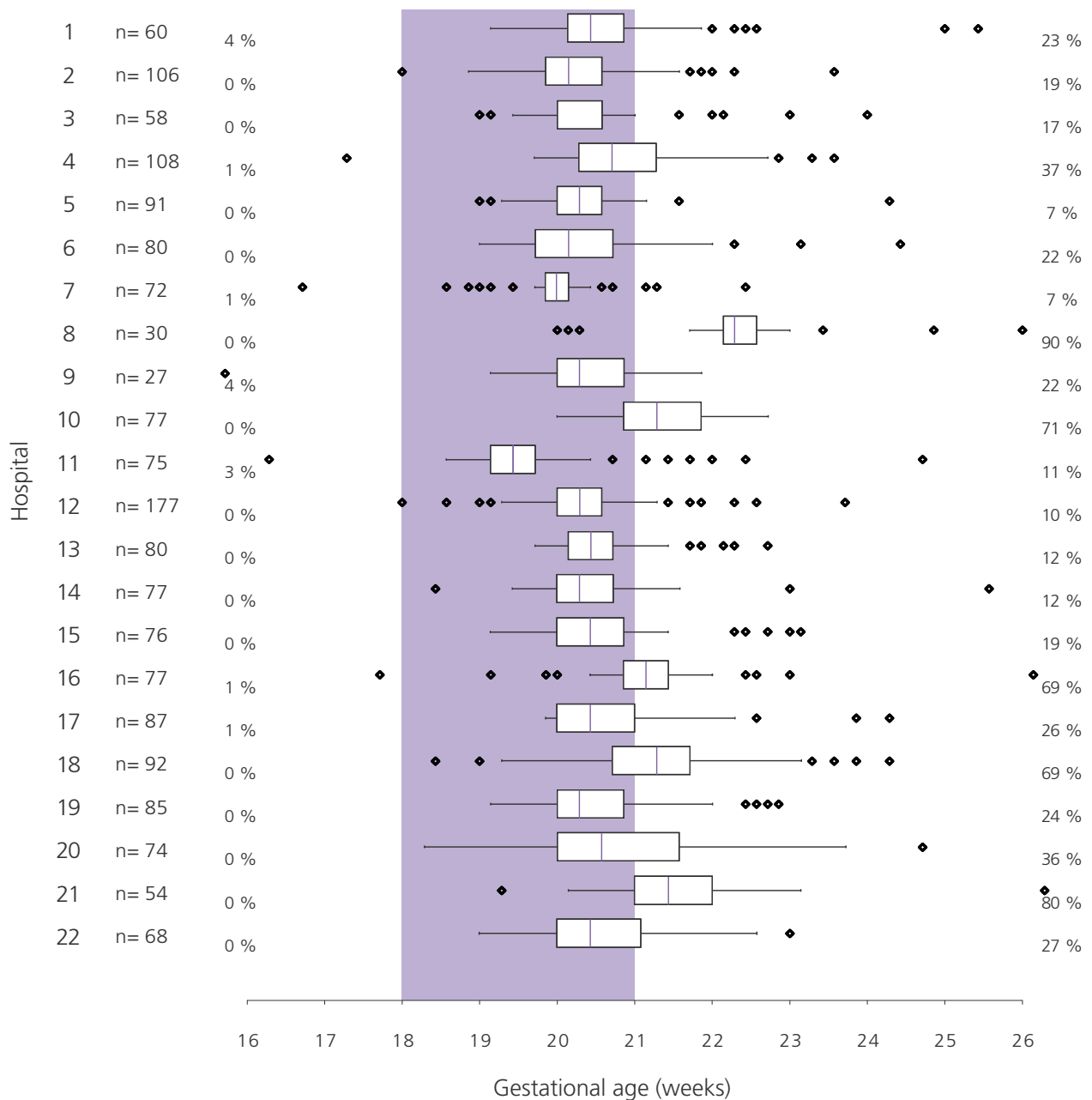
Figure 5: Box plots of gestational age at anomaly scan, by hospital

The recommended gestational age range for completing an anomaly scan is highlighted and the proportion (%) of scans performed outside this range is given for each hospital; n is the total number of anomaly scans performed by the individual hospitals; the box contains the middle 50% of the data, with a line at the median. The whiskers show the range of values within 1.5*IQR (Interquartile range) of the quartiles and any data values beyond this range are indicated by a point

Participating Hospital ID	Number of anomaly scans covered by the audit	% failures	Gestational age in weeks		Scans performed at < 18 weeks		Scans performed at ≥21 weeks	
			Median	(5th, 95th)	n	(%)	n	(%)
1	60	18	20	(19, 22)	2	(4)	13	(23)
2	106	18	20	(19, 21)	0	(0)	20	(19)
3	58	21	20	(19, 22)	0	(0)	10	(17)
4	108	10	20	(19, 22)	1	(1)	40	(37)
5	91	0	20	(19, 21)	0	(0)	6	(7)
6	80	20	20	(19, 22)	0	(0)	17	(22)
7	72	1	20	(19, 21)	1	(1)	5	(7)
8	30	13	22	(20, 24)	0	(0)	26	(90)
9	27	11	20	(19, 21)	1	(4)	6	(22)
10	77	4	21	(20, 22)	0	(0)	55	(71)
11	75	24	19	(18, 21)	2	(3)	8	(11)
12	177	14	20	(19, 21)	0	(0)	18	(10)
13	80	6	20	(19, 21)	0	(0)	10	(12)
14	77	14	20	(19, 21)	0	(0)	9	(12)
15	76	5	20	(19, 22)	0	(0)	14	(19)
16	77	5	21	(20, 22)	1	(1)	52	(69)
17	87	1	20	(20, 21)	1	(1)	22	(26)
18	92	8	21	(20, 24)	0	(0)	63	(69)
19	85	29	20	(19, 22)	0	(0)	19	(24)
20	74	23	20	(19, 22)	0	(0)	26	(36)
21	54	19	21	(20, 24)	0	(0)	43	(80)
22	68	16	20	(19, 22)	0	(0)	17	(27)
Totals	1731	13	20	(19, 22)	9	(1)	499	(29)

Table 5: Characteristics of anomaly scans

Proportions of anomaly scans that failed to be completed in the appointment covered by the audit, median and 5% and 95% quantiles for gestation and proportion of scans performed outside the recommended gestational age range

3.3.3 Time scheduled and time taken for routine scans

Figures 6a and 6b illustrate the times taken to perform dating and anomaly scans in each hospital. The corresponding times allocated for these appointments are highlighted. Two noticeable features of these figures are that (i) the times taken exceeded the times allocated in more hospitals when performing anomaly scans compared with dating scans; (ii) the failure rates for anomaly scans were generally higher than those for dating scans.

Dating scans

The overall mean time taken for a dating scan appointment was 14 minutes. This ranged from 8 to 23 minutes across hospitals. Broken down by time allocated, the mean times taken were as follows:

- Five hospitals allocated 10 minutes; mean time taken 10 minutes

- Eleven hospitals allocated 15 minutes; mean time taken 13 minutes

- Five hospitals allocated 20 minutes; mean time taken 17 minutes

- One hospital allocated 30 minutes; mean time taken 24 minutes

- The three hospitals performing routine NT scans scheduled 10, 15 and 30 minutes; mean time taken 14 minutes with a range of 9 to 24 minutes

Anomaly scans

The overall mean time taken for an anomaly scan appointment was 23 minutes. This ranged from 17 to 32 minutes across hospitals. Broken down by time allocated, the mean times taken were as follows:

- Two hospitals allocated 15 minutes; mean time taken 18 minutes

- Twelve hospitals allocated 20 minutes; mean time taken 20.5 minutes

- One hospital allocated 25 minutes; mean time taken 29 minutes

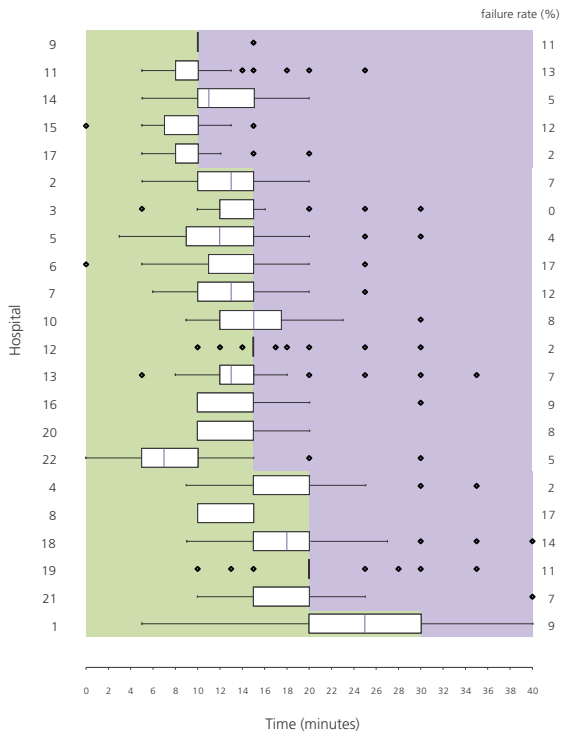- Seven hospitals allocated 30 minutes; mean time taken 28 minutes

Figure 6a: Box plots of time taken to perform dating scans, by hospital

The corresponding times allocated for these appointments are highlighted in pale green. The faliure rates for each of the hospitals are also given
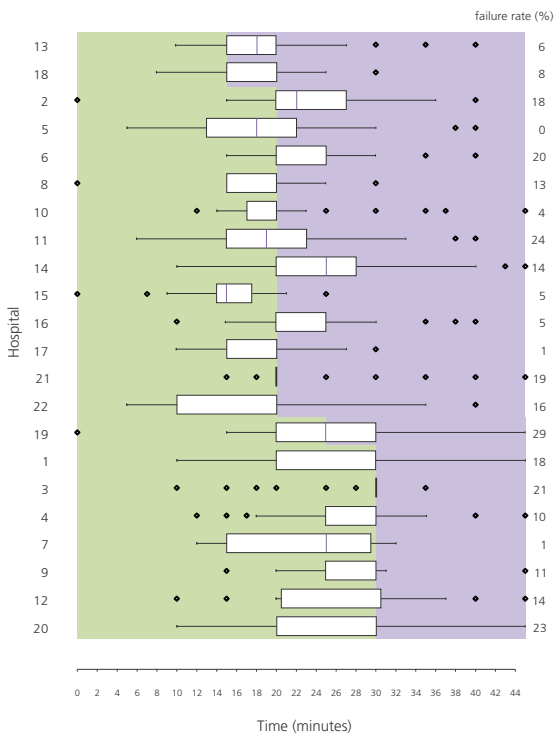

Figure 6b: Box plots of time taken to perform anomaly scans, by hospital

The corresponding times allocated for these appointments are highlighted in pale green. The faliure rates for each of the hospitals are also given

3.4 Non-routine scans

Overall, 43% (range 29-54%) of scans performed were classified as non-routine. Non-routine scans were categorised by gestation as follows; pre-dating, between dating and anomaly and post-anomaly.

Table 6 presents the frequencies of the three non-routine scans by hospital together with summaries of the gestational ages at the time of scan. Of the 2,504 non-routine scans 31% (range 4-74%) were pre-dating scans, 6% (range 2-13%) were performed between dating and anomaly scans and 63% (range 17 – 88%) were post-anomaly scans. The proportion of all women attending for a routine scan who had previously attended for a pre-dating scan, by hospital, ranged from 6% to 40%. This is presented in Figure 7.

Because of the small proportion of between dating and anomaly scans performed, no further analysis has been performed on this group.

| Participating Hospital ID | Pre-dating scans | | | | Between dating and anomaly scans | | | | Post-anomaly scans | | | | Total |
| | n | (%) | Gestational age in weeks | | n | (%) | Gestational age in weeks | | n | (%) | Gestational age in weeks | | n |
			Median	(5th, 95th)			Median	(5th, 95th)			Median	(5th, 95th)	
1	63	(41)	7	(5, 11)	6	(4)	16	(13, 17)	84	(55)	31	(23, 38)	153
2	34	(26)	6	(5, 10)	7	(5)	12	(10, 17)	90	(69)	33	(23, 38)	131
3	73	(74)	6	(5, 11)	8	(8)	14	(11, 21)	17	(17)	31	(22, 38)	98
4	33	(36)	8	(6, 11)	5	(5)	16	(13, 17)	53	(58)	36	(22, 38)	91
5	21	(24)	7	(5, 10)	12	(14)	15	(9, 18)	53	(62)	32	(24, 38)	86
6	52	(37)	7	(5, 11)	4	(3)	16	(15, 16)	85	(60)	34	(22, 37)	141
7	19	(18)	7	(4, 10)	7	(7)	15	(11, 17)	77	(75)	34	(27, 38)	103
8	16	(29)	8	(5, 12)	3	(5)	18	(14, 20)	37	(66)	34	(28, 39)	56
9	11	(22)	8	(5, 13)	1	(2)	18	(18, 18)	39	(76)	32	(24, 39)	51
10	56	(35)	7	(5, 10)	12	(8)	14	(12, 18)	92	(57)	32	(24, 37)	160
11	31	(17)	7	(5, 10)	6	(3)	16	(13, 17)	144	(80)	31	(24, 38)	181
12	72	(37)	7	(5, 12)	13	(7)	14	(12, 18)	112	(57)	33	(25, 38)	197
13	63	(56)	7	(5, 12)	8	(7)	16	(12, 18)	42	(37)	34	(26, 37)	113
14	25	(16)	7	(4, 11)	17	(11)	15	(11, 18)	118	(74)	33	(23, 38)	160
15	8	(7)	6	(3, 9)	5	(5)	17	(15, 18)	97	(88)	34	(24, 38)	110
16	31	(35)	7	(4, 12)	4	(4)	15	(14, 17)	54	(61)	33	(27, 38)	89
17	40	(31)	8	(5, 12)	8	(6)	16	(9, 17)	83	(63)	35	(28, 39)	131
18	58	(42)	6	(4, 10)	8	(6)	17	(15, 19)	72	(52)	35	(24, 38)	138
19	31	(30)	6	(5, 11)	4	(4)	13	(12, 14)	70	(67)	34	(23, 38)	105
20	3	(4)	7	(6, 11)	6	(9)	15	(13, 17)	61	(87)	34	(26, 39)	70
21	17	(20)	8	(6, 11)	8	(9)	16	(13, 18)	60	(71)	34	(27, 37)	85
22	15	(27)	8	(7, 9)	7	(13)	16	(13, 17)	33	(60)	30	(24, 37)	55
Totals	772	(31)	7	(5, 12)	159	(6)	15	(11, 18)	1573	(63)	33	(24, 38)	2504

Table 6: Characteristics of non-routine scans

Frequencies of the three non-routine scans by hospital and summaries of the gestational ages at the time of scan
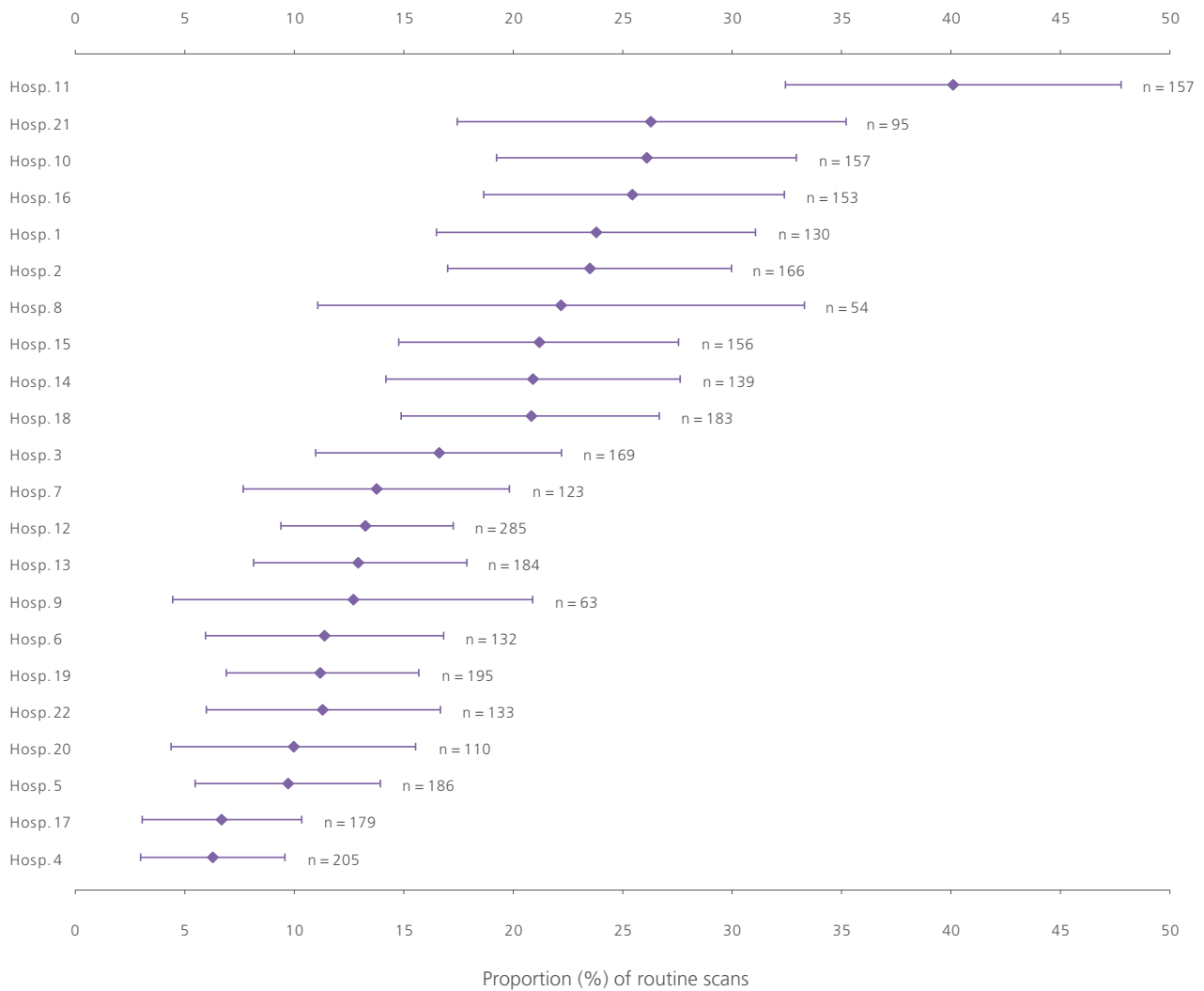
Figure 7: Proportion (%) of all women attending for a routine scan who had previously attended for a pre-dating scan, by hospital

For each hospital, the estimated proportion of women who have had a pre-dating scan is represented by a point, with the 95% confidence interval for this estimate shown; n is the total number of routine scans performed in the hospital during the audit

3.4.1 Pre-dating scans: n = 772 (13% (range 2-27%) of all scans)

The overall median gestational age at pre-dating scan was 7 weeks, ranging from 6 to 8 weeks across hospitals. Gestational age at pre-dating scan by hospital is shown in Figure 8 and summarised in Table 6.

The reasons for pre-dating scans were categorised according to whether they were performed due to a previous pregnancy problem, current pregnancy problem or other problem. This is summarised in Table 7. A current pregnancy problem was the most common reason for referral, being given in 82% of cases (range 50-100%) with previous pregnancy problem reported in 11% of cases (range 0-38%).

Frequencies of the specific clinical referral indications recorded for pre-dating scans are shown in Figure 9. Up to three indications could be entered in the audit form, however only the first indication is presented in Figure 9. Reassurance, as an indication, only features here when it was the sole entry recorded. The most common clinical indication recorded was related to early pregnancy bleeding (59% of scans with clinical indication stated), followed by those relating to pain (13%), previous miscarriage (6%), suspected miscarriage (6%), reassurance (5%) and ectopic or possible ectopic pregnancy (3%).

A summary of the sources of referral and information on the person performing the scan can be found in Appendix 4. Pre-dating scans were referred by a general practitioner (20%), maternity unit (67%) or another hospital department (12%). These scans were performed by a sonographer or midwife sonographer in nearly all cases (97%). In 10% of cases, the person performing the scan thought the referral was inappropriate, accounting for 3% of all non-routine referrals and 1% of all referrals covered by the audit.
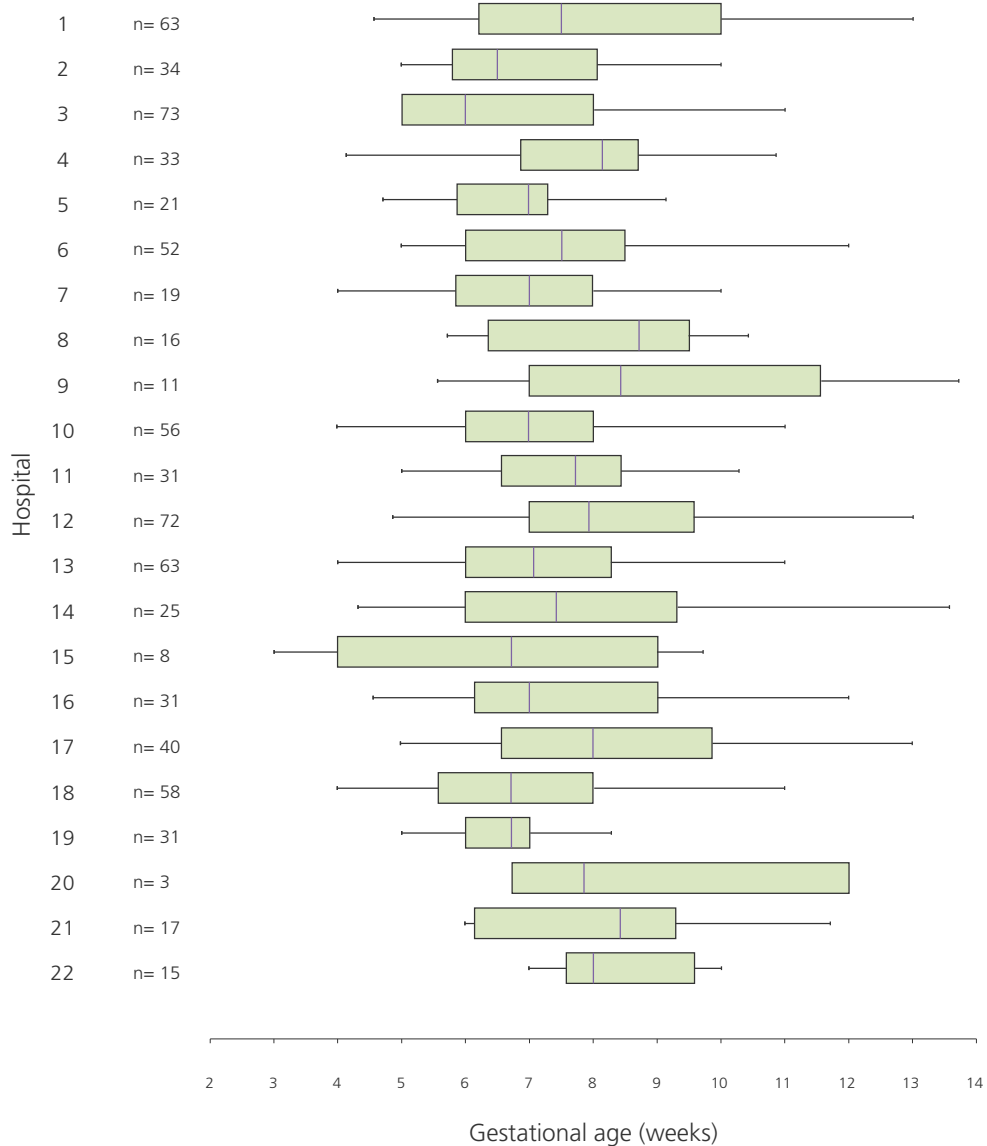
Figure 8: Box plots of gestational age at pre-dating scan, by hospital

n is the total number of pre-dating scans performed in each hospital; the box contains the middle 50% of the data, with the line at the median; the whiskers show the range of values within 1.5*IQR (Interquartile range) of the quartiles and any data values beyond this range are indicated by a point

Participating Hospital ID	Number of pre-dating scans	Reason for scan					
		Previous pregnancy problem		Current pregnancy problem		Other problem	
		n	(%)	n	(%)	n	(%)
1	63	11	(17)	44	(70)	5	(8)
2	34	4	(12)	28	(82)	1	(3)
3	73	8	(11)	63	(86)	0	(0)
4	33	8	(24)	25	(76)	5	(15)
5	21	0	(0)	21	(100)	0	(0)
6	52	17	(33)	40	(77)	0	(0)
7	19	2	(11)	17	(89)	0	(0)
8	16	2	(13)	11	(69)	0	(0)
9	11	1	(9)	9	(82)	0	(0)
10	56	2	(4)	53	(95)	3	(5)
11	31	5	(16)	24	(77)	0	(0)
12	72	5	(7)	60	(83)	3	(4)
13	63	1	(2)	36	(57)	23	(37)
14	25	4	(16)	22	(88)	1	(4)
15	8	3	(38)	4	(50)	1	(13)
16	31	2	(6)	28	(90)	2	(6)
17	40	0	(0)	39	(98)	1	(3)
18	58	3	(5)	51	(88)	4	(7)
19	31	1	(3)	30	(97)	1	(3)
20	3	1	(33)	2	(67)	0	(0)
21	17	2	(12)	15	(88)	0	(0)
22	15	3	(20)	11	(73)	0	(0)
Totals	772	85	(11)	633	(82)	50	(6)

Table 7: Pre-dating scans. Frequencies and reasons for scans, by hospital

Row percentages may not sum to 100 as more than one reason can be given for each scan and in some cases no reason was given
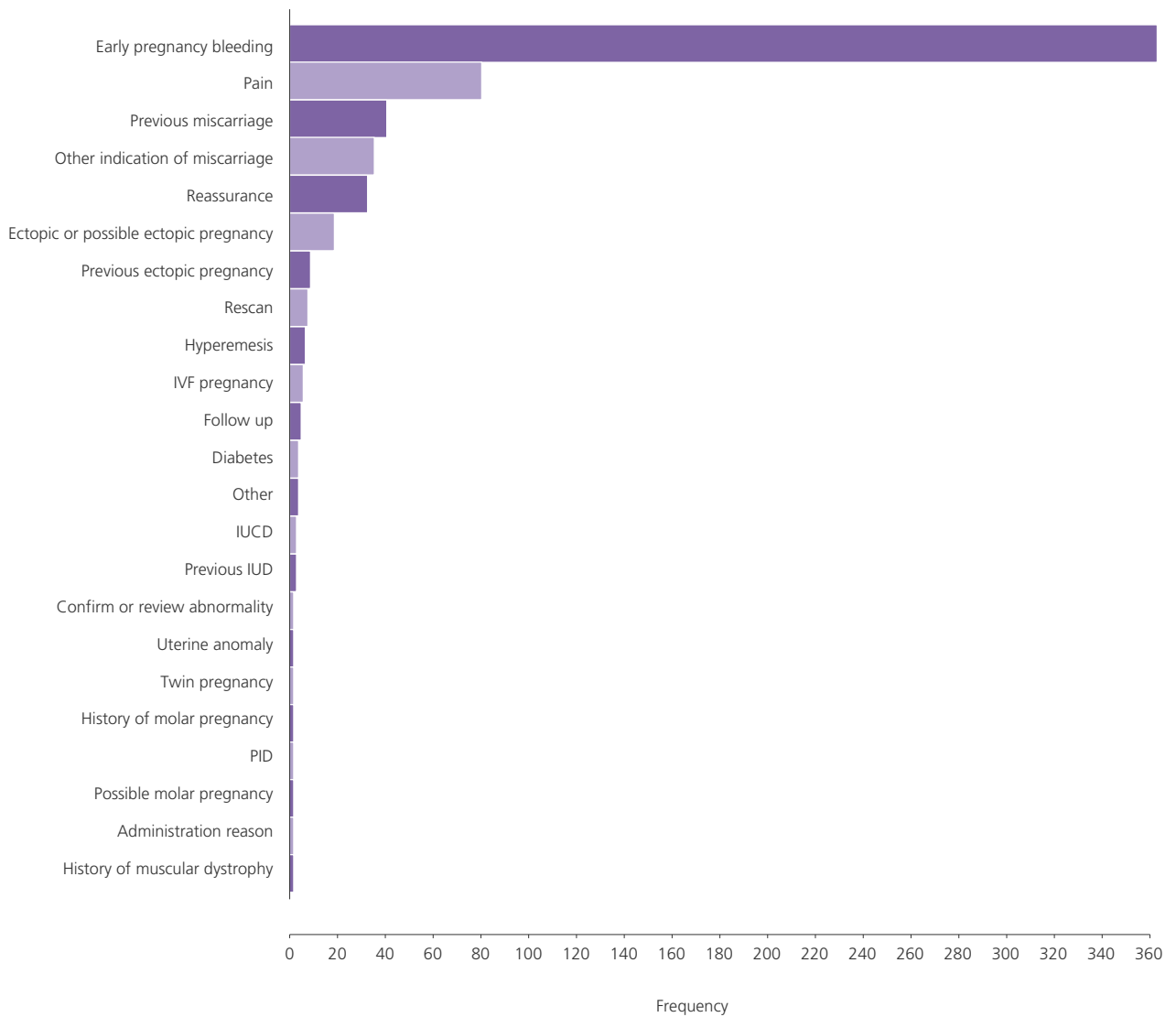
Figure 9: Frequency of primary clinical referral indications given for pre-dating scans for all participating hospitals combined

IVF: In-vitro fertilisation; IUCD: Intra-uterine contraceptive device; IUD: Intra-uterine device; PID: Pelvic inflammatory disease

3.4.2 Post-anomaly scans: n = 1,573 (27% (range 6-43%) of all scans)

The overall median gestational age at post-anomaly scan was 33 weeks, ranging from 30 to 36 weeks across hospitals. Gestational age at post-anomaly scan by hospital is shown in Figure 10 and summarised in Table 6.

The reasons for post-anomaly scans were categorised as for pre-dating scans. A current pregnancy problem was the most common reason for referral, being given in 66% of cases (range 32-86%) with previous pregnancy problems reported in 16% of cases (range 5-30%). This is summarised in Table 8.
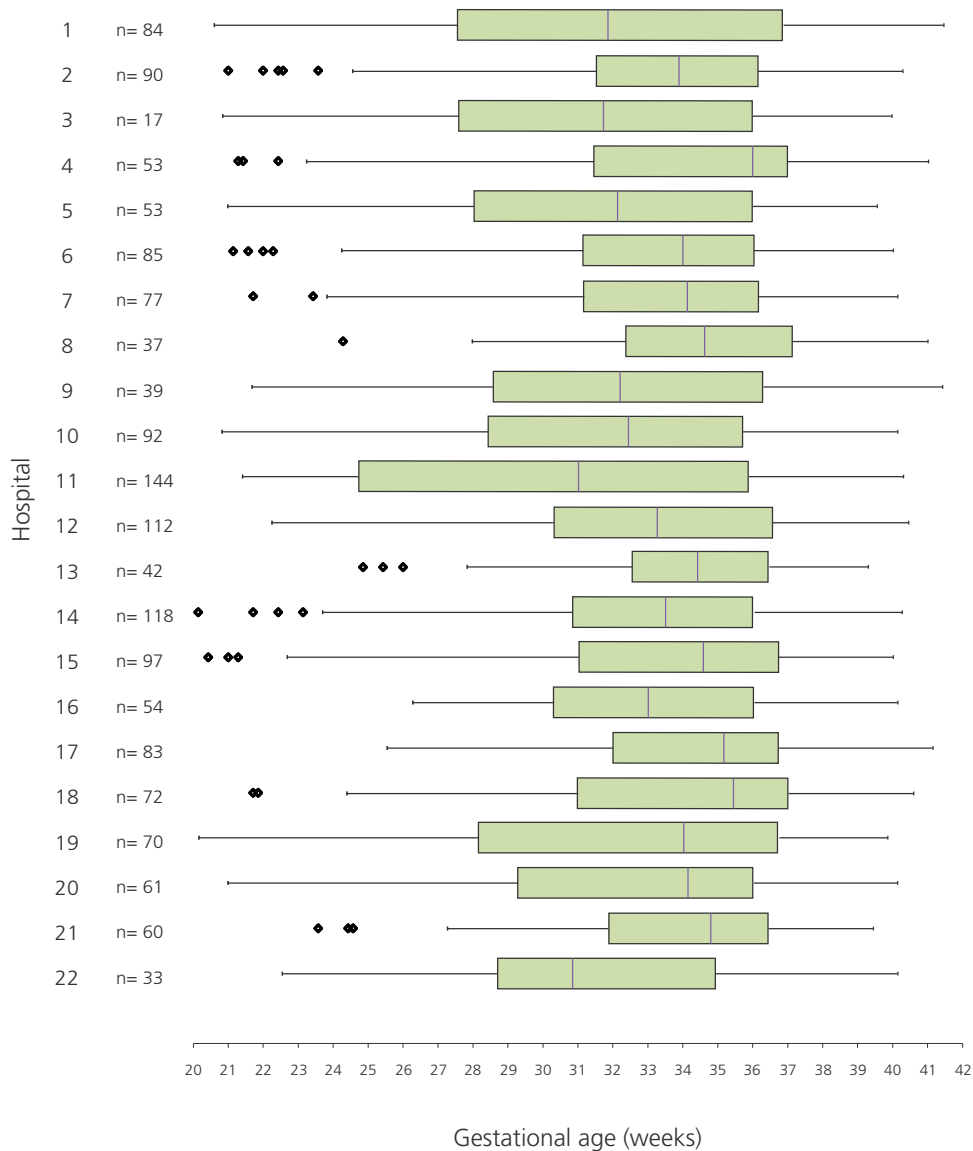

Figure 10: Box plots of gestational age at post-anomaly scan, by hospital

*n is the total number of pre-dating scans performed in each hospital; the box contains the middle 50% of the data, with the line at the median; the whiskers show the range of values within 1.5*IQR (Interquartile range) of the quartiles and any data values beyond this range are indicated by a point*

Participating Hospital ID	Number of post anomaly scans	Reason for scan					
		Previous pregnancy problem		Current pregnancy problem		other problem	
		n	(%)	n	(%)	n	(%)
1	84	5	(6)	46	(55)	30	(36)
2	90	16	(18)	72	(80)	7	(8)
3	17	1	(6)	14	(82)	1	(6)
4	53	9	(17)	36	(68)	9	(17)
5	53	10	(19)	39	(74)	6	(11)
6	85	14	(16)	60	(71)	13	(15)
7	77	18	(23)	62	(81)	4	(5)
8	37	8	(22)	30	(81)	1	(3)
9	39	3	(8)	29	(74)	6	(15)
10	92	17	(18)	72	(78)	10	(11)
11	144	7	(5)	46	(32)	88	(61)
12	112	14	(12)	96	(86)	7	(6)
13	42	5	(12)	24	(57)	13	(31)
14	118	31	(26)	69	(58)	28	(24)
15	97	16	(16)	43	(44)	39	(40)
16	54	9	(17)	37	(69)	13	(24)
17	83	17	(20)	48	(58)	23	(28)
18	72	5	(7)	56	(78)	12	(17)
19	70	11	(16)	49	(70)	12	(17)
20	61	18	(30)	45	(74)	0	(0)
21	60	5	(8)	46	(77)	9	(15)
22	33	7	(21)	14	(42)	11	(33)
Totals	1573	246	(16)	1033	(66)	342	(22)

Table 8: Post-anomaly scans. Frequencies and reasons for scans, by hospital

Row percentages may not sum to 100 as more than one reason can be given for each scan and in some cases no reason was given

Frequencies of specific clinical referral indications for post-anomaly scans (primary indication, as described in 3.4.1 above), are shown in Figure 11. Indications relating to small size were the most common (18% of scans with clinical indications stated), followed by those relating to low lying placenta (8%), twin pregnancy (7%), suspected large for dates (6%), confirmation of presentation (6%) previous large or small baby (6%), diabetes (5%) and reassurance (5%).

The median gestational age for scans performed primarily for placental site assessment was 35 weeks. 10% (10/98) of these scans were referred at less than 32 weeks gestation; 2 of which had a secondary indication relating to vaginal bleeding. The median gestational age for scans performed primarily for assessment of presentation was 37 weeks. 18% of these scans were referred at less than 36 weeks gestation; none of these scans had a secondary indication relating to vaginal bleeding or premature delivery.
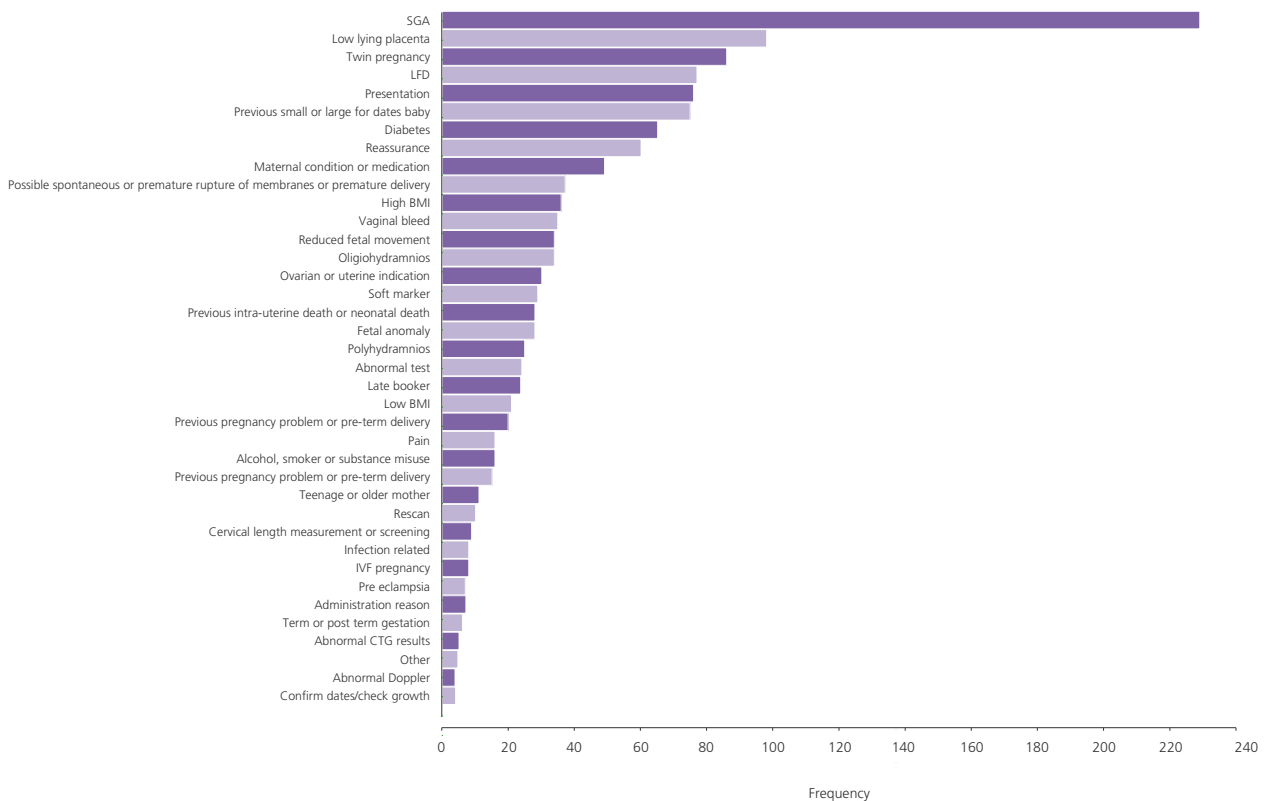

Figure 11 Frequency of primary clinical referal indications given for post-anomaly scans for all participating hospitals combined

SGA: Small for gestational age; LFD: large for dates; BMI: body mass index; IVF: In-vitro fertilisation; CTG: cardiotocography

Components of the post-anomaly scans are shown in Figure 12. The most common components of this scan type are:

- liquor volume assessment (LVA) perfomed in 82% of post-anomaly scans

- growth scans perfomed in 81% of post-anomaly scans

- presentation performed in 62% of post-anomaly scans

- placental site performed in 51% of post-anomaly scans

Where a growth component was included in today's post-anomaly scan and the previous scan, the time interval between the scans is shown in Figure 13. The most frequent intervals observed were 2 and 4 weeks.

A summary of the source of referral and information on the person performing the scan can be found in Appendix 4. Post-anomaly scans were referred by a maternity unit (91%), community midwife (5%) or another hospital department (2%). These scans were performed by a sonographer or midwife sonographer in nearly all cases (92%). The person performing the scan was asked to comment on whether they thought the scan was inappropriate. In 17% of cases, the person performing the scan thought the referral inappropriate, which accounts for 11% of all non-routine referrals and 5% of all referrals covered by the audit.

Frequent reasons given were:

- referrals relating to fetal size but where a previous growth scan had been reported as normal

- referrals made prior to a clinical assessment being undertaken

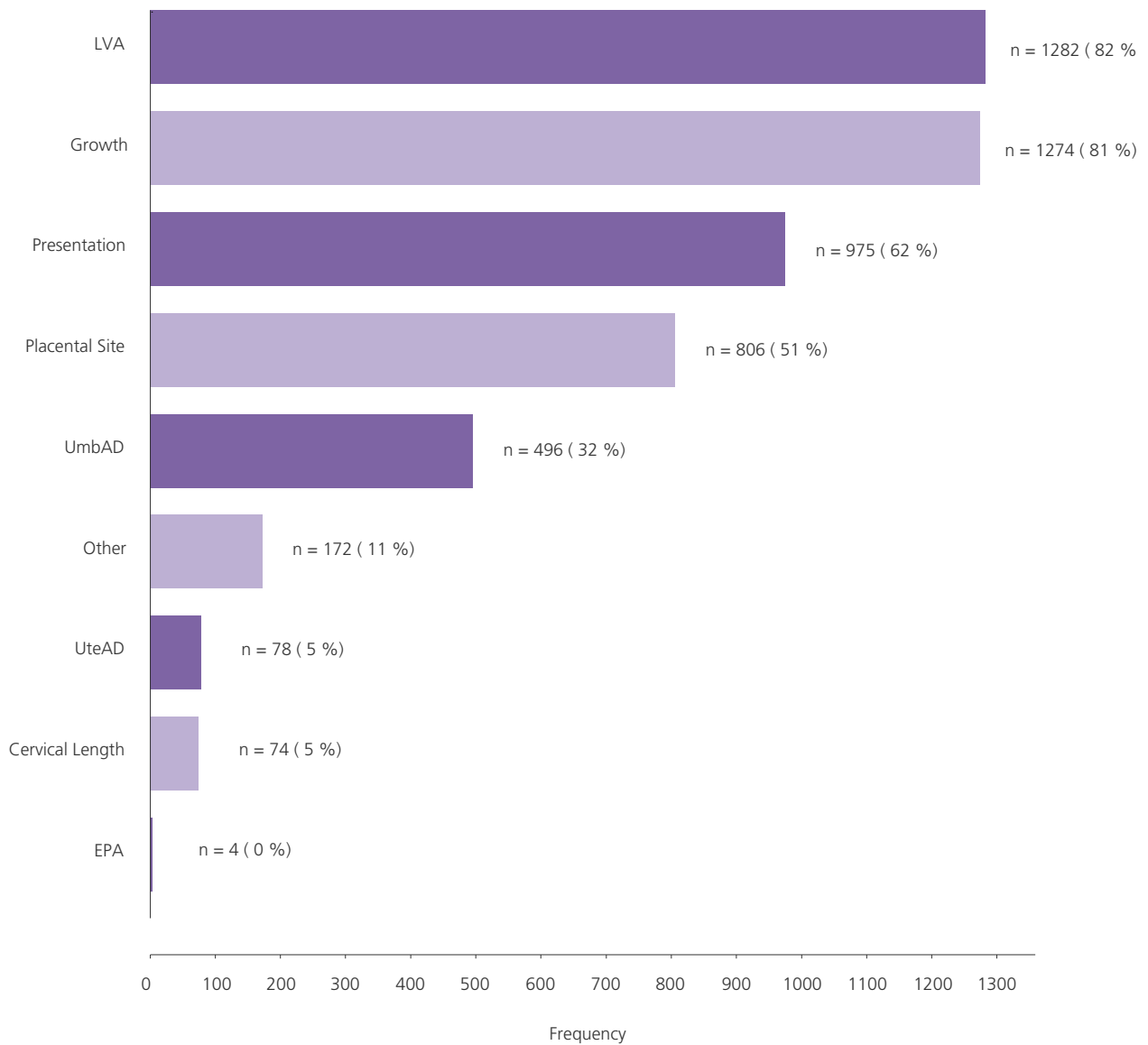- referrals made too early in pregnancy with regard to low lying placenta

Figure 12: Frequency of components included in post-anomaly scans for all participating hospitals combined

LVA: Liquor volume assessment; UmbAD: umbillical artery doppler; UteAD: uterine artery doppler; EPA: early pregnancy assessment
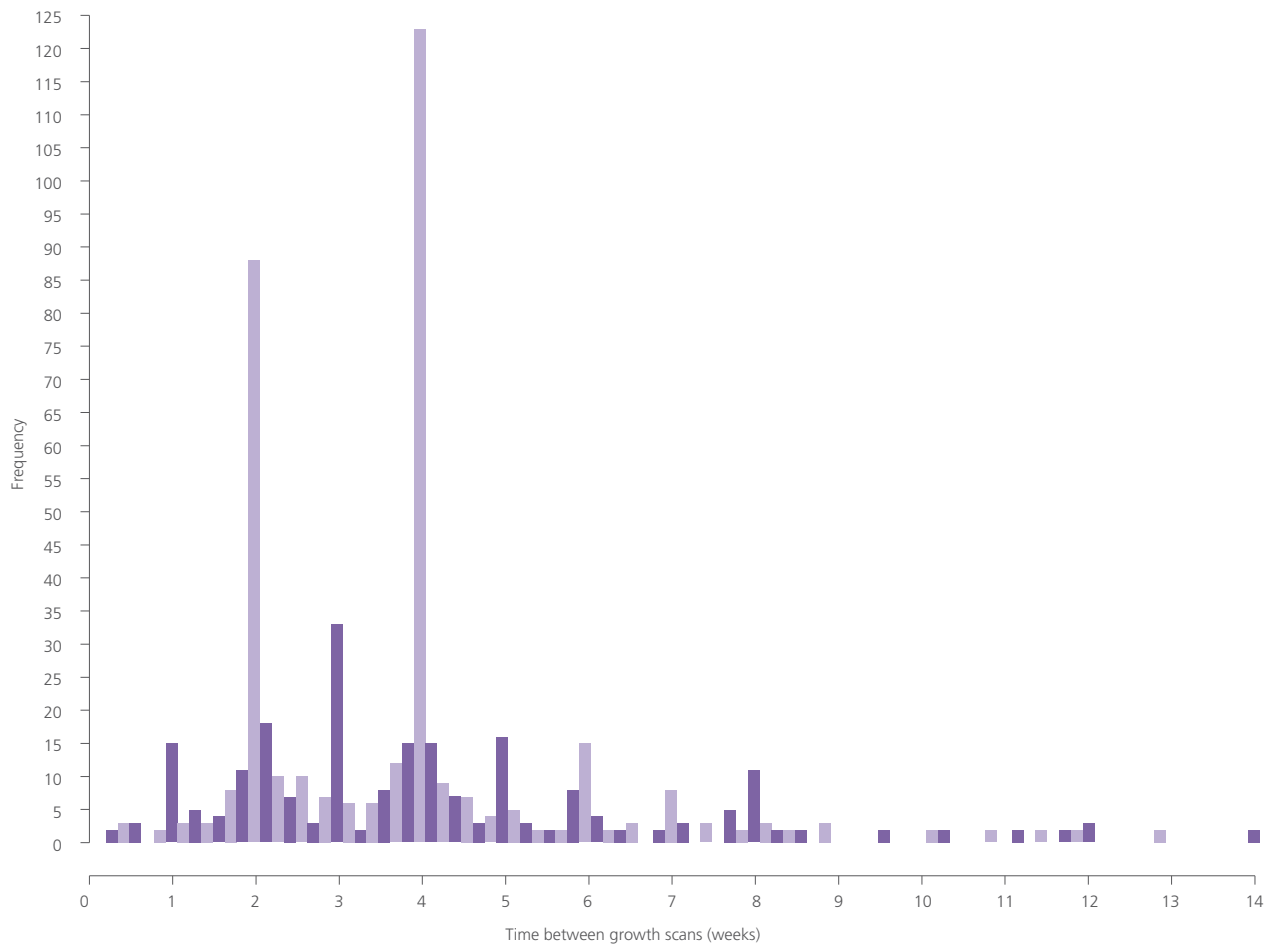
Figure 13: Time interval (weeks) between today's post-anomaly scan and the previous scan, where both of these scans have included a growth component

4 Discussion

4.1 Overview

This is the first report to describe the work performed in antenatal ultrasound units covering a wide geographical area of England and Wales. It aims to map the current situation in hospital antenatal ultrasound units and provide a snapshot of the number and types of referrals and scans performed in the 22 participating hospitals, comparing these results with national recommendations. Over the last 25 years, management and protocols relating to antenatal ultrasound have developed from a time when no guidelines existed, to the current (2008) antenatal care guidelines issued by NICE[6]. These guidelines state that "pregnancy is a normal physiological process and that, as such, any interventions offered should have known benefits and be acceptable to pregnant women". They also clarify at what gestational age routine scans should be offered, debate and make recommendations regarding non-routine scans performed after 24 weeks of gestation.

There are some acknowledged limitations of the data collected in this audit. The selection of participating hospitals was not random; the reporting of background information on protocols and the proportion of scans covered by the audit relied on a subjective assessment by the lead sonographer and the aim to cover every scan in each clinic was not achieved by all hospitals. In spite of these limitations, the audit provides a valuable insight into the pattern of referrals and the workload and current practices in a number of ultrasound units in England and Wales in 2007.

Although the aim to attempt to state which referrals are considered appropriate has not been fully achieved, the wide variation in practice between some units and comparison with existing guidelines has highlighted some areas of good practice and some of concern, with identification of areas where further research would allow guidelines to be produced.

In order to address the first aim of the audit: to rationalise ultrasound antenatal referrals, scans were categorised first into those that were routine and those that were non-routine.

4.2 Routine Scans

The data from the 22 hospitals is encouraging regarding the performance of routine scans, with the majority of these scans being performed within the recommended gestational age range. Overall, 77% of dating scans were performed within the gestational age range recommended by NICE (10 weeks 0 days to 13 weeks 6 days). Wide variation in the proportion of scans performed outside the recommended gestational age limits was observed across hospitals.

The three hospitals offering routine NT scans had a higher percentage of women attending at the correct time (4% attended before 10 weeks, compared to 12% in hospitals without routine NT scans and 6% attended after 13 weeks 6 days compared to 16%). This suggests that by introducing a new policy, it is possible to achieve a change in referral patterns.

Overall, 70% of anomaly scans were performed within the recommended gestational age range (18 weeks 0 days to 20 weeks 6 days). However, as with dating scans, there was wide variation across hospitals.

The length of time scheduled for routine scan appointments varied across hospitals, from 10 to 30 minutes for dating scans (with or without an NT scan) and from 15 to 30 minutes for anomaly scans. Recommendations regarding appointment times for anomaly scans will be issued by the NHS FASP following extensive work by the National Ultrasound Standards Core Reference Group. However, in this audit, failure rates of routine scans did not appear to be affected by the time scheduled for the appointment. Although the majority of scans were completed in one visit, there was a large variation in the failure rates between hospitals (range 0-29%).

Failures of dating scans were largely due to referrals being made too early in pregnancy. Anomaly scan failures were significantly associated with high BMI. Information on the woman's BMI would be useful when booking a scan, to allow for the possibility of a longer appointment time and consideration of the seniority of the sonographer performing the scan. Differing protocols across hospitals concerning when to "fail" a scan could explain the variation in failure rates. For example, some hospitals may continue scanning for more than the recommended time until the scan is complete, while others may make a further appointment. Guidelines on scheduled appointment times for routine scans as well as when to fail a scan and offer a further appointment would be useful.

4.3 Non-routine scans

Pre-dating scans accounted for 13% of all scans and 31% of non-routine scans. There was a large variation in the proportion of pre-dating scans performed across hospitals, which could be partly explained by cross referrals between neighbouring hospitals. For example scans, for early pregnancy assessments may be performed in a different hospital to the one performing the routine dating and anomaly scans.

The main referral indications for pre-dating scans related to possible miscarriage or ectopic pregnancy, including early pregnancy bleeding and pain. These indications are appropriate for this scan type; there is therefore little scope for rationalisation of referrals for pre-dating scans. However, cases should be reviewed where reassurance was the only indication given. Including further information on the referral card, for example the reason that reassurance is required, could aid rationalisation in these situations.

The largest contribution to workload for scan units, with potential for rationalisation, was from the scans performed after the anomaly scan. These accounted for 27% of all scans and 63% of non-routine scans. NICE has stated that "evidence does not support the routine use of ultrasound scanning after 24 weeks of gestation and therefore it should not be offered", suggesting that there may be considerable scope for rationalisation within post-anomaly scans. However, these guidelines do not apply to pregnancies at increased risk due to a clinical concern in the current pregnancy or past history. The questions concerning whether the referrals are appropriate and what the interval between scans should be are difficult to answer. This category of scan referral was most frequently deemed inappropriate by the person performing the scan.

The main referral indication for post-anomaly scans related to small fetal size. This indication is appropriate for this scan type as the association with morbidity and mortality[14,15] is well recognised. However, comments on the appropriateness of this referral indication suggested that some women were referred because of a clinical suspicion of small fetal size without having previously received a clinical assessment and some of these scans were repeated regularly despite the fact that there was no evidence of poor growth or fetal compromise. These comments raise concern about poor communication between referrer and operator and highlight the need for clear guidance regarding referrals in this area. In the first instance, this guidance should be given to staff within maternity units, as almost all referrals originated from these units. It is likely that, with clear guidelines, the number of repeat scans to monitor fetal growth could be reduced and the interval between scans extended in some units.

It is recognised however, that difficulties exist in distinguishing a fetus that is constitutionally small from one that has true fetal growth restriction (FGR) and is thus at greatest risk. Current guidelines recommend that all women with evidence of FGR should be offered surveillance with Umbilical Artery Doppler (UmbAD) and biometry as a minimum and do not recommend the use of customised growth charts[16] or routine third trimester scans[6,17]. There is a need for further prospective research in these areas.

Low lying placenta was the second most frequent indication for referral for post-anomaly scans. Current guidelines state that "only a woman whose placenta extends over the internal cervical os (at the anomaly scan) should be offered another transabdominal scan at 32 weeks"[6].

Twin pregancy, large for dates (LFD) and presentation were also frequent referral indications for post-anomaly scans. The current NICE guidelines state that "ultrasound estimation of fetal size for suspected large-for

gestational-age unborn babies should not be undertaken in a low-risk population". It is not possible from this audit to state whether the women having these scans were at high or low risk of LFD, however, given the large numbers of referrals, it seems probable that some of these may have been inappropriate. It is recommended that assessment of fetal presentation by abdominal palpation should not be offered before 36 weeks and when malpresentation is suspected it should be confirmed by ultrasound. 18% of scans performed primarily to assess presentation were referred at less than 36 weeks gestation.

The large number of referrals for non-routine scans with reassurance cited as the primary indication highlights the need to provide further guidance to the referrers and amend the details included on the referral cards. Therefore, the possibility of issuing a national referral card, with prompts to ensure that the need for referral is appropriately assessed should be explored further.

The current NICE guidelines state that evidence does not support the routine use of ultrasound scanning after 24 weeks of gestation but acknowledge that further prospective research is required to evaluate its cost-effectiveness and value in predicting small for gestational age (SGA) fetuses. Some European countries have a policy for three routine scans in pregnancy[18], one being in the third trimester; these countries report lower fetal and neonatal mortality rates and a lower percentage of SGA infants than in England and Wales[19]. However, it is not known whether this is a consequence of the third trimester scan or how the introduction of a routine third trimester scan would affect the workload in ultrasound units.

This audit was supported with enthusiasm by the sonographers from the participating hospitals. There is currently an acknowledged shortage of professionals trained to carry out antenatal ultrasound scans and the workload is continuing to increase due to the introduction of first trimester NT scans. The results from this audit, which highlight variations in practices, will allow hospitals to compare their own procedures and systems with others in order to identify areas for improving efficiency.

The current NICE guidelines were issued after data collection for this audit was undertaken. Given the dynamic state of the practice of ultrasound, it is probable that in some of the hospitals appropriate changes to practice may have already been made in line with these guidelines. Inevitably there will be continued advances both in antenatal testing and new technologies. Whatever these may be, continued surveillance to enable effective planning for the future is important.

4.4 Recommendations for further research

The results of this audit have highlighted a number of areas for further research:

- The impact of introducing a routine third trimester scan

- Frequency, timing and components of growth scans for clinical indications such as multiple pregnancy, previous growth restriction or suspected growth restriction

- What aspects of a woman's history lead to a scan referral for reassurance?

- For women with a high BMI, does (i) the gestation at which the dating or anomaly scans are performed, or (ii) the seniority of the professionals performing the scans, affect the failure rate?

Appendix 1:
Membership of the Core Study and Expert Group

Members of the Audit of Ultrasound Scans Core Study Group

Dr Patricia Boyd
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National Perinatal Epidemiology Unit,
University of Oxford

Mrs Caroline Dillon
Lead Advanced Practitioner,
The Oxford Radcliffe Hospitals NHS Trust

Mrs Julie Edwards
Lead Advanced Practitioner,
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Statistician,
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NHS Fetal Anomaly Screening Programme

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Mr Kim Hinshaw
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Mr David Howe
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Mrs Jane McFarlane
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Hull & East Yorkshire Hospitals NHS Trust

Dr Nigel Marshall
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Dr Barry Nix
Statistician,
Cardiff University

Mrs Pat Ward
National Programme Director,
NHS Fetal Anomaly Screening Programme

Prof Dave Wright
Statistician,
University of Plymouth

Appendix 2:
Hospitals participating in the audit of antenatal ultrasound scans

Airedale General Hospital, Steeton (Airedale NHS Trust)

Barnsley General Hospital, Barnsley (Barnsley Hospital NHS Foundation Trust)

Calderdale Royal Hospital, Halifax (Calderdale and Huddersfield NHS Trust)

Diana Princess of Wales Hospital, Grimsby (Northern Lincolnshire and Goole Hospitals NHS Trust)

Elizabeth Garrett Anderson Hospital, London (University College London Hospitals NHS Foundation Trust)

Fairfield General Hospital, Bury (The Pennine Acute Hospitals NHS Trust)

Frimley Park Hospital, Frimley (Frimley Park Hospital NHS Foundation Trust)

Good Hope Hospital, Sutton Coldfield (Good Hope Hospital NHS Trust)

Hope Hospital, Salford (Salford Royal Hospitals NHS Trust)

John Radcliffe Hospital, Oxford (The Oxford Radcliffe Hospitals NHS Trust)

Kettering General Hospital, Kettering (Kettering General Hospital NHS Trust)

Maidstone Hospital, Maidstone (Maidstone and Tunbridge Wells NHS Trust)

Mayday University Hospital, Croydon (Mayday Healthcare NHS Trust)

North Manchester General Hospital, Manchester (The Pennine Acute Hospitals NHS Trust)

Pembury Hospital, Pembury (Maidstone and Tunbridge Wells NHS Trust)

Rochdale Infirmary, Rochdale (The Pennine Acute Hospitals NHS Trust)

Rotherham District General Hospital, Rotherham (The Rotherham NHS Foundation Trust)

Royal Glamorgan Hospital, Llantrisant (Cwm Taf NHS Trust)

Royal Oldham Hospital, Oldham (The Pennine Acute Hospitals NHS Trust)

Southend Hospital, Westcliff-on-Sea (Southend University Hospital NHS Foundation Trust)

West Suffolk Hospital, Bury St Edmonds (West Suffolk Hospital NHS Trust)

Women and Children's Hospital, Hull Royal Infirmary, Hull (Hull & East Yorkshire Hospitals NHS Trust)

Appendix 3:
The questionnaire completed by ultrasound departments in July 2007

TODAY'S SCAN TYPE (please tick)

Pre dating scan:	☐	Anomaly scan:	☐	
Dating scan +/- nuchal scan:	☐	Post anomaly scan:	☐	
Between dating and anomaly scan	☐			

IF TODAY'S SCAN IS A DATING SCAN

Was a nuchal scan performed with this dating scan?	Y ☐	N ☐		
Has there been a previous attempt at this dating scan?	Y ☐	N ☐		
Was the scan successfully completed today?	Y ☐	N ☐		
If no, has a further appointment been made to repeat the scan?	Y ☐	N ☐		

IF TODAY'S SCAN IS A DATING SCAN GO TO PAGE 3

IF TODAY'S SCAN IS AN ANOMALY SCAN:

Has there been a previous attempt at this anomaly scan?	Y ☐	N ☐		
Was the scan successfully completed today?	Y ☐	N ☐		
If no, has a further appointment been made to repeat the scan?	Y ☐	N ☐		

IF TODAY'S SCAN IS AN ANOMALY SCAN GO TO PAGE 4

IF TODAY'S SCAN IS NOT A DATING OR AN ANOMALY SCAN

What was the reason for the scan, (please tick all that apply)   Please give details:

Previous pregnancy problem:	☐	_____
Current pregnancy problem:	☐	_____
Other:	☐	_____

_____

Please indicate the different components of today's Scan (tick any that apply)

Early pregnancy assessment:	☐	Uterine Artery Doppler:	☐
Growth:	☐	Placental Site:	☐
Liquor volume assessment:	☐	Cervical Length:	☐
Umbilical Artery Doppler:	☐	Presentation:	☐

Other (please specify) ☐ _____

_____
_____
_____

2

Appendix 4:
Summary statistics

Maternal characteristics

Maternal age (years)							
Type of scan	n	Missing	Min	Max	Mean	Median	SD
Pre-dating	753	19	15	46	29	29	7
Dating	1594	29	12	46	28	28	6
Between dating and anomaly	156	3	16	51	30	30	7
Anomaly	1694	37	14	49	28	28	6
Post-anomaly	1541	32	15	46	29	29	6
Overall	5738	120	12	51	29	29	6

BMI							
Type of scan	n	Missing	Min	Max	Mean	Median	SD
Pre-dating	605	167	16	62	25	24	6
Dating	1370	253	14	51	25	24	5
Between dating and anomaly	134	25	17	42	26	25	6
Anomaly	1554	177	12	68	26	24	5
Post-anomaly	1373	200	15	69	27	25	6
Overall	5036	822	12	69	26	24	6

The current and previous pregnancies

Previous pregnancies >24 weeks

| | | | Number of previous pregnancies >24 weeks | | | | | | | | | | |
| | | | 0 | | 1 | | 2 | | 3 | | 4 | | 5 or more | |
Type of scan	n	Missing	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Pre-dating	697	75	316	(41)	215	(28)	111	(14)	31	(4)	14	(2)	10	(1)
Dating	1524	99	685	(42)	510	(31)	203	(13)	74	(5)	22	(1)	30	(2)
Between dating and anomaly	150	9	61	(38)	45	(28)	25	(16)	11	(7)	5	(3)	3	(2)
Anomaly	1626	105	720	(42)	534	(31)	216	(12)	95	(5)	38	(2)	23	(1)
Post-anomaly	1479	94	584	(37)	519	(33)	236	(15)	81	(5)	31	(2)	28	(2)
Overall	5476	382	2366	(40)	1823	(31)	791	(14)	292	(5)	110	(2)	94	(2)

IVF pregnancies

| | | Missing | | IVF pregnancy | | Non-IVF | | Not known | |
Type of scan	n	n	(%)	n	(%)	n	(%)	n	(%)
Pre-dating	772	82	(11)	7	(1)	668	(87)	15	(2)
Dating	1623	158	(10)	10	(1)	1374	(85)	81	(5)
Between dating and anomaly	159	15	(9)	7	(4)	131	(82)	6	(4)
Anomaly	1730	167	(10)	35	(2)	1423	(82)	106	(6)
Post-anomaly	1571	144	(9)	50	(3)	1309	(83)	70	(4)
Overall	5855	566	(10)	109	(2)	4905	(84)	278	(5)

Multiple pregnancies

| | | Missing | | Multiple pregnancy | | Singleton pregnancy | | Not known | |
Type of scan	n	n	(%)	n	(%)	n	(%)	n	(%)
Pre-dating	772	106	(14)	8	(1)	612	(79)	46	(6)
Dating	1623	246	(15)	19	(1)	1289	(79)	69	(4)
Between dating and anomaly	159	15	(9)	9	(6)	133	(84)	2	(1)
Anomaly	1730	170	(10)	42	(2)	1511	(87)	8	(0)
Post-anomaly	1571	144	(9)	85	(5)	1335	(85)	9	(1)
Overall	5855	681	(12)	163	(3)	4880	(83)	134	(2)

Today's scan

Person performing the scan												
			Sonographer		Midwife/ Sonographer		Obstetrician		Other Doctor		Midwife	
Type of scan	n	Missing	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Pre-dating	769	3	656	(85)	91	(12)	3	(0)	19	(2)	0	(0)
Dating	1613	10	1436	(88)	122	(8)	10	(1)	18	(1)	27	(2)
Between dating and anomaly	158	1	134	(84)	10	(6)	11	(7)	3	(2)	0	(0)
Anomaly	1727	4	1641	(95)	63	(4)	16	(1)	7	(0)	0	(0)
Post-anomaly	1561	12	1321	(84)	130	(8)	39	(2)	56	(4)	15	(1)
Overall	5828	30	5188	(89)	416	(7)	79	(1)	103	(2)	42	(1)

Source of referral												
			Maternity Unit		Other Hospital Department		Other Hospital		GP		Community midwife	
Type of scan	n	Missing	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Pre-dating	766*	6	515	(67)	89	(12)	1	(0)	151	(20)	9	(1)
Dating	1609	14	996	(61)	10	(1)	5	(0)	351	(22)	247	(15)
Between dating and anomaly	158	1	122	(77)	11	(7)	0	(0)	17	(11)	8	(5)
Anomaly	1722	9	1378	(80)	2	(0)	1	(0)	210	(12)	131	(8)
Post-anomaly	1561	12	1437	(91)	28	(2)	2	(0)	15	(1)	79	(5)
Overall	5816	42	4448	(76)	140	(2)	9	(0)	744	(13)	474	(8)

Included in this number is one referral from the private sector.

Non-routine scans

Did the person performing the scan consider the referral to be appropriate?						
			Appropriate referral?			
			Yes		No	
Type of scan	n	Missing	n	(%)	n	(%)
Pre-dating	772	0	695	(90)	77	(10)
Between dating and anomaly	159	0	123	(77)	36	(23)
Post-anomaly	1573	0	1308	(83)	265	(17)
Overall	2504	0	2126	(85)	378	(15)

Daily counts of scans performed, by hospital

Date	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Freq(06-07)	4800	2387	5436	3629	2639	3390	2416	2398	2443	4235	3744	6112	2743	3129	2214	2332	2393	4500	2882	2943	2701	3850
06/07/2007	Friday																				13		
07/07/2007	Saturday																						
08/07/2007	Sunday																						
09/07/2007	Monday																				11		
10/07/2007	Tuesday																				8		
11/07/2007	Wednesday					49					63							18			13		
12/07/2007	Thursday		6			21				32	65							29			20		
13/07/2007	Friday		35			8				21	52							13			24		
14/07/2007	Saturday		1								1												
15/07/2007	Sunday																						
16/07/2007	Monday		26			28		25		31	62	71	19					34	76		14		
17/07/2007	Tuesday		8			46		23		19	74	68	47					22	66		14		
18/07/2007	Wednesday		12			42		16		1		55	33					18	68		5		
19/07/2007	Thursday		32			25		23		11		73	59					27	68		12		
20/07/2007	Friday		14			6		11				57	34					25	43		13		
21/07/2007	Saturday		1										12										
22/07/2007	Sunday																						
23/07/2007	Monday		15			18		22					50	34			13	27		29		3	34
24/07/2007	Tuesday		17		29			17					0	41			37	18		48		6	12
25/07/2007	Wednesday		10					6					40	37			32	16		34		5	21
26/07/2007	Thursday		16					10					38	33			10	22		33			27
27/07/2007	Friday		14					17	9				28	32			24	14		34		6	29
28/07/2007	Saturday																						
29/07/2007	Sunday																			5			
30/07/2007	Monday		18	27				1	34				33	35			42	28		32	1	25	15
21/07/2007	Tuesday		19	49				2	34				23	29			38			33		31	23
01/08/2007	Wednesday		9	28				9	17				7	28			30			28		20	11
02/08/2007	Thursday	51	8	15				7	15				3	28			12			22		11	2
03/08/2007	Friday	47	14	22									13	3			27			4		31	15
04/08/2007	Saturday			6									6										
05/08/2007	Sunday		1																				
06/08/2007	Monday	68	3	30			48	3					20									21	
07/08/2007	Tuesday	62		27			50	5					18			16					9	19	
08/08/2007	Wednesday	47	7	11			50	3					4			17					2	12	
09/08/2007	Thursday	3	11	9			44	5							16	12							
10/08/2007	Friday	4		7			49								43								
11/08/2007	Saturday			9																			
12/08/2007	Sunday																						
13/08/2007	Monday	1	15	33			31								33	18						4	
14/08/2007	Tuesday		10	32				8							40	25						4	
15/08/2007	Wednesday	3	5	51											25	33						1	
16/08/2007	Thursday	1		37				1							14	16							
17/08/2007	Friday			38				6							24	20							
18/08/2007	Saturday			1											1								
19/08/2007	Sunday																						
20/08/2007	Monday			16											30	20							
21/08/2007	Tuesday			51				1							40	24							
22/08/2007	Wednesday			23											14	15							
23/08/2007	Thursday			18				5							17	20							
24/08/2007	Friday			1												10							
25/08/2007	Saturday																						
26/08/2007	Sunday																						

Glossary

Types of Specialist Clinic

Primary   Typically delivered by general practices, although encompassing a range of family health services in addition to GP care. Primary services are offered outside hospitals and are usually the first point of contact between patients and healthcare practitioners.

Secondary   Hospitals offering acute care to in-patients and out-patients. These will often be district general hospitals.

Tertiary   Major regional medical centres providing complex treatments, which are delivered by specialised personnel and facilities. Sometimes called tertiary referral centres, these hospitals receive referrals from both primary and secondary care and are often university teaching hospitals.

Definitions for Types of Hospital adapted from the NHS Quality Improvement Scotland website.

Types of Specialist Clinics

EPAU   Early Pregnancy Assessment Unit.

PND   A Prenatal Diagnosis unit is a tertiary referral hospital where cases with a suspicion of a fetal anomaly, or those with an increased risk are referred for specialist advice and prenatal tests.

FMU   Following diagnosis at a PND some cases are referred to a Fetal Medicine Unit for ongoing care.

Types of Ultrasound Scan

Pre-dating   Where women experience problems in the early stages of pregnancy, such as vaginal bleeding or previous complications, they may be referred (for instance, by their GP) for an Early Pregnancy Assessment scan.

Dating   This scan will confirm or alter the expected date of delivery by dating the gestational age of the fetus. It takes place after 8 weeks of gestation and should highlight any multiple pregnancies.

NT   Nuchal Translucency scans use ultrasound to measure the thickness of fluid at the nape of the fetal neck. Either as an independent marker or in conjunction with serum screening based on blood samples drawn from the pregnant woman, an increased amount of this nuchal fluid may indicate that the fetus has a structural, genetic or chromosomal anomaly, such as trisomy 21.

Anomaly   Recommended between 18 weeks and 20 weeks 6 days by NICE, anomaly scans are routine procedures where ultrasound is used to monitor the healthy growth of the fetus. Where anomalies are identified, prenatal forewarning is advantageous for their clinical management.

Post-anomaly   Any ultrasound scan taking place after the anomaly scan. These include growth scans, performed in the later stages of pregnancy if there is a query about the growth of the fetus.

Parameters of the Audit

Components   This term is used to define which of the scan elements were performed during the scan, for example placental site or growth assessments.

Clinical indications   This term is used to define the reasons for the referral for a non-routine antenatal ultrasound scan.

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