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An intrapartum intervention scoring system for the comparison of maternity units' intrapartum care of nulliparous women suitable for midwifery-led care*

Marianne M.P. Mead, and Diane Kornbrot

Objective: to develop an intrapartum intervention scoring tool which could be used to define maternity units as either 'lower intrapartum intervention' or 'higher intrapartum intervention' units. This scoring tool was designed to form the basis of a comparison of the perception of risk by midwives working in either 'lower intrapartum intervention' or 'higher intrapartum intervention' units.

Design: three aspects were included: (1) the systematic data reduction of the St Mary's Maternity Information System database used by 11 maternity units to include Caucasian nulliparous women suitable for midwifery-led care; (2) the calculation and the ranking of frequency distributions for the following interventions/management: (a) the management of breech presentation and of one previous caesarean section, the choice of home birth; and (b) augmentation of labour, use of electronic fetal monitoring, use of epidural, method of delivery; (3) the sum of the individual intrapartum ranking marks made up the final intrapartum score for each unit.

Results: intrapartum interventions varied considerably between units. The scoring system enabled units to be described as either 'Lower intrapartum intervention' or 'Higher intrapartum intervention' units.

Conclusions: routinely collected computerised data can be used to identify the outcomes of intrapartum care. This study suggests that the analysis of computerised data could provide a suitable basis for the audit and the comparison of intrapartum interventions for the care of women suitable for midwifery-led care. © 2003 Published by Elsevier Ltd.

Marianne M.P. Mead
BA (OU), PhD, RM, MTD
Principal Lecturer,
Department of Midwifery
and Child

Diana Kornbrot
BSc, MSc, MA, PhD
Associate Dean (Research),
Department of Psychology,
University of
Hertfordshire,
College Lane, Hatfield,
Herts AL10 9AB, UK

(Correspondence to:
MMPM, E-mail:
m.m.p.mead@herts.ac.uk)

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BACKGROUND

Extensive research has been undertaken on some common intrapartum practices: the use of artificial rupture of membranes (ARMs) and other forms of augmentation of labour (Bidgood & Steer 1987, Fraser et al. 1998, Rouse et al. 1999), cardiotocography (CTG) (Lidegaard et al. 1992, Thacker et al. 1995, Kline et al. 1998, Goddard 2001, Young et al. 2001) and epidural analgesia (Porreco & Thorp 1996, Cammu et al. 1998, Graninger & Mccool 1998, Ades et al.

1999, Goldberg et al. 1999, Rogers et al. 1999, Howell 2000, Leong & Sivanesaratnam 2000, Wimmer & Jakobi 2000).

The comparison of maternity units tends to be made on the basis of single specific criteria, e.g. rates of epidural analgesia, caesarean section (CS) or home birth (Macfarlane & Mugford 2000a, b), and comparisons of the intrapartum care provided to women suitable for midwifery-led care are not readily available. The development of the concept of 'the standard primip', defined as a Caucasian woman aged 20–34 years, height over 155 cm, with a singleton fetus, cephalic presentation, more than 37 weeks gestation, delivered in the same unit as booked

*This study was undertaken as part of a PhD programme of work.

2 Midwifery

1 and with no medical complications of pregnancy (Cleary et al. 1996), has enabled comparisons
3 between units using the St Mary's Maternity Information System (SMMIS) (Harris &
5 Chapple 1998, 2000), but the data reduction procedure that enables the exclusion of women
7 who do not fulfil the criteria of the 'standard primip' has not been described.

9 Major variations in intrapartum care have been reported in the UK (Macfarlane &
11 Mugford 2000a, b) and elsewhere (Nozton 1990, Nozton et al. 1994, Elferink-Stinkens
13 et al. 1996, Kaczorowski et al. 1998), and the rise in the CS rate is giving cause for concern
15 (World Health Organization—Regional Office for Europe 1986, World Health Organization 1996,
17 Thomas & Paranjothi 2001). This rise has been associated with factors such as nulliparity, birth
19 weight, maternal age, maternal weight (Cnattin-gius et al. 1998), and ethnicity (Gould et al. 1989,
21 Thomas & Paranjothi 2001), but also with different levels of intrapartum interventions in
23 otherwise similar populations (Porreco & Thorp 1996, Goffinet et al. 1997, Johnson et al. 1997,
25 Cammu et al. 1998, Rogers et al. 1999, Mead et al. 2000, Wimmer & Jakobi 2000), which
27 would suggest differences in individual's or units' policies or philosophies (Strobino et al. 1988,
29 Guillemette & Fraser 1992, Rosenblatt et al. 1997, Vandenbussche et al. 1999).

31 Inconsistencies have also been demonstrated in the care provided by midwives and obstetri-
33 cians to 'low-risk' women, with midwives generally providing less interventionist care and
35 achieving a higher proportion of normal deliveries than doctors (Davis et al. 1994, Cheyne et al.
37 1995, Oakley et al. 1995, Fullerton et al. 1996, Oakley et al. 1996, Beckmann et al. 1997,
39 Rosenblatt et al. 1997, Scheepers et al. 1998, Law & Lam 1999, Janssen et al. 2002). Differ-
41 ences in the care provided by midwives and obstetricians has also been noted in the case of a
43 history of previous CS (Harrington et al. 1997).

45 An earlier study, using a systematic data reduction of the SMMIS data, compared the
47 intrapartum care of healthy Caucasian women suitable for midwifery-led care in four neigh-
49 bouring maternity units. Significant variations in intrapartum interventions, i.e. the use of ARM,
51 electronic fetal monitoring (EFM) and epidurals, were found. A higher level of intervention was
53 also associated with a higher level of abnormal deliveries (Mead et al. 2000). These findings were
55 consistent with other research that had demon-
57 strated wider variations in care in healthy
59 women, but more consistent care in complicated
61 pregnancies (Baruffi et al. 1984). Since the
context in which midwives operate has also been
shown to influence their practice (Kirkham 1999,
Kirkham & Stapleton 2000), the differences
identified suggested the hypothesis that midwives

working in 'higher intrapartum intervention' 63
units may have a higher perception of risk than 65
midwives working in 'lower intrapartum inter-
vention' units, for women suitable for midwifery- 67
led care.

To test this hypothesis, two approaches were 69
used. In the first instance, the comparison of the 69
intrapartum care of women suitable for mid-
wifery-led care using the SMMIS database 71
enabled the establishment of an intrapartum 73
score that classified the 11 units as either 'higher 75
intrapartum intervention' or 'lower' intrapartum 75
intervention units. Secondly, a questionnaire, 77
using a standardised scenario of a healthy 77
nulliparous woman in spontaneous labour at 79
term of a normal pregnancy, was used to survey 79
the midwives' perception of risk for common 81
events, both positive and negative, during labour 81
and at delivery. How the variations in the 83
interventions selected were used to develop an 83
individual intrapartum intervention score for 11 85
units, which could then be described as either 85
'lower intrapartum intervention' or 'higher in- 87
trapartum intervention' units, are described in 87
this paper.

METHODS

Sample

89 All 12 units using SMMIS and making their data 89
available centrally on a yearly basis were 91
contacted for this study. These maternity units 91
are situated in and around the London area. One 93
unit declined to take part in the study because 95
of other research commitments. Research ethics 95
approval was granted by a multicentred research 97
ethics committee and each of the 11 local 97
research committees. The 1998 anonymised 99
maternity data of the 35 367 deliveries in the 11 101
maternity units (ranging from 2719 – 7.4% of the 103
total number of cases – for the smallest unit to 105
3861 – 10.0% – for the largest) were made 105
available in early 2000 and transferred onto 107
SPSS for Windows. These deliveries represent 107
4–5% of the annual number of recorded 109
deliveries for the United Kingdom (Department 109
of Health 2000). At the end of the data 111
reduction, 9887 cases remained – 4909 nullipar- 111
ous women (ranging from 252 or 5.1% to 580 or 113
11.8% per unit) and 4978 multiparous women 113
(ranging from 134 or 2.8% to 615 or 12.4% per 115
unit). 115

Process

117 The SMMIS database includes the data of all 117
pregnancies and deliveries, whatever the gesta- 119
tional age. Midwives are responsible for data 120
entry. Four data reduction stages were used to 121

1 exclude women who could not normally be seen
 2 as suitable for midwifery-led care during the
 3 intrapartum period. The staging of the data
 4 reduction enabled the intermediate analyses of
 5 the potential differences between the 11 units in
 6 terms of socio-economic background as well as
 7 the management of specific situations in women
 8 who were healthy, even if their care ultimately
 9 was the responsibility of a medical practitioner,
 10 as in the case of breech presentation and a
 11 previous CS. The final stage of the data
 12 reduction enabled the comparison of the intra-
 13 partum care of similar nulliparous women. These
 14 exclusion criteria match those used for the
 15 analysis of intrapartum intervention in other
 16 studies (Koong et al. 1997, Williams et al. 1998).

17 Stage One

18 Exclusion – multiple pregnancies, pregnancies
 19 concluded before 24 and after 42 weeks and non-
 20 Caucasian women. Analysis – differences in
 21 prematurity rates, taking into consideration
 22 information available on SMMIS: parity, marital
 23 status, maternal age, cigarette smoking. This
 24 analysis was restricted because only limited
 25 socio-economic information is available on the
 26 SMMIS database.

27 Stage Two

28 Exclusion – women identified as having previous
 29 medical history (i.e. heart disease, hypertension,
 30 diabetes, epilepsy, haemoglobinopathies), pre-
 31 sent pregnancy abnormality (i.e. gestational
 32 diabetes, pregnancy-induced hypertension, pla-
 33 centa praevia), grand multiparity (≥ 4 previous
 34 children), women booked in another hospital
 35 than the one used for delivery, fetal presentation
 36 other than cephalic or breech, congenital ab-
 37 normalities and intrauterine deaths. Analysis –
 38 rates of planned and actual home birth, manage-
 39 ment of breech presentation and previous CS(s).
 40 Although it is acknowledged that the manage-
 41 ment of a breech presentation and a previous CS
 42 is usually the preserve of medical practitioners,
 43 their management in healthy women who would
 44 otherwise be suitable for midwifery-led care was
 45 included in the calculation of intrapartum score
 46 because the decision regarding the initial man-
 47 agement and the final outcome of labour was
 48 seen as potential indicators of the philosophy of
 49 the practitioners if major differences were
 50 identified between the units. The publication of
 51 the multicentred study on the management of
 52 breech presentations at term (Hannah et al.
 53 2000) post-dates this study.

54 Stage Three

55 Exclusion – women who had a previous perinatal
 56 or neonatal mortality, previous CS(s) or pre-
 57 sentations other than cephalic. Women who had
 58 a previous perinatal mortality were excluded on

59 the basis of increased risk in the present
 60 pregnancy (Robson et al. 2001). Analysis –
 61 methods of onset of labour (spontaneous,
 62 induction or elective CS).

63 Stage Four

64 Exclusion – present pregnancy induction of
 65 labour and elective CS. At this stage, the women
 66 remaining in the analysis could be said to be
 67 suitable for midwifery-led care. Analysis –
 68 differences in the intrapartum care and outcomes
 69 between the 11 units.

70 The interventions and outcomes measured at
 71 the four steps of data reduction were examined
 72 for both nulliparous and parous women. The
 73 calculation of the nulliparous score which was
 74 used for the subsequent comparison of midwives'
 75 perception of risk, where standardised scenarios
 76 of a nulliparous woman formed the basis of the
 77 study, is reported here. However, the correlation
 78 between the overall intrapartum scores of the
 79 two groups demonstrated a close relationship
 80 between the care of nulliparous and parous
 81 women ($r = 0.703$, $p = 0.008$). The nulliparous
 82 intrapartum score used the rates of the following
 83 criteria:

84 Breech presentation

85 Spontaneous onset of labour – nulliparae
 86 Vaginal delivery – nulliparae

87 Previous CS in a second pregnancy

88 Spontaneous onset of labour
 89 Normal delivery
 90 Emergency CS

91 Home births

92 Planned home birth – nulliparae
 93 Home birth – nulliparae

94 Women suitable for midwifery-led care – nulliparae

95 Spontaneous onset of labour
 96 Elective CS
 97 No augmentation of labour
 98 Oxytocin augmentation
 99 ARMs + oxytocin augmentation
 100 No CTG
 101 CTG done and identified as normal
 102 CTG identified as abnormal
 103 Epidural
 104 Normal delivery
 105 Emergency CS
 106 Emergency CS in second stage of labour

107 Each intervention/outcome rate was calcu-
 108 lated and each unit automatically awarded a
 109 score of 1–11, 1 being attributed to the unit
 110 with the lowest intervention rate and 11 to the
 111 unit with the highest intervention rate. The
 112 sum of the individual ranked scores was then
 113 used to calculate the intrapartum score of each
 114 unit.

4 Midwifery

SPSS for Windows, version 10.07, was used for statistical analysis. Statistical significance was set at $p < 0.05$. Pearson χ^2 was used for categorical data, ANOVA for the comparison of means, binary logistic regression in multivariate analyses for the control of potential confounders. The ranking tool of Excel for Windows was used for the automatic ranking of units for each variable under consideration.

FINDINGS

Data reduction

In all 35 367 deliveries were recorded in these 11 units in 1998, including 553 twin and 26 triplet pregnancies. Following the exclusion of multiple pregnancies and babies delivered before 24 weeks or after 42 weeks, 34 096 cases remained. The number of singleton pregnancies per unit varied between 2533 and 3702. Information on the ethnic background of women identified 108 different groups which were related to nationality rather than ethnicity. Following contact with the Department of Epidemiology and Public Health, St Mary's, London, responsible for the definition of the 'standard primip' (Cleary et al. 1996), the decision was made to use the categories they classified as Caucasian: Western European women, white British, English, Scottish, Welsh, Irish and white other. Non-Caucasian women, 10 427 (30.6%), were excluded for two main reasons: (1) their proportion varied widely, ranging from 4.2% to 57.1% between the 11 units; (2) the rate of prematurity was significantly higher in the non-Caucasian women: 7.8% v 5.6% for primigravidae ($\chi^2 = 26.272$, df 1, $p < 0.001$) and 6.7% v 5.2% for multigravidae ($\chi^2 = 17.769$, df 1, $p < 0.001$).

Only women who delivered at the hospital they intended to deliver at were kept in the analysis because no information was available on the timing or the purpose of either transfers in or transfers out.

Further criteria of exclusion were applied because these women would normally have required referral to a medical practitioner:

- previous medical history (diabetes, epilepsy, hypertension, haemoglobinopathies, cardiac and renal disease);
- present pregnancy complications (gestational age below 37 or above 42 weeks, pregnancy-induced hypertension if diastolic blood pressure ≥ 90 mmHg, gestational diabetes, Rhesus iso-immunisation, pyelonephritis, antepartum haemorrhage, proteinuria identified as 'persistent ++', cervical suturing, ≥ 3 antenatal nights in hospital, fetal abnormalities and stillbirths, grand multiparae, e.g. para ≥ 4);
- previous perinatal or neonatal mortality;
- presentations other than cephalic;
- elective CSs and induction of labour.

At the end of the data reduction 9887 women remained in the study; 4909 were nulliparous women. The number of cases varied between 252 and 552 deliveries per maternity unit, each unit accounting for between 5.1% and 11.8% of the total number of deliveries (see Table 1).

Social and demographic data

Only limited demographic data are available on SMMIS: maternal age, parity, marital status, cigarette smoking, gestational age at delivery (Table 2). However, their analyses demonstrated significant differences between the 11 units. The overall rate of nulliparae was 49.7%, with eight of the 11 units ranging from 46% to 51%, one unit with a much lower rate of nulliparae at 43.1%, and two units, both teaching hospitals (THs), with a rate of 62.5–64.5%. These two

Table 1 Maternity units before and after data reduction

Units	N initial total singleton deliveries	% Non-Caucasian women	N nulliparous deliveries – after data reduction	% Nulliparous deliveries
DGHI	2705	29.4	423	8.6
DGH2	2543	8.3	455	9.3
DGH3	3141	12.1	556	11.3
DGH4	2564	4.2	550	11.2
DGH5	2942	8.1	512	10.4
DGH6	3340	23.7	552	11.2
DGH7	3702	49.3	377	7.7
TH1	3659	32.5	580	11.8
TH2	2643	38.7	325	6.6
TH3	3159	55.4	252	5.1
TH4	3698	57.1	327	6.7
All	34 096	30.6	4909	100.0

Table 2 Socio-economic background of nulliparae by unit – $n=4909$

Hosp.	<i>n</i>	Nulliparae* (%)	Maternal age†	< 18 years‡ (%)	> 35 years (%)	Single§ (%)	Smoking¶ (%)	Preterm (%)
%		49.7	27.92	3.4	9.9	33.6	17.2	6.3
DGHI	423	50.9	28.27	2.6	10.9	31.7	21.8	6.4
DGH2	455	43.1	26.51	5.1	7.3	41.1	18.2	7.4
DGH3	556	47.5	28.33	2.5	10.1	37.4	15.2	6.6
DGH4	550	49.3	27.80	3.1	8.4	21.3	13.3	5.2
DGH5	512	46.1	28.33	1.4	10.7	33.8	13.9	5.0
DGH6	552	48.3	26.78	5.8	8.5	19.0	22.3	7.6
DGH7	377	48.0	26.08	6.9	5.3	44.6	19.4	6.7
THI	580	62.5	30.28	0.5	14.1	26.4	10.5	5.9
TH2	325	46.8	27.21	5.8	11.4	48.9	23.7	4.8
TH3	252	64.5	29.06	1.6	13.9	49.2	14.7	6.2
TH4	327	49.3	27.90	3.4	9.5	37.0	21.2	6.8

* Calculated on final data reduction $\chi^2=125.893$.† Calculated on final data reduction $F=24.771$, df 10, $p < 0.001$.§ Calculated on final data reduction $\chi^2=59.314$, df 10, $p < 0.001$.¶ Calculated on final data reduction $\chi^2=203.137$, df 10, $p < 0.001$.|| Calculated on final data reduction $\chi^2=61.928$, df 10, $p < 0.001$.|| Calculated on all pregnancies 24–42 weeks ($n=34\ 096$) $\chi^2=18.651$, df 10, $p=0.045$.

units are situated in a very busy urban area, with high house prices; families are therefore more likely to leave the area when larger family accommodation is required.

The average maternal age of nulliparae was 27.9 years, ranging from 26.5 to 30.3 years between the 11 units. These differences were statistically significant ($F = 24.771$, df 10.4908, $p < 0.001$). The proportion of very young mothers varied in the 11 units ($\chi^2 = 61.928$, df 10, $p < 0.001$). This socio-demographic group is associated with lower educational achievement and a corresponding lower income (Macfarlane & Mugford 2000a, b). Paradoxically, the units that had a lower rate of younger nulliparae also had a higher rate of older first-time mothers.

Overall 65.2% of the nulliparae were married, although the rate dropped to 17.6% for the women aged ≤ 19 years, and rose to 73% for women aged ≥ 35 years. About 17.2% of the women were smokers, ranging from 10.5% to 23.7%, between units ($\chi^2 = 203.137$, df 10, $p < 0.001$). Single women were significantly more likely to smoke (30% v 10.4%), but the maternal age also played a significant role: 41.6% of women aged ≤ 19 years smoked, compared to 15.5% for women aged 20–34 years, and 8.2% for women ≥ 35 years.

The average gestational age at hospital booking was 14 weeks, ranging between 11 and 17 weeks between the 11 units. These differences were significant ($F = 32.965$, df 102 308, $p < 0.001$) but may reflect gestational age at first hospital contact rather than initial antenatal contact, and may therefore be unreliable for the comparison of the maternity units.

The analysis of the socio-demographic variables available on the SMMIS database provided some basis for the comparison of the units, but the scope of the information available on the social background of the women was too limited

to provide a reliable basis for a socio-economic score.

Intrapartum interventions

The intrapartum intervention score was made up of four areas of comparison: (1) the management of a breech presentation in nulliparae in an otherwise normal pregnancy, the management of a previous CS in a second pregnancy in an otherwise normal pregnancy and the choice and achievement of a home birth for nulliparae; (2) the onset of labour in nulliparous women suitable for midwifery-led care; (3) the level of intervention in these nulliparous women in spontaneous labour at term; and (4) the methods of delivery.

Although the management of a breech presentation and a previous CS are principally decisions made by women in consultation with an obstetrician, these two aspects were included in the scoring system because, in the absence of medical complications, one might expect a similar management.

(1) Breech, previous CS and home births

The management of previous CSs, breech presentations and the rates of planned and actual home birth varied substantially between the 11 units.

There were 272 breech presentations, 11–38 cases per unit, in the healthy nulliparous women with uncomplicated term pregnancies. Elective CS was the most common approach (170 women or 62.5%, varying between 54.5% and 80.0%), followed by spontaneous onset of labour (95 women or 34.9%, ranging between 54.5% and 16.7%). Only seven women (2.6%), in five units had their labour induced. The onset of labour did not vary significantly between the 11 units ($\chi^2 = 28.632$, df 20, $p = 0.095$), when all cases were considered. However, if only spontaneous

onset and elective CSs were considered, the differences were significant. The overall rate of elective CS was 64.2%, with variations ranging between 45.5% and 82.4% ($\chi^2 = 18.515$, $df = 10$, $p = 0.047$). The women whose labour was spontaneous (85.3%) had an emergency CS. This rate varied between 66.7% and 100% in the 11 units, but the numbers involved were too small to detect any significant difference (Table 3).

In this series, 732 healthy women were having their second baby after a previous CS. The rate of spontaneous onset and elective CS were similar (349 or 46.3% and 339 or 47.7%, respectively). Forty-four women (6.0%) had their labour induced. There were marked differences between the 11 maternity units. The rate of spontaneous onset varied between 67.1% and 31.1%, the rate of induction between 0.9% and 17.1%, and the rate of elective CS between 17.1% and 66.7% ($\chi^2 = 77.700$, $df = 20$, $p < 0.001$). Of the 349 women – 14–47 women in these 11 units – whose labour was spontaneous, 165 (47.3%) had a normal delivery, 89 (25.5%) an instrumental vaginal delivery and 95 (27.2%) an emergency CS. The rates of emergency CS varied between 17.1% and 50.0%, but the differences between units did not reach a significant level ($\chi^2 = 18.791$, $df = 20$, $p = 0.535$) (Table 3).

A small number of nulliparae (97 women) planned a home birth. The rate of intended home

birth per maternity unit varied between 0.4% and 6.9%, with absolute figures varying between 1 and 20. Sixty-four of the 97 nulliparae (66%) delivered at home, ranging from 100% down to 42.9% between the 11 units. Of the 33 women who delivered in hospital, 13 (39.4%) had a normal delivery, 10 (30.3%) had an instrumental vaginal delivery and a further 10 (30.3%) had an emergency CS. The numbers involved were too small for statistical analysis (Table 3).

(2) Onset of labour, intrapartum interventions and mode of delivery

The second part of the nulliparous intrapartum score took into consideration specific intrapartum episodes: the onset of labour (rates of spontaneous onset and elective CS), the augmentation of labour (none, the use of oxytocin alone, ARM + oxytocin), the use of EFM (none, done and diagnosed as normal, done and diagnosed as abnormal), the use of an epidural, and the type of delivery (normal, CS in the first stage of labour and CS in the second stage of labour).

The overall rate of spontaneous labour in nulliparous women suitable for midwifery-led care was 78.9%, ranging between 83.0% and 75.3%. The overall rate of induction of labour was 19.2%, ranging between 16.5% and 22.6%, and the rate of elective CS was 1.9%, ranging from 0.4% up to 3.9%. These differences between hospitals were significant ($\chi^2 = 53.054$, $df = 20$, $p = 0.001$) (see Table 3).

Table 3 Intervention rates by units

	DH1	DH2	DH3	DH4	DH5	DH6	DH7	TH1	TH2	TH3	TH4
Breech – P0* (n = 272)	16	27	38	33	26	35	11	32	11	25	18
Onset spontaneous labour	43.8	25.9	52.6	18.2	38.5	45.7	54.5	34.4	36.4	20.0	16.7
Vaginal delivery	14.3	14.3	26.3	16.7	10.0	12.5	16.7	0.0	25.0	0.0	33.3
Previous CS – PI† (n = 732)	45	63	116	87	70	77	62	65	35	65	47
Spontaneous onset of labour	31.1	55.6	37.1	51.7	67.1	37.7	56.5	47.7	65.7	38.5	46.8
Normal delivery	75.6	61.9	80.2	64.4	58.6	70.1	66.1	67.7	40.0	83.1	55.3
Emergency CS	20.0	17.5	10.3	13.8	24.3	18.2	21.0	21.5	37.1	13.8	23.4
Home births – P0 (n = 73)	4	8	2	6	15	16	5	20	13	7	1
Intended place of delivery	1.2	1.8	0.4	4.0	5.8	3.5	6.9	1.1	6.5	1.1	1.1
Place of delivery	75.0	87.5	0.0	50.0	46.7	62.5	80.0	85.0	69.2	42.9	100.0
Onset of labour – P0 (n = 6555)	557	607	768	717	695	711	472	777	459	336	456
Spontaneous onset	79.4	79.2	76.4	81.0	78.1	81.9	83.0	78.0	76.1	79.1	75.3
Elective CS	0.6	2.2	2.2	0.9	2.4	1.3	0.4	3.9	1.4	3.4	2.1
Spontaneous labour – P0 (n = 4909)	423	455	556	550	512	552	377	580	325	252	327
Augmentation of labour											
No augmentation	38.1	34.5	34.9	38.9	35.0	38.2	37.7	51.6	30.8	38.1	23.2
Oxytocin	26.2	22.9	21.4	24.4	24.6	18.5	17.5	17.6	23.4	25.0	39.8
ARM+oxytocin	11.3	10.5	15.3	9.6	15.0	10.5	10.9	6.0	10.8	9.9	13.8
CTG											
No CTG	6.4	23.3	0.4	2.0	0.6	0.5	3.7	1.6	0.6	0.0	0.6
CTG done and normal	70.9	52.5	72.8	74.0	61.5	79.7	64.7	81.6	73.5	73.4	56.9
CTG abnormal	22.7	24.2	26.8	24.0	37.9	19.7	31.6	16.9	25.8	26.6	42.5
Epidural											
Epidural	57.8	22.5	43.9	38.6	28.9	42.6	45.8	62.2	55.9	59.7	65.6
Method of delivery											
Normal delivery	71.9	79.3	63.8	63.5	59.8	62.7	61.5	62.1	60.6	58.7	56.9
CS	8.7	5.3	8.3	11.6	9.4	11.4	11.1	10.5	14.2	13.1	12.5
CS 2 nd stage	29.7	20.8	32.6	29.7	22.9	27.0	19.0	31.1	26.1	15.2	17.1

* P0 – nullipara.

† PI – para I.

Labour progressed without augmentation in 37.3% of cases, ranging from 51.6% down to 23.2%. For the purpose of this study, augmentation of labour was defined as either an ARM, or the use of oxytocin, or a combination of both. The SMMIS database included two variables, one on augmentation of labour (yes or no) and one on the membranes rupture (spontaneous or artificial). In 28.5% of cases, membranes were ruptured artificially and no other form of augmentation was used. However, in 29.7% of these cases, labour was identified as not having been augmented. This rate varied considerably between units, from 58.9% down to 6.6%. The SMMIS database does not include information on why labour was augmented or considered to have been augmented. Given the significant differences between units in the proportion of ARM considered to be augmentation of labour and the lack of information regarding the purpose of any ARM, the decision was made to consider any ARM to have been a form of augmentation of labour. There were significant variations between the 11 units - $\chi^2 = 174.997$, df 30, $p < 0.001$ (Table 3).

CTG (EFM) was either 'not done', or 'done & normal' or 'done & abnormal', but neither the timing (on admission or the during the first or the second stage of labour) nor the length of time EFM was used was available. However, its use was widespread; only 179 (3.6%) of the nulliparous women had no EFM, at any stage during labour. No information was available on the criteria that defined the normality or abnormality of CTGs, but the information available on the SMMIS database showed that EFM were identified as abnormal in 26.4% of cases. Whereas, 177 out of 179 (98.9%) of women who had no EFM delivered normally and none had an emergency CS, only 32.6% of women diagnosed as having abnormal EFM had a normal delivery, 44.5% an assisted vaginal delivery and 22.9% a CS. Where the CTG was diagnosed as 'normal', 74.0% of women had a normal delivery, 19.7% an assisted vaginal delivery and 6.2% an emergency CS. However, the use of EFM and the proportion identified as abnormal varied substantially between units, $\chi^2 = 722.457$, df 20, $p < 0.001$ (Table 3).

Intrapartum analgesia was coded as either 'none', 'Entonox', 'pethidine' or 'Epidural'. In all 46.4% of nulliparae had recourse to an epidural. The epidural rates varied significantly between units, ranging between 22.5% and 65.6% ($\chi^2 = 328.139$, df 20, $p < 0.001$), and the rates were also significantly higher in THs than district general hospitals (DGHs) (61.2% v 39.8% - $\chi^2 = 183.106$, df 1, $p < 0.001$) (Table 3).

Delivery was identified as either normal (64.0%), forceps/vacuum extraction (25.7%) and emergency CS (10.3%), with significant

differences between units where the rate of normal delivery varied between 79.3% and 56.9%, and that of CS between 5.3% and 14.2% ($\chi^2 = 88.909$, df 20, $p < 0.001$) (Table 3). As many as 25.5% of emergency CSs were performed during the second stage of labour. This rate varied between 15.2% and 32.6%, but these differences were not statistically significant ($\chi^2 = 8.016$, df 10; $p = 0.627$) (see Table 3).

Intrapartum interventions score

Maternal and fetal factors could account for some differences in progress and outcomes of labour. Larger birth weights were associated with an increased rate of augmentation of labour, epidural analgesia and abnormal deliveries. There were statistically significant differences in the babies' birth weight between the 11 units, with an average of 3399 g, ranging from 3364 up to 3459 g ($F(10, 4894) = 2.262$, $p = 0.012$). However, the range was hardly clinically significant at 95 g and indeed the proportion of babies weighing more than 4000 g did not vary significantly between units ($\chi^2 = 26.971$, df 20, $p = 0.136$). No significant difference was found in the proportion of babies weighing more than 4000 g and the individual intrapartum interventions.

Boy babies have been shown to be associated with longer labours and fewer normal deliveries, although girls have an increased rate of meconium-stained liquor (Mead et al. 1998, Eogan et al. 2003). This was also the case in this study, e.g. the rate of normal delivery was higher in girl babies (66.9% v 61.3%, OR 1.273, 95% CI 1.132-1.431) but the distribution of boys and girls did not vary significantly between the units, and cannot therefore explain the variations in intrapartum interventions.

THs are more likely to care for women presenting with high-risk pregnancies. However, the data reduction excluded high-risk pregnancies and enabled the comparison of healthy nulliparous women. Furthermore, the variations in intrapartum interventions were not systematically higher in THs, although the use of epidural was significantly higher.

The analysis of each selected intrapartum intervention demonstrated significant differences between the 11 maternity units. Logistic regressions were used to examine the influence of known confounding factors (e.g. birth weight, length of labour, maternal age) and the maternity units on binary dependent variables: augmentation of labour, use of EFM, diagnosis of abnormal fetal heart rate, epidural analgesia and method of delivery (Khan et al. 1999). The analysis of the method of delivery also included augmentation of labour, the use and diagnosis of fetal heart rate and epidural analgesia as

covariates. In a series of logistic regression analyses, maternal age was not linked to augmentation of labour, the use or diagnosis of an abnormal fetal heart rate; the length of labour was not associated with an increased rate of abnormal fetal heart rates; and birth weight was not linked to the use of epidural analgesia. However, the hospitals could not be excluded from any single analysis as a factor which was influential in the differences in either intervention (augmentation, EFM, epidural) or method of delivery.

The frequency distributions of each intrapartum intervention were ranked, 1 mark allocated for the lowest level of intervention and 11 for the highest. The sum of the ranks made up the intrapartum score of each unit (Table 4). The total scores ranged between 78.5 marks up to 148 marks, with a median score of 113.25 marks. Five units (DGH7, DGH 2, DGH 4, DGH 6 and DGH 1) attracted a score below the median measurement six units (TH1, DGH3, DGH5, TH2, TH3 and TH4) above the median score; the units were then identified as belonging to the 'lower' or 'higher' intervention units.

The exclusion of the management of the breech presentation, previous CS, with or without the option for home births led to the same five units being identified as 'lower' intervention units.

This intrapartum score is descriptive rather than predictive inasmuch as it ranks units

according to a set number of intrapartum interventions, but does not suggest a predictive measure of outcome given specific individual or multiple interventions. The use of the dichotomy 'lower' or 'higher' intervention units served as a basis for the analysis of the perception of risk of midwives working in these 11 units.

DISCUSSION AND CONCLUSIONS

The more widespread use of computerised maternity services records enables more comprehensive comparisons of maternity units and has long been recommended (Paterson et al. 1991). The publication of maternity statistics has demonstrated marked variations in the UK (Macfarlane & Mugford 1984, 2000a, b, Government Statistical Service 2002) and elsewhere (Elferink-Stinkens Pm et al. 1996, Macdorman et al. 2002). Studies have also examined the differences in obstetricians' practice (Nozton 1990, Guillemette & Fraser 1992, Rosenblatt et al. 1997), but the potential differences in midwives practising in different maternity units have not yet been examined in detail.

A systematic data reduction enabled useful statistical analyses of a large database of women who were suitable for midwifery-led care, even if the use of predefined databases in this retrospective study had disadvantages. The SMMIS program includes mainly the collection of factual

Table 4 Intervention rates by units – ranks

	DH1	DH2	DH3	DH4	DH5	DH6	DH7	TH1	TH2	TH3	TH4
Breech – P0											
Onset spontaneous labour	4	8	2	10	5	3	1	7	6	9	11
Vaginal delivery	6.5	6.5	2.0	4.5	9.0	8.0	4.5	10.5	3.0	10.5	1.0
Previous CS Paral											
Spontaneous onset of labour	11	4	10	5	1	9	3	6	2	8	7
Normal delivery	3	8	2	7	9	4	6	5	11	1	10
Emergency CS	6	4	1	2	10	5	7	8	11	3	9
Home births – P0											
Intended place of delivery	7	6	11	3	3	5	1	8	3	9	10
Place of delivery	5	2	11	8	9	7	4	3	6	10	1
Onset of labour – P0											
Spontaneous onset	4	5	9	3	7	2	1	8	10	6	11
Elective CS	2	7	8	3	9	4	1	11	5	10	6
Augmentation of labour – P0											
No augmentation	4.5	9	8	2	7	3	6	1	10	4.5	11
Oxytocin	10	5	4	7	8	3	1	2	6	9	11
ARM+Oxytocin	8	4	11	2	10	5	7	1	6	3	9
EFM – P0											
No CTG	2	1	10	4	7	9	3	5	7	11	7
EFM done and normal	7	11	6	3	9	2	8	1	4	5	10
EFM abnormal	9	7	4	8	2	10	3	11	6	5	1
Epidural – P0											
Epidural	8	1	5	3	2	4	6	10	7	9	11
Method of delivery – P0											
Normal delivery	2.0	1.0	3.0	4.0	9.0	5.0	7.0	6.0	8.0	10.0	11.0
CS	3	1	2	8	4	7	6	5	11	10	9
CS 2nd stage	8	4	11	9	5	7	3	10	6	1	2
P0 Total Score	110	94.5	120	95.5	125	102	78.5	118.5	128	134	148
P0 final ranking	5	2	7	3	8	4	1	6	9	10	11

*P0 – nullipara.

rather than more subjective data, but further information, such as the timing and the cervical dilatation at the time of interventions, would have helped determine whether a higher level of intervention was also associated with earlier intervention. However, the accuracy and the consistency of the SMMIS data has been found to be sound and to allow meaningful comparison of different units on major variables (Cleary et al. 1994). Absence of the underlying reason(s) for particular interventions is a disadvantage, but the systematic data reduction enabled the comparison of the intrapartum care of women who were essentially similar, i.e. suitable for midwifery-led care. Different practices in the care of similar women, therefore, suggests that the maternity unit may exercise a strong influence on the care women receive. On the other hand, it is also possible that more affluent women may exercise more choice in their intrapartum care. Indeed the values that women attribute to the outcome of pregnancy have been shown to be different from that of obstetricians (Vandenbussche et al. 1999).

Two of the criteria selected for the establishment of the intrapartum – breech presentation in a nullipara and a previous CS in a second pregnancy – are not cases suitable for midwifery-led care, but midwives are directly involved in the ‘booking’, planning and care of women who choose a home birth. Variations in the management of these conditions and variations in the rate of home births may be linked to variation in the perception of risks by obstetricians and midwives. These variations were therefore included in the intrapartum intervention score established at the completion of the comparison of the 11 units. Furthermore, there was a positive correlation ($r = 0.682$, $p = 0.021$) between the scores that could be obtained with or without the removal of these cases.

Some differences existed between DGHs and THs, the most striking being the increased use of epidural analgesia in THs. An ARM was also less likely to be seen as a form of augmentation of labour in these four THs. However, most of the other interventions were not systematically more common in THs. The overall rating did indeed show that TH1 was less interventionist than two DGHs. The variation in the rate of fetal heart rates diagnosed as ‘abnormal’, from 16.9% up to 42.5%, is of particular concern. Paradoxically, the highest and lowest rate of fetal heart rates diagnosed as ‘abnormal’ were in teaching hospitals. Increased interventions may be linked with increased abnormalities, but it is also possible that this may be associated with differences in the criteria used to diagnose an abnormal CTG. The criteria used for defining a heart rate as ‘normal’ or ‘abnormal’ are not available on the database, but the differences in

the rate of ‘abnormal’ fetal heart rates between the 11 units are a cause for concern, because of the potential differences in diagnostic criteria between the various units, and because an ‘abnormal’ heart rate was much more likely to be associated with an emergency CS.

This intrapartum intervention score can be criticised for its simplicity since none of the ranks given were weighted to take into consideration factors such as socio-economic background, or staff availability or experience. However, despite its potential limitations, this is the first attempt at using a number of different intrapartum criteria to provide an overall picture of the intrapartum care provided to women which is essentially suitable for midwifery-led care.

The initial purpose of the calculation of this intrapartum score was to provide a basis for the exploration of the hypothesis that midwives working in more interventionist units would have a greater perception of risk for women suitable for midwifery-led care. This approach proved useful and the findings will be reported in a subsequent paper.

In the context of the continuous improvements demanded for maternity services (Maternity Care Working Party 2001) this tool could be a simple approach that would enable the initial comparison of care and provide an inter-institution benchmarking for excellence.

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