

Risk of complicated birth at term in nulliparous and multiparous women using routinely collected maternity data in England: a cohort study

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Table S1: Coding structures used to identify women at increased, intermediate and low risk according to NICE intrapartum care guideline				
Factor	ICD – 10 code	Frequencies		Classified as
		n	%	
Medical conditions indicating increased risk suggesting planned birth at an obstetric unit				
Confirmed cardiac disease	I01 I05-09 I20-28 I30-152 I97-98	2852	0.80%	Increased risk
Hypertensive disorders	O10-O11 I10-116	2031	0.06%	Increased risk
Asthma requiring an increase in treatment or hospital treatment	J45 - not possible to restrict by treatment	37314	10.47%	Low risk
Cystic fibrosis	E84	36	0.01%	Increased risk
Haemoglobinopathies – sickle-cell disease, beta-thalassaemia major	D570, D571, D572, D578, D561	467	0.13%	Increased risk
History of thromboembolic disorders	I74-I76, I63, I26, O88, I80-I82	843	0.24%	Increased risk
Immune thrombocytopenia purpura or other platelet disorder or platelet count below 100×10 ⁹ /litre	D693, D691, D694, D695, D696	1522	0.43%	Increased risk
Von Willebrand's disease	D680	183	0.05%	Increased risk
Bleeding disorder in the woman	D68, D65, D66, D67, D699	1811	0.51%	Increased risk
Bleeding disorder in the unborn baby	Not possible			Not included
Atypical antibodies which carry a risk of haemolytic disease of the newborn	P55, P56; O361; O360	1511	0.42%	Increased risk
Hyperthyroidism	E05	838	0.24%	Increased risk
Diabetes	E10-E14, O24	2859	0.80%	Increased risk
Hepatitis B/C with abnormal liver function tests	B180, B181, B16, B171, B182 (+ R945)	680	0.19%	Increased risk
Carrier of/infected with HIV	B20-B24 ; Z21 ; O987	<5	<0.01%	Increased risk
Toxoplasmosis – women receiving treatment	B58	9	0.00%	Increased risk
Current active infection of chicken pox/rubella/genital herpes in the woman or baby	B01; B06; A60	13	0.00%	Increased risk
Tuberculosis under treatment	A15,A17,A18,A19	12	0.00%	Increased risk
Systemic lupus erythematosus	M32	293	0.08%	Increased risk
Scleroderma	M34; L940	30	0.01%	Increased risk
Abnormal renal function or renal disease requiring supervision by a renal specialist	N17-N19; P96; D594; K767; R392 E87 (most commonly renal) I12, I13, N00-N19; N25; N28; N29	2811	0.79%	Increased risk
Epilepsy	G40	2859	0.80%	Increased risk
Myasthenia gravis	G70	44	0.01%	Increased risk
Previous cerebrovascular accident	I60-I66 through lookback	102	0.03%	Increased risk
Liver disease associated with current abnormal liver function tests	K70-K77 (+ R945 OR R748)	225	0.06%	Increased risk
Psychiatric disorder requiring current inpatient care [inclusive approach as under outpatient care also included]	F20-31, F322, F323, F332, F333, F42, F431, F500, F502, F503, F60,	14517	4.07%	Increased risk
Other factors indicating increased risk suggesting planned birth at an obstetric unit: (1) Previous complications				
Unexplained stillbirth/neonatal death or previous death related to intrapartum difficulty	Previous stillbirth using look back approach; Z352	3604	1.01%	Increased risk
Previous baby with neonatal encephalopathy	Not possible			

Pre-eclampsia requiring preterm birth	Previous pre-term and pre-eclampsia using combination of codes in lookback approach O13, O14	17799	5.00%	Increased risk
Placental abruption with adverse outcome	O45 ; not possible to define adverse outcome	1022	0.29%	Increased risk
Eclampsia	O15	220	0.06%	Increased risk
Uterine rupture	O710 O711	146	0.04%	Increased risk
Primary postpartum haemorrhage requiring additional treatment or blood transfusion	O72, X33 (OPCS)	44896	12.60%	Increased risk
Retained placenta requiring manual removal in theatre	O73	2986	0.84%	Increased risk
Caesarean section	Indication of previous caesarean section in either MIS or HES lookback	45104	12.66%	Increased risk
Shoulder dystocia	O660	2908	0.82%	Increased risk
Other factors indicating increased risk suggesting planned birth at an obstetric unit: (2) Current pregnancy				
Multiple birth	O30, numberinfant>1	excluded from cohort		Increased risk
Placenta praevia	O44	2138	0.60%	Increased risk
Pre-eclampsia or pregnancy-induced hypertension	O10-O16	23022	6.46%	Increased risk
Preterm labour or preterm prelabour rupture of membranes	Gestational age not term, O60, O42	21198	5.95%	Increased risk
Placental abruption	O45	1410	0.40%	Increased risk
Anaemia – haemoglobin less than 85 g/litre at onset of labour	Not possible		0.00%	Low risk
Confirmed intrauterine death	from maternity information system data	1271	0.36%	Increased risk
Substance misuse or alcohol misuse	F10-16; F18-19; Z86.4;	1322	0.37%	Increased risk
Gestational diabetes	O244; O249	17210	4.83%	Increased risk
Malpresentation – breech or transverse lie	Uses fetal presentation recorded in maternity information system and in delivery method; assumes cephalic if missing	27606	7.75%	Increased risk
BMI at booking >35	Uses BMI recorded in maternity information system	39330	11.04%	Increased risk
Recurrent APH	O46 (note this is any APH)	39324	11.04%	Increased risk
Small for gestational age in this pregnancy (less than 5 th centile, or reduced growth velocity on US)	O365	5337	1.50%	Increased risk
Abnormal FHR/Doppler studies	O363, O365	16759	4.70%	Increased risk
Ultrasound diagnosis of oligo- or polyhydramnios	O40, O41	11090	3.11%	Increased risk
Previous myomectomy	O342 [previous]	13118	3.68%	Increased risk
Previous hysterotomy	Not able to be identified separately from previous caesarean section			Increased risk
Medical conditions indicating individual assessment when planning place of birth				
Cardiac disease without intrapartum implications	I20-I52 *note no severity available	2852	0.80%	Increased risk

Atypical antibodies not putting the baby at risk of haemolytic disease	As previous	1511	0.42%	Increased risk
Sickle-cell trait	D573	1973	0.55%	Increased risk
Thalassaemia trait	D563, D569	1703	0.48%	Increased risk
Anaemia – haemoglobin 85–105 g/litre at onset of labour	O990 but not able to differentiate whether ante- or postpartum	642	0.18%	Low risk
Hepatitis B/C with normal liver function tests	B180, B181, B16, B171, B182 (not able to differentiate)	680	0.19%	Increased risk
Non-specific connective tissue disorders	M30-M31, M33-M36	1099	0.31%	Increased risk
Unstable hypothyroidism such that a change in treatment is required	E018, E03, E063 - not possible to differentiate treatment	6683	1.88%	Low risk
Spinal abnormalities	M40-M43	1709	0.48%	Increased risk
Previous fractured pelvis	Previous S32	193	0.05%	
Neurological deficits	G13-G99	10425	2.93%	Increased risk
Liver disease without current abnormal liver function	K70-K77	225	0.06%	Increased risk
Crohn's disease	K50	996	0.28%	Increased risk
Ulcerative colitis	K51	877	0.25%	Increased risk
Other factors indicating individual assessment when planning place of birth (1): previous complications				
Stillbirth/neonatal death with a known non-recurrent cause	Use prev_sb from lookback	3604	1.01%	Increased risk
Pre-eclampsia developing at term	O14, O15 + no evidence of preterm delivery previously	17799	5.00%	Increased risk
Placental abruption with good outcome	O45 in lookback	1022	0.29%	Increased risk
History of previous baby more than 4.5 kg	O366 in previous record	5029	1.41%	Low risk
Extensive vaginal, cervical, or third- or fourth-degree perineal trauma	Able to differentiate previous third- or fourth- degree tear only from HES lookback: O702,O703,O704 or procedure code R322, R325	5614	1.58%	Increased risk
Previous term baby with jaundice requiring exchange transfusion	Nil			Unable to measure
Other factors indicating individual assessment when planning place of birth (1): current pregnancy				
Antepartum bleeding of unknown origin (single episode after 24 weeks of gestation)	O46	39324	11.04%	Increased risk
BMI at booking of 30–35 kg/m ²	Use BMI	46422	13.03%	Intermediate risk
Blood pressure of 140 mmHg systolic or 90 mmHg diastolic or more on 2 occasions	Not possible without diagnostic			Not possible
Clinical or ultrasound suspicion of macrosomia	O366	2061	0.58%	Increased risk
Para 4 or more	Use parity	13143	3.69%	Intermediate risk
Recreational drug use	Unable to distinguish from substance misuse above			Increased risk
Under current outpatient psychiatric care	Unable to distinguish from psychiatric conditions above			Increased risk
Age over 35 at booking	Uses age in maternity information system	62786	17.62%	Intermediate risk
Fetal abnormality	O35	2464	0.69%	Increased risk
Previous major gynaecological surgery; Previous cone biopsy or large loop excision of the transformation zone	O342, O346, O348 in lookback or current; previous record of procedures Q238, Q239, Q24, Q01, Q05, Q544, Q555, Q556, Q557	7771	2.18%	Increased risk
Previous fibroids	O341 D25 in lookback	667	0.19%	Increased risk

Supplementary material Table S2: Components of composite outcome by risk sub-group, parity and obstetric history in 41 001 women who gave birth at term following a trial of labour, and were intermediate risk at the onset of labour (*elective caesarean births excluded)

	Low risk women		Intermediate risk				All		
	n	%	BMI 30.0-34.9		Age 35-44			Parity≥4	
			n	%	n	%			
Primiparous	61039		6943		8656		16491		
<i>without ELCS</i>	59413		6671		8134		15616		
Spontaneous vaginal delivery	36586	61.58%	4065	60.94%	4636	57.00%	9127		
Instrumental birth	15377	25.88%	1391	20.85%	2263	27.82%	3830		
Emergency caesarean birth	7445	12.53%	1215	18.21%	1233	15.16%	2657		
Postpartum haemorrhage	1561	2.56%	210	3.02%	221	2.55%	468		
Obstetric anal sphincter injury	3565	6.00%	336	5.04%	388	4.77%	755		
Apgar score less than 7 at 5 minutes	696	1.14%	92	1.33%	92	1.06%	194		
Complicated birth	25838	43.49%	2938	44.04%	3806	46.79%	8451		
Multiparous	56513		8875		11674	2042	26056		
<i>without ELCS</i>	55426		8700		11284	2022	25385		
Spontaneous vaginal delivery	52302	94.36%	8178	94.00%	10297	91.25%	1954	96.64%	23530
Instrumental birth	2140	3.86%	283	3.25%	650	5.76%	34	1.68%	1098
Emergency caesarean birth	976	1.76%	237	2.72%	334	2.96%	32	1.58%	749
Postpartum haemorrhage	689	1.22%	143	1.61%	191	1.64%	17	0.83%	414
Obstetric anal sphincter injury	1125	2.03%	123	1.41%	306	2.71%	7	0.35%	485
Apgar score less than 7 at 5 minutes	318	0.56%	52	0.59%	76	0.65%	16	0.78%	185
Complicated birth	4929	8.89%	771	8.86%	1449	12.84%	1922	95.05%	22673

Supplementary material Table S3: Risk ratios for complicated birth in 276 766 women who gave birth at term following a trial of labour (*elective caesarean births excluded).

NICE risk classification	Nulliparous women				Multiparous women without previous CS				Multiparous women with previous CS			
	Number in group	Complicated births	%	Risk ratio‡ (95% CI)†	Number in group	Complicated births	%	Risk ratio‡ (95% CI)†	Number in group	Complicated births	%	Risk ratio‡ (95% CI)†
Low risk	59 413	25 805	43.4	4.89 (4.75 to 5.03)	55 426	4 879	8.8	Reference				
Intermediate risk	15 616	7 153	45.8	5.16 (5.00 to 5.33)	25 385	2 712	10.7	1.20 (1.15 to 1.26)				
BMI 30 to 34 alone	6 671	2 933	44.0	4.95 (4.76 to 5.14)	8 700	771	8.9	1.00 (0.93 to 1.07)				
Age 35+ alone	8 134	3 799	46.7	5.26 (5.08 to 5.45)	11 284	1 449	12.8	1.44 (1.37 to 1.53)				
Parity 4+ alone	0	0	-	-	2 022	100	4.9	0.56 (0.46 to 0.67)				
Multiple risk factors	811	421	51.9	5.84 (5.44 to 6.27)	3 379	392	11.6	1.35 (1.22 to 1.49)				
Increased risk	43 902	25 230	57.5	6.46 (6.28 to 6.64)	57 330	9 767	17.0	1.92 (1.86 to 1.98)	19 694	10 908	55.4	6.23 (6.05 to 6.41)
Previous caesarean section alone									7 993	3 426	42.9	4.82 (4.65 to 5.00)
BMI 35+ alone*	7 063	3 260		5.19 (5.00 to 5.38)	8 134	917	11.3	1.27 (1.19 to 1.35)	790	317	40.1	4.51 (4.13 to 4.93)
Pre-existing medical conditions alone*	9 920	5 098	51.4	5.78 (5.59 to 5.97)	11 446	1 445	12.6	1.42 (1.34 to 1.50)	1 217	571	46.9	5.28 (4.94 to 5.63)
Significant obstetric history alone*					8 415	1 511	18.0	2.02 (1.92 to 2.13)	1 110	505	45.5	5.12 (4.77 to 5.48)
Complications in current pregnancy alone*	19 464	12 456	64.0	7.20 (6.99 to 7.41)	13 230	2 826	21.4	2.40 (2.30 to 2.51)	4 601	3 480	75.6	8.51 (8.24 to 8.78)
Number of risk factor types												
1*	36 447	20 814	57.1	6.42 (6.24 to 6.60)	41 225	6 709	16.3	1.83 (1.77 to 1.89)	7 718	4 873	63.1	7.10 (6.88 to 7.33)
2*	6 889	4 052	58.8	6.61 (6.40 to 6.84)	13 294	2 445	18.4	2.07 (1.98 to 2.16)	3 147	2 055	65.3	7.34 (7.08 to 7.62)
3+*	566	364	64.3	7.23 (6.76 to 7.73)	2 811	613	21.8	2.49 (2.31 to 2.68)	836	554	66.3	7.45 (7.05 to 7.87)

* significant obstetric history, not including previous CS
‡ Risk in low-risk multiparous women was used as the reference category.
† all p values, except the comparison with multiparous women with BMI 30-34 as the only risk factor (highlighted with a \$), are less than 0.001. \$p=

Supplementary material Table S4. Components of composite outcome without instrumental delivery by risk group, parity and obstetric history in 276 766 women who gave birth at term following a trial of labour (*elective caesarean births excluded)

	Low risk women			Intermediate risk			Increased risk		
	Women with outcome			Women with outcome			Women with outcome		
	n	%	(95% CI)	n	%	(95% CI)	n	%	(95% CI)
Nulliparous with a trial of labour	59 413			15 616			43 902		
Complicated birth	12 492	21.0	(20.7 to 21.4)	3 808	24.4	(23.7 to 25.1)	15 013	34.2	(33.8 to 34.6)
Emergency caesarean birth	7 445	12.5	(12.2 to 12.9)	2 657	17.0	(16.4 to 17.6)	11 274	25.7	(25.3 to 26.1)
Obstetric anal sphincter injury	3 565	6.0	(5.8 to 6.2)	755	4.8	(4.5 to 5.2)	2 266	5.2	(5.0 to 5.4)
Postpartum haemorrhage	1 561	2.6	(2.5 to 2.8)	468	3.0	(2.7 to 3.3)	1 903	4.3	(4.1 to 4.5)
5-minute Apgar ≤ 7	696	1.2	(1.0 to 1.3)	194	1.2	(1.1 to 1.4)	820	1.9	(1.7 to 2.0)
Multiparous no previous caesarean section with a trial of labour	55 426			25 385			57 330		
Complicated birth	2 939	5.3	(5.1 to 5.5)	1 676	6.6	(6.3 to 6.9)	6 737	11.8	(11.5 to 12.0)
Emergency caesarean birth	976	1.8	(1.6 to 1.9)	749	3.0	(2.7 to 3.2)	3 589	6.3	(6.1 to 6.5)
Obstetric anal sphincter injury	1 125	2.0	(1.9 to 2.1)	485	1.9	(1.7 to 2.1)	1 541	2.7	(2.6 to 2.8)
Postpartum haemorrhage	689	1.2	(1.1 to 1.3)	414	1.6	(1.5 to 1.7)	1 515	2.6	(2.5 to 2.8)
5-minute Apgar ≤ 7	318	0.6	(0.5 to 0.6)	185	0.7	(0.6 to 0.8)	645	1.1	(1.0 to 1.2)
Multiparous with previous caesarean section with a trial of labour							19 694		
Complicated birth							7995	40.6	(40.0 to 41.3)
Emergency caesarean birth							6 748	34.3	(33.6 to 34.9)
Obstetric anal sphincter injury							747	3.8	(3.5 to 4.1)
Postpartum haemorrhage							1 322	6.7	(6.4 to 7.1)
5-minute Apgar ≤ 7							575	2.9	(2.7 to 3.2)

Supplementary material Table S5: Characteristics of included and excluded NHS hospital trusts, and women who gave birth to a singleton infant at term within those trusts

	Included Number (%)	Not included Number (%)	p value[†]
Trust size (births per annum)	87 NHS hospital trusts	37 NHS hospital trusts	
<2500 births	13	4	0.70
2500-3999 births	18	11	
4000-5999 births	35	13	
6000+	21	9	
Region of England			0.68
London	11	5	
South East/Home Counties	17	9	
East of England	2	1	
Midlands	14	10	
Northeast and Yorkshire	16	5	
Southwest	12	4	
North West	15	3	
Age (year)	322 949 women	159 792 women	<0.001
15-24	60 693 (18.8%)	30 478 (19.1%)	
25-34	211 195 (65.4%)	95 387 (59.8%)	
35-44	51 061 (15.8%)	33 729 (21.1%)	
Missing	n/a	198	
Ethnicity of women giving birth			<0.001
White	233 237 (77.6%)	109 312 (76.3%)	
Black	18 421 (6.1%)	9 638 (6.7%)	
Asian	36 643 (12.2%)	18 331 (12.8%)	
Other	12 110 (4.0%)	6 008 (4.2%)	
Unknown	22 538	1650	
Index of multiple deprivation			<0.001
1 (least deprived)	53 096 (17.6%)	24 958 (16.7%)	
2	43 100 (14.3%)	20 390 (13.6%)	
3	57 691 (19.1%)	26 594 (17.8%)	
4	67 073 (22.2%)	33 941 (22.7%)	
5 (most deprived)	80 998 (26.8%)	43 625 (29.2%)	
Missing	20 991	10 284	
[†] using chi2 tests to compare proportions *For this comparison, we have restricted to singleton term live births in women aged 15-45 within excluded trusts			