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Antenatal ultrasound screening: NHS vs. women's costs

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Introduction

The usefulness of antenatal ultrasound screening where clinically indicated has, rightly or wrongly, rarely been questioned. What has been controversial has been the routine use of ultrasound in all pregnancies, a procedure that has become standard practice in many countries. However, ultrasound, in common with other interventions, has the capacity for harm as well as good. Studies of the safety of ultrasound have been reassuring¹ but nevertheless, findings of unclear significance may result in considerable anxiety and distress. In addition, resources used in unnecessary ultrasound scans may be better used elsewhere in the health service.

A preliminary review of the literature revealed a paucity of good cost data. In particular, little explanation was provided in most papers on the methods used to estimate costs or what was included in the costs reported. For instance when the cost of a scan was reported it was not clear who had carried out the scan, what exactly the scan was for, for example, whether for dating or anomaly, whether or not counselling or other additional care was included in the basic cost provided.

Most economic evaluations of health care interventions do not look beyond the perspective or viewpoint of the health service. However, many health service interventions have implications for the users of the service and for society as a whole. These may include direct costs such as travel and childcare expenses; indirect costs to society in terms of lost productivity²; also the opportunity cost of unpaid time³. It is therefore recommended that a societal viewpoint be adopted where there is doubt about the extent of the impact of a policy beyond the health sector⁴. From previous work done at the National Perinatal Epidemiology Unit we were aware that little work had been done on women's costs of attending for care in pregnancy and childbirth⁵.

We therefore undertook a primary study to estimate resource use and costs of procedures directly involved and associated with routine antenatal ultrasound screening at Liverpool Women's Hospital including costs to both the health service and to users of the service. This centre was chosen primarily for its convenience, as it was the centre of study for two of the authors (JN & LB). It is also one of the largest centres providing antenatal care in Europe.

The authors acknowledge that these costs are representative of only one UK centre and will not necessarily be generalisable to other UK centres. These methods could, however, be applied in other centres willing to repeat the exercise.

This study formed part of a larger project which used systematic reviews to update evidence of clinical effectiveness, to review women's views and the cost effectiveness of routine antenatal ultrasound screening. The objective of the primary research reported here was twofold: to provide a contextual NHS based comparison for data collected from the systematic literature review of economic studies, and to fill gaps in information needed for estimation of cost-effectiveness.

Methods

Setting

At the Liverpool Women's Hospital women attend for a booking scan as well as various other tests at about 16 weeks gestation. This takes place at the antenatal clinic and the scan is carried out by staff from the Imaging department. At 18-20 weeks women routinely attend for an anomaly scan. If a problem is detected, the women may go on to have other scans and/or amniocentesis or chorionic villus sampling (CVS). These are described in more detail in Appendix 1.

Health service costs

For each type of scan (booking, anomaly, growth, placental site and fetal wellbeing) performed in the Imaging department, and for scans and procedures performed by specialist staff in the Fetal Centre (detailed scans +/- fetal echocardiography, amniocentesis, CVS), costs were estimated in consultation with the finance department at the Liverpool Women's Hospital, and the administrative staff of the Imaging department, Fetal Centre and Cytogenetics department.

Staff costs

a) Staff hourly rates

For non-medical staff, hourly rates were calculated by adding up annual salaries and dividing by the total number of hours expected to work per annum taking annual leave and bank holidays into account. Two of the radiographers had both administrative and clinical duties, and therefore in determining hourly rates only the percentage of their salary apportioned to

clinical work was included in calculating hourly rates. The remaining portion of their salary for administrative work was included in the administrative cost calculations.

Hourly consultant rates were calculated using information from the finance department which stated the number of sessions each consultant dedicated to work in the Fetal Centre and the portion of their salary attributed to these sessions. Annual leave and bank holidays were taken into account.

All salaries were obtained from 1998/1999 pay budgets and included employer's contributions for national insurance and superannuation.

b) Staff time

For each type of scan performed by radiographers in the Imaging department, staff time was recorded by using diaries designed for this purpose over a period of 1 week in November 1998. The particular week chosen represented a typical week of work in the Imaging department, and no member of staff was on annual or sick leave at the time. If staff training was involved, this was indicated in the diaries.

For each type of scan or procedure performed in the Fetal Centre during 5 weeks in November and the beginning of December 1998, details of the procedure, staff time and other staff assisting or present were recorded using datasheets. Training during scans or procedures was also documented. The times calculated for scans and procedures at the Fetal Centre were supplemented by observation of events.

All these calculations included time spent counselling and documenting the scan or procedure. Clerical time related to each scan was estimated to be 5 minutes in each case.

Consumables

Consumable costs were calculated using different methods. For the cost of gel and tissue paper used per scan, the radiographers reported how much was used in a particular day and the cost was then apportioned to the number of scans they performed in that day using those consumables (i.e. costed up). Other consumables were costed by listing what is used in an

average scan / procedure and working out the costs from the purchasing documents in the Imaging department and Fetal Centre.

Laboratory costs

Laboratory costs for processing and reporting on samples for karyotyping were obtained from the cytogenetics department who had performed a costing exercise independently.

Administration costs

Administrative staff costs for the two departments were calculated by adding together the administrative salary portion of the 2 radiographers who have administrative duties, the Imaging department office manager's salary, and in the case of the 2 clinical directors the extra payment received for their work related to clinical directorship, and then dividing the total by the number of tests / procedures performed in each department (Imaging or Fetal Centre) in the year 1997. In the case of the Imaging department the calculations included non-obstetric tests / procedures, including those performed in other areas of the hospital (e.g. gynaecology urgency room, neonatal unit) as the department also provides gynaecological and neonatal services, and if these were not accounted for the costs would have been overestimated.

Other departmental costs

Other departmental costs (i.e. costs not included in the other calculations and overheads) such as postage, computer consumables, furniture replacement etc. were obtained from 1998/99 costing based on year end expenditure documents provided by the finance department for each of the two departments and apportioned by dividing the total by the number of tests / procedures performed in each department in the year 1997. Some of the costs were shared by both departments, and some were specific to individual departments, and therefore the unit costs are slightly different.

Overheads

Hospital overhead costs were estimated at 11% of recurrent costs and include the cost of management and administration, IT services, cleaning, electricity, water etc.

Capital charges

Annual equipment costs were estimated based on the net present value of the equipment used, using straight line depreciation at 7% per annum, using the discount factor recommended by HM Treasury, and length of life of equipment as recorded in the departmental inventory. Cost of equipment per test was estimated by dividing annual cost by number of scans performed in either the Imaging department or Fetal Centre. Equipment costs for each department were calculated separately; Fetal Centre equipment costs were higher as relatively fewer tests / procedures were performed in this department per annum, and the equipment itself is technologically more complex.

Building costs were calculated by apportioning annualised building costs for the year end 1997/8 (from the finance department) according to floor space of each department and dividing by the number of scans / procedures performed in each department separately.

Six percent was added to all capital charges for return on capital employed (ROCE), which is an external charge imposed by the government. Administrative, other departmental, equipment and building costs were apportioned per scan / procedure. This assumes that non-obstetric scans did not consume disproportionately more or less of these resources.

All costs are presented in Sterling at 1998/99 price levels.

Women's costs

Women attending the Liverpool Women's Hospital for ultrasound scans in one week of January 1999 were asked to complete a short questionnaire in which they were asked about costs incurred by themselves or their friends and family to attend for their scan. The questionnaire was adapted from one used in a WHO trial of antenatal care⁶. Women were asked about lost pay for themselves or anyone accompanying them, how long they spent at the hospital and in travelling, what their travel costs were and whether they had any additional costs for childcare or care of other dependants. Separate, slightly different, questionnaires were used for women attending the Imaging department or Fetal Centre and for women having a scan in the course of their antenatal booking appointment (i.e. first antenatal visit). This was to accurately estimate the time spent on ultrasound without confusing it with time spent in other

departments and was assessed differently purely for logistic reasons. Scans done in the course of a booking appointment were to determine dates, fetal viability and multiple pregnancies. These were all performed at the antenatal clinic. All other scans (anomaly, growth, fetal wellbeing) were performed at the Imaging department or Fetal Centre.

The opportunity cost of time lost from work was estimated from the mean gross weekly wage rate for women in Great Britain at April 1998 which was £309.60⁷. Minus tax, pension and national insurance contributions (estimated at 35% of gross salary), the mean hourly rate (assuming a 37.5 hour week) was £5.37. This rate was used where the woman lost pay to attend for care. Where she took annual leave or her appointment was outside work time her time was valued at 40% of the mean female wage rate (i.e. £2.15 per hour). This valuation of leisure time is somewhat arbitrary and was varied in the sensitivity analysis. Women who were not in paid employment were considered in the base case scenario to have an opportunity cost of zero. Where women were accompanied for the duration of their visit we could not assume the *female* wage rate and the mean adult wage rate was used (i.e. £384.50 gross or £6.66 net per hour using the same assumptions as above). It was also assumed that all of the accompanying people who would have otherwise been working had taken unpaid leave.

Liverpool health authority reimburses travel expenses to women on income support at the rate of 10p per mile or their bus or train fare (not taxis), and we used this same rate for cost of travel by public transport. All costs are expressed in Sterling at 1998/99 prices.

Results

Health service costs

During the 1 week in November 317 obstetric scans were performed and diarised in the Imaging department, of which only 5 were excluded from analysis due to incomplete data. During the 5 weeks in November and December in the Fetal Centre, 200 datasheets were completed of which 12 were excluded from analysis due to incomplete data. These datasheets varied greatly in terms of indication for the scan / procedure, time spent on the scan / procedure and other staff involved.

It was assumed that all the different scans had the same costs for consumables, administrative staff, buildings, other departmental costs and equipment. Only duration and staffing were assumed to vary. Staff present and the average duration of each different type of scan and procedure is presented in Table 1, based on the staff diaries and datasheets and, in parenthesis, the minimum and maximum recorded time involved.

Table 1 also shows the increase in duration of scans in which a sonographer was being trained. No booking scans involved training in the time period studied, but for growth scans and anomaly scans training increased procedure time by 36 - 44 %.

For each procedure presented, the variation in time was reflected only in the key person(s) carrying out the scan, but typically 5 minutes of clerical time was associated with each procedure, for filing, arranging appointment etc. For the detailed scans carried out by the consultant, a Health Care Assistant usually set up the trolley and cleared away. For other secondary procedures such as amniocentesis or transabdominal CVS (TA CVS) or transvaginal CVS (TV CVS) a midwife was usually also present during the procedure.

All elements of the costs for the different scans and procedures are presented in Table 2. Booking, anomaly, growth and fetal well-being scans typically cost between £13 - £15. This contrasts with detailed scans in which the estimated cost was £49 and amniocentesis, TA CVS and TV CVS in which the costs were £187, £237 and £262 respectively.

Sensitivity analysis

The key variables in this analysis were: (i) staff present; (ii) the duration of the different scans and procedures; (iii) the effect of training; (iv) equipment costs.

- (i) The status and grade of staff present has the potential to influence the results. The baseline analysis used data from the finance department relating to the staff employed. If staff were employed on a lower grade the costs would be proportionately lower. Similarly, at the LWH consultants carried out the detailed scans, amniocenteses and CVS. Registrars typically get paid about half the salary of consultants⁸ thus costs would be commensurately lower.
- (ii) The range of durations of different scans and procedures is shown in Table 1. For dating, anomaly, growth and fetal well being scans the range was quite small and only

made a difference of £3 - £4. For the detailed scans, however, the range was large, from 17 – 70 minutes representing a range in cost of £12 - £45.

- (iii) The effect of sonographer training is shown in Table 1 in which the duration of anomaly and growth scans was increased by 36-44%. We do not have data about other scans and procedures or about training of other staff but the effect is likely to be the same.
- (iv) Equipment costs are based on a number of assumptions including the interest rate used, the estimated lifetime of the equipment and whether maintenance costs are included. In the sensitivity analyses we varied interest rates between 3-10%; length of life of equipment, based on the departmental inventory, was extended by 25% in the sensitivity analysis. For the baseline analysis, maintenance costs were assumed covered in the purchase price; for the sensitivity analysis maintenance costs were estimated at 10% of the purchase price per year. All of these together produced a range of equipment costs of £3.97 -£5.77 for the Imaging department and £13.79 - £20.30 for the Fetal Centre.

Women's costs

The response rate for questionnaires to women attending Imaging Department / Fetal Centre was 72 out of 89 (81%). For women being scanned at the antenatal booking clinic the response rate was 35 out of 36 (97%). The total number of women who completed a questionnaire was 107. Response rates to individual questions (or sets of questions) was >99% except only 42% of women attending the Imaging Department / Fetal Centre responded to the question on the duration of their appointment. The results are summarised in Table 3.

Lost pay

If not attending for a scan 41 women (38%) would have been in paid employment. Of these 25 took paid absence, the cost being borne by the employer; 6 took unpaid absence or intended to make the time up, the cost therefore being borne by themselves; and 4 took holiday. The other 6 came outside work time.

The mean duration of an appointment at the Imaging Department / Fetal Centre was 29.4 minutes; in antenatal booking clinics ultrasound appointments were of shorter duration averaging 17.2 minutes. Mean journey time (one way) for all women was 22 minutes. Thus women who lost pay to attend for ultrasound scans on average lost £6.57 to attend the Imaging Department / Fetal Centre and £5.48 to attend ultrasound at antenatal booking.

Four women took annual leave to attend for ultrasound. At 40% of the mean wage rate their time can be valued at £2.63 and £2.19 to attend the Imaging Department / Fetal Centre and antenatal booking clinic respectively (40% of £6.57 and £5.48).

The vast majority (92%) of women said they were not losing income through attending for ultrasound. The other responses ranged from £5 to £200. Forty-five women (81%) were accompanied by people taking time off work (costs summarised in Table 3).

Travel

The majority of women (74%) travelled by private car. Parking fees were paid by 23 women ranging from 20p to £5.50, mean cost 53p. Mean distance travelled (one way) was 7.0 miles. Sixteen women travelled by public transport and paid an average of £1.99 (one way). Nine women travelled by taxi costing £4.23 on average.

Thirty women were on income support and were thus eligible to have their travel costs reimbursed by the health authority. Assuming that they all claimed reimbursement the travel costs of these 30 women cost the health authority £27.80 in total.

Childcare / care of dependants

Only 3 women paid for childcare while they attended for ultrasound. Three women indicated that someone had taken time off work to care for other children or dependants. Assuming average travel and ultrasound time ($22 + 29 + 22 = 73$ minutes) this may have cost the carer £8.15 in lost pay. It is, however, also possible that a half day may have been taken off work (costing more) or that the time off may have been taken as holiday (leisure time) and thus costed at other than the full working rate.

Costs to employers

Additional costs to society through employers are incurred through paid absence for women to attend for ultrasound when they would otherwise be working. Using average gross female weekly wage rates of £309.60 (as above) and mean time off work of 73 minutes for women attending the Imaging Department / Fetal Centre and 61 minutes for women being scanned at the antenatal clinic, the estimated cost to employers was £10.04 and £8.39 respectively. The cost per woman averaged over all women (including those not in paid employment) was £2.39 and £2.00 respectively.

Sensitivity analyses

The key assumptions we made in valuation of women's costs were:

- i. that women not in paid employment had no cost on their time;
 - ii. that leisure time should be valued at 40% of work time;
 - iii. that the mean female wage rate was appropriate for this population;
 - iv. that all women entitled to reimbursement of travel costs claimed them.
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- i. If this assumption is changed to reflect the type of activity they might otherwise be doing, such as housework or childcare, this might be costed at about £4 per hour. This applied to 55% of the women sampled. It would increase the costs to women by £4.86 per woman for those attending the Imaging Department / Fetal Centre and by £4.07 for women attending for antenatal booking. Averaged over all women responding this amounts to £2.67 and £2.24 respectively.
 - ii. Leisure time can be valued at anything from zero to 150% of the usual wage rate⁴ This only applied to 4 women but for them 150% would amount to £9.79 to attend the Imaging Department / Fetal Centre or £8.18 to attend the antenatal booking clinic. However, averaged over all women responding this amounted to only 37p and 31p respectively.
 - iii. We did not collect the detailed occupational information required to accurately estimate costs to employers and employees of time off work. We therefore used average female wage rates. However, wages have a skewed distribution and the mean may be a poor measure of central tendency. If the median female wage rate was used instead (i.e.

£270.00 instead of £309.60 per week) minus tax, national insurance and pension contributions (estimated at 35% of gross salary) and an average working week of 37.5 hours, the total cost per woman sampled declined to £5.69 for women attending the Imaging Department / Fetal Centre and £4.76 for women attending the antenatal booking clinic.

- iv. In many cases people entitled to benefits do not claim them. If none of the women entitled to reimbursement of travel costs claimed them then these women would be on average 93p worse off.

Discussion

The estimated cost to the NHS of routine antenatal ultrasound scans at Liverpool Women's Hospital was between £13 - £15 each. Detailed scans and other 'knock-on' procedures cost considerably more but are not needed by the majority of women. These costs are sensitive to assumptions about staff present and duration of scans. The importance of training and equipment costs should also be noted.

For women to attend for ultrasound scans, they may lose between £6 and £7. The costs are slightly higher for women attending the Imaging Department / Fetal Centre compared to those for women having a scan in the course of an antenatal booking appointment. This is because booking scans are quicker to carry out than other scans. It should, however, be noted that duration of appointment at the Imaging Department / Fetal Centre is based on a 42% response rate. The results are, nevertheless, consistent with the staff reported scan durations.

The opportunity cost of attending for a scan whilst already at the hospital for antenatal care is less than if the scan was the sole reason for the appointment. It is, however, unusual for a woman to attend hospital solely for a scan so travel costs have been included in all cases. The majority of the women sampled were not in paid employment and the majority of those who were took paid absence from work. Their employers and society therefore bore the cost of these absences. A small proportion of women took unpaid leave, intended to make the time up

or took holiday to attend for their scan but averaged over all women attending the impact of this was small. Eighty-one percent of women attending for a scan were accompanied by at least one other adult and approximately half of these accompanying adults took time off work to do so. These costs made up nearly half of the total costs incurred by the women and their friends and family. Women's costs were sensitive to assumptions about the valuation of unpaid work. Otherwise the findings were robust.

Because of employment rights for pregnant women, most costs of lost working time for employed women are met by the employer. The employers' costs we have estimated for a scan are only a small part of the much larger cost to them of providing for maternity rights, part of which are repaid by the Department of Social Security through the Statutory Maternity Pay scheme. Although we have attempted to take a societal perspective and have considered employers' costs, there may well be other costs to society which we have not considered.

Conclusions

Costs to women and to society for attending ultrasound were about £9 per woman (£7 + £2) compared to about £15 in health service costs per scan. Nevertheless, such costs may be an important proportion of household resources in low income households. The impact of changes in health care practice may therefore influence either the family economy or clinic attendance as a result, but this would require further evaluation. Costs to families are sensitive to assumptions about value of women's time given to this activity. There is scope for more investigation of the values women attach to their own time and to attending for a scan in different circumstances.

Points for discussion

- The generalisability of these findings to other UK hospitals. Liverpool Women's Hospital is a large teaching hospital.
- Generalisability of patient costs to other out-patient care outside maternity care e.g. physiotherapy.
- Other costs to society. We have only included costs to employers. Are there other important societal costs?

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Table 1 – Staff time for each scan or procedure

Staff	Cost / hour	Mean (range) minutes							
		Dating / Booking scan	Anomaly scan	Growth scan	Fetal well-being scan	Detailed scan	Amniocentesis	TA CVS	TV CVS
Sonographer <i>training</i>	16.46	16 (9.4-23.4)	20.2 (17-30) 29.1 (22.5-35.7)	21 (14-28) 28.6 (21.6-35.6)	20.2 (17-30)	n/a	n/a	n/a	n/a
Consultant	37.88	n/a	n/a	n/a	n/a	34 (17-70)	40	45	45
Midwife	12.87	n/a	n/a	n/a	n/a	n/a	30	45	45
Health care assistant	3.73	n/a	n/a	n/a	n/a	n/a	5	5	5
Clerical	6.20	5	5	5	5	5	5	5	5

Table 2 – Cost for each scan or procedure at Liverpool Women’s Hospital (UK Sterling £ 1998/99)

	Dating / Booking scan	Anomaly scan	Growth scan	Fetal well- being scan	Detailed scan	Amnio- centesis	TA CVS	TV CVS
<i>Department</i>	<i>Imaging</i>	<i>Imaging</i>	<i>Imaging</i>	<i>Imaging</i>	<i>Fetal Centre</i>	<i>Fetal Centre</i>	<i>Fetal Centre</i>	<i>Fetal Centre</i>
Consumables	0.15	0.15	0.15	0.15	0.15	8.91	26.78	49.11
Laboratory costs	n/a	n/a	n/a	n/a	n/a	105.00	126.00	126.00
Administrative staff	1.17	1.17	1.17	1.17	1.89	1.89	1.89	1.89
Building	1.01	1.01	1.01	1.01	3.86	3.86	3.86	3.86
Other departmental costs	0.50	0.50	0.50	0.50	0.51	0.51	0.51	0.51
Equipment	5.00	5.00	5.00	5.00	17.54	17.54	17.54	17.54
Staff (range)	5.02 (3.10- 6.94)	6.06 (4.22- 7.90)	6.28 (4.36- 8.20)	7.68 (3.13- 12.62)	22.29 (11.56- 45.02)	32.52	38.89	38.89
Hospital overheads*	0.74	0.86	0.86	0.86	2.73	16.37	21.35	23.80
TOTAL COSTS	13.48 (11.47- 15.73)	14.75 (12.71- 16.80)	15.00 (12.87- 17.13)	14.75 (10.96- 20.45)	48.98 (37.06- 74.20)	186.60	236.82	261.60
<i>Training</i>		<i>17.46 (15.46- 19.47)</i>	<i>17.31 (15.18- 19.44)</i>					

* implies 11% added to all costs except buildings and equipment

Table 3: Costs to women or their family and friends of attending for ultrasound scans at Liverpool Women’s Hospital

	N	%	Mean cost per woman affected		Cost averaged over all women responding	
			Fetal Centre	Booking Clinic	Fetal Centre	Booking Clinic
Lost pay (100%)	6	5.7	£6.57	£5.48	37p	31p
Lost leisure (40%)	4	3.8	£2.63	£2.19	10p	8p
Accompanying adults off work	45	42.8	£8.15	£6.79	£3.49	£2.91
Travel ^a						
- car	79	74.5	£1.40		£1.04	
- public transport	16	15.1	£5.48		83p	
- taxi	9	8.5	£8.46		72p	
Parking fees	23	21.9	53p		12p	
Childcare						
- paid	3	2.8	£17		49p	
- time off work	3	2.8	£8.15		23p	
Totals						
Imaging dept/ Fetal Centre	72		£7.39			
Antenatal Booking Clinic	35		£6.73			

^a does not include women eligible to have their travel cost reimbursed by health authority

Appendix 1

Definition of different scans / procedures

Booking scan - scan undertaken at first antenatal visit, preferably before 16 weeks gestation, to measure the fetus for gestational dating, identify multiple pregnancies and associated chorionicity, and assess viability.

Anomaly scan - scan undertaken at 18-20 weeks gestation to perform a fetal structural survey and detect structural anomalies, fetal biometry to confirm appropriate size for gestational age, and assess the placental site and liquor volume.

Growth scan - scan performed for fetal biometry to assess fetal size and growth.

Fetal wellbeing scan - this represents a number of alternatives used to assess the condition of the fetus, and which may include fetal biometry, fetal weight estimation, liquor volume assessment subjectively or by measuring the amniotic fluid index, umbilical artery Doppler velocimetry, and biophysical profile assessment (fetal tone, fetal movements, fetal breathing movements and amniotic fluid volume). As all, some or one of the above factors may be assessed in different combinations, we 'lumped' them together because the data the staff collected for the various combinations was small in number, not dissimilar in time spent and too complicated to present separately.

Detailed scan - scan performed by a consultant (subspecialist in feto-maternal medicine, special interest in feto-maternal medicine, radiologist) to assess all or some of the fetal structural anatomy, or other aspects of the pregnancy such as suspected pelvic abnormalities. This scan may occur as a result of an abnormality suspected at routine ultrasound scan, a family or personal or obstetric history of congenital abnormality, a maternal condition associated with a higher risk of congenital abnormality (e.g. diabetes, advanced maternal age), or an abnormal antenatal test other than ultrasound (e.g. serum screening).

Amniocentesis - invasive procedure performed transabdominally under ultrasound guidance whereby amniotic fluid is tapped and sent for cytogenetic or in some cases other analysis.

Chorionic villus sampling - an invasive procedure performed transabdominally or transvaginally whereby placental tissue is aspirated and sent for cytogenetic analysis.