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Unexplained variation in hospital caesarean section rates

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ABSTRACT

Objective: Concern over rising caesarean rates has focused attention on initiatives to reverse this trend. We assessed variation in caesarean rates among hospitals to identify potential targets for intervention.

Design, Setting and Participants: This is a population-based, record linkage study of 183,310 births in 81 hospitals in New South Wales, 2009–2010. The Robson classification was used to categorise births into 10 risk-based groups based on parity, plurality, labour onset, previous caesarean, fetal presentation and gestation. Multilevel logistic regression was used to examine variation in hospital caesarean rates within Robson groups, adjusted for differences in maternal age, country of birth, smoking, diabetes, hypertension and type of maternity care. The 20th centile ("best practice" rate) of the risk-adjusted rates was used to quantify the potential impact on the overall caesarean rate of reducing practice variation.

Main outcome measures: Hospital caesarean rates

Results: The overall caesarean rate was 30.9%, ranging from 11.8% to 47.4% among hospitals. Women with previous caesareans (36.4% of all caesareans) and nulliparous term births (induction or pre-labour caesarean 23.4%, spontaneous 11.1%) were the greatest contributors to the overall rate. After adjustment, marked unexplained variation in hospital caesarean rates persisted for: nulliparae at term, previous caesareans, multi-fetal pregnancies and preterm births. If variation in practice was reduced for these risk-based groups by achieving the "best practice" rate, this would lower the overall rate by 3.1%.

Conclusion: Understanding hospital heterogeneity in performing caesarean sections and implementing evidence-based practices may result in improved maternity care. We have identified five risk-based groups as priority targets for reducing practice variation in caesarean rates.

INTRODUCTION

Variation in clinical practice has been reported in many medical disciplines.[1] Reducing unwarranted practice variation is important where it influences health outcomes, health care costs, and provision of appropriate and patient-focused care.[1]

From 2000 to 2009, the caesarean section (CS) rate in Australia increased from 23% to 32%,[2] one of the 10 highest rates in OECD countries.[3] This is well above the UK Royal College of Obstetricians and Gynaecologists recommended CS rate of 20%[4] and the US Department of Health and Human Services Healthy People 2010 goal of 15% for low-risk nulliparous women.[5] In Australia, CS rates vary by State and Territory (from 28% in the Australian Capital Territory to 33% in both Queensland and Western Australia), between public and private hospitals (28% and 43% respectively), and among individual public hospitals.[2] This variation is potentially attributable to differences in women's risk profiles, preferences and expectations, and local maternity care practices.[6] Identifying and better understanding the drivers of this variation may have a significant and important impact on maternity care reform in Australia.[7]

To date, comparison of CS rates among hospitals has primarily been based on two approaches. The first approach compares hospital CS rates only among nulliparous women with a cephalic presenting singleton at term.[8,9] However, this is of limited value for generalising the results to the whole maternity population. Other studies have extended this approach and categorised births into clinically homogeneous groups according to combinations of pregnancy characteristics, most commonly using a classification proposed by Robson.[10,11] This risk-based approach allows comparison of CS rates either among different hospitals or within the same hospital over time, as well as identifying the contribution of each group to the overall CS rate. Although the risk-based approach allows a more meaningful comparison among hospitals by eliminating potential confounding effects of some pregnancy characteristics, it does not take into account other maternal factors (e.g., maternal age and medical conditions) that influences rates.[11] For example, a hospital with a high proportion of older women may have a higher CS rate.[12]

Quantifying divergent hospital CS rates after adjustment for maternal and pregnancy characteristics (case-mix) is important for determining the role that differences in clinical practice play in the variation in CS rates at a hospital level. Identification of demonstrably achievable CS rates may help prioritise interventions to enhance maternity care.[6] The aims of our study were to: assess recent hospital CS rates in New South Wales (NSW) adjusting for case-mix; quantify the amount of variation that can be explained by case-mix differences; and examine the potential impact on the overall CS rate of reducing variation in practice.

METHODS

Study population

The study population included 183,310 births in 81 NSW public and private hospitals in 2009 and 2010 (Figure 1). The primary outcome was the CS rate for each hospital. Multifetal births were counted as a single caesarean if one or more of the infants was delivered by CS; else as a vaginal birth. Hospitals with continuous maternity services during the study period and with≥50 births per annum were included in the study. Five hospitals with midwifery-only (no caesarean) service were excluded. To examine variation in hospital CS rates for preterm births, we included only those hospitals with a service capability to manage preterm infants.[13] Although some preterm births occur as emergencies outside these hospitals, they do not contribute to the understanding of variation and so were excluded (*n* = 308, 0.2% of preterm births at 30 hospitals).

Data source and study variables

Data were obtained from longitudinally linked birth records of the NSW Perinatal Data Collection (PDC). The PDC is a legislated population-based surveillance system covering all live births, and stillbirths of at least 20 weeks gestation or at least 400 grams birth weight in NSW. The following obstetric information was available and is reliably reported in the PDC:[14,15] maternal age, country of birth of the mother, parity, plurality, onset of labour (spontaneous labour, induced or no labour), CS in the previous and current pregnancies, fetal presentation, gestational age, maternal smoking, diabetes (pre-existing or gestational), hypertension (chronic or gestational hypertension, or pre-eclampsia), and type of maternity care (private care in a private hospital, private care in a public hospital or public care in a public hospital).

Record linkage was carried out by the NSW Centre for Health Record Linkage (CHeReL) using a best practice approach in preserving privacy.[16] For this study, the CHeReL reported the quality of the record linkage as <1 in 1,000 false positive links and <2 in 1,000 missed links. Ethical approval for the study was obtained from the NSW Population and Health Services Research Ethics Committee.

Statistical analysis

Births were categorised into 10 risk-based, mutually exclusive groups according to the Robson classification (Robson group). These 10 groups are inclusive of all births, and are based on a woman's pregnancy characteristics including parity, plurality, onset of labour, previous CS, fetal presentation and gestational age (Table 2).[16] When information on parity and previous CS was missing for the current pregnancy (*n* = 2,449 births, 1.3%), it was obtained from linked historical birth records where available. Consequently, only 713 (0.4%) records with missing information on one or more of the maternal/pregnancy characteristics were excluded from the analysis. The final data set included 183,310 births from 81 hospitals representing 97.2% of all births occuring in 2009–2010 in NSW (Figure 1).

For each Robson group we determined the number of births, number of CS, observed CS rate and contribution to the overall CS rate. Due to the hierarchical structure of the data (births nested within hospitals), multilevel logistic regression with a random intercept for each hospital was used to examine variation in hospital CS rates for each of the 10 Robson groups, adjusting for case-mix (maternal characteristics: maternal age, country of birth, maternal smoking, diabetes, hypertensive disorder and type of maternity care; pregnancy characteristics: parity, plurality, onset of labour, previous CS, fetal presentation and gestational age) while taking into account similarities of births within hospitals.[17]
To account for fluctuation in CS rates for hospitals with a small number of births, a shrinkage factor was applied to the estimated CS rates, moving them towards the statewide rate. The resulting estimates are thus less variable and better represent the hospitals' true underlying CS rates.[18]
Two models were fitted for each Robson group: a crude model (with no adjustment) and an adjusted model. Within each group, the risk-adjusted CS rate and 95% confidence interval for each hospital were calculated by first converting the estimated hospital's odds ratio of CS obtained from the multilevel logistic regression model into a relative risk and then multiplying by the statewide rate.[19] To describe the variation in hospital CS rates, we standardised the ranges of the 95% confidence intervals for risk-adjusted hospital CS rates. Variation in CS rates was classified as *low* (where the standardised difference between the highest upper confidence bound and the lowest lower confidence bound was <0.3), *medium* (standardised confidence interval range 0.3–0.6), or *high* (standardised confidence interval range ≥0.6). The proportion of variation among hospitals explained by adjusting for case-mix was calculated as the difference between the variation of the crude and adjusted models, as a proportion of the crude model variation. To illustrate differences in hospital CS rates after adjustment, risk-

adjusted CS rates with 95% confidence intervals (with hospitals ordered by increasing risk-adjusted CS rate) were plotted for each Robson group.

We explored the potential impact of reducing variation in CS practice by calculating the 20th centile of the risk-adjusted hospital CS rate for each Robson group and overall. The 20th centile rate has been suggested as the "best practice" rate; it represents the rate of CS at or below which 20% hospitals are currently operating and is demonstrably achievable.[19,20] Analysis was carried out using SAS 9.3 (SAS Institute, USA).

RESULTS

Caesarean section rates in each Robson group

Of the 183,310 births in 81 hospitals, 56,696 were by caesarean section giving an overall CS rate of 30.9 per 100 births. Hospital CS rates varied from 11.8 to 47.4 per 100 births (interquartile range 23.9–33.1). Compared with women who delivered vaginally, women who had a CS were older, more likely to be Asian-born and nulliparous. Having had a previous caesarean, diabetes, hypertension, private maternity care and preterm birth were also associated with increased likelihood of CS (Table 1). The observed CS rate within the 10 Robson groups ranged from 2.3% among multiparous women with spontaneous labour at term to 96.7% among nulliparous women with breech presentation (Table 2). Figure 2 shows the risk-adjusted hospital CS rates and their 95% confidence intervals for each Robson group.

Three groups accounted for 70.9% of all CS: women with previous CS (Group 5, 36.4%); nulliparous women with induction or pre-labour caesarean at term (Group 2, 23.4%); and nulliparous women with spontaneous term births (Group 1, 11.1%) (Table 2).

Variation among hospital CS rates after adjusting for case-mix

After accounting for case-mix, medium to high unexplained variation in CS rates among hospitals persisted for the following Robson groups: nulliparous women at term (Group 1: spontaneous, Group 2: induction or pre-labour caesarean), previous CS (Group 5), multi-fetal pregnancies (Group 8) and preterm births (Group 10) (Table 2 and Figure 2). Case-mix explained only 19.7%, 36.0%, 17.3% and 19.0% of the variation among hospitals for Robson groups 1, 2, 5 and 10 respectively (Table 2). Conversely, the largest proportion of variation in hospitals CS rates explained by case-mix was for multiparous women with breech presentation (Group 7); the degree of variation was medium for this group. In contrast, adjustment for case-mix slightly increased the between-hospital variation (by 6.0%) for multiparous women with spontaneous labour at term (Group 3), although the variation remained extremely low for this group (Table 2).

Overall, the "best practice" CS rate (20th centile) was 27.3 per 100 births (3.6% lower than the 30.9/100 observed overall CS rate). Applying the "best practice" rate to the five Robson groups with the greatest variability (1, 2, 5, 8 & 10) without changing the rate in other groups gave an estimated overall CS rate of 27.8 per 100 births, 3.1% lower than the observed overall CS rate.

DISCUSSION

In the period 2009–2010 in NSW hospitals, almost one in three women gave birth by CS, and the CS rates varied considerably across hospitals overall and within risk-based groups. Nulliparous women at term and women with previous CS accounted for two-thirds of the overall CS rate. Some hospitals achieved CS rates compatible with international guidelines of 20–24% CS rates.[4,5] Wide variation in hospital CS rates persisted after adjusting for case-mix, with marked unexplained variation in the following groups: nulliparous women at term; women with previous CS; multi-fetal pregnancies; and preterm births. These groups appear to be managed differently across hospitals and may present opportunities for practice improvement. However, further research needs to examine whether these differences are supported by differences in outcome. In contrast, negligible unexplained variation was observed for multiparous women with spontaneous labour at term and women with breech presentation.

The Robson classification has been used in single- and multi-institutional studies worldwide, and recommended as the most appropriate CS classification for auditing and monitoring purposes.[21] The Robson classification is useful for prospectively identifying groups of women at risk of CS, since classification is based on a woman's risk profile rather than on the indications for CS.[16] Groups with persisting variation after case-mix adjustment suggest lower CS rates are achievable in certain populations. Where these groups also make a large contribution to the overall CS rate, they are priority targets for initiatives to reduce practice variation and caesarean births where appropiate. Reducing variation can be achieved by identifying the best evidence-based practices (those with optimal obstetric outcomes with a minimum of intervention) and translating this knowledge to local circumstances for improvement of maternity care.[6] Our study suggests that nulliparous women at term and women with multi-fetal pregnancies or preterm birth meet these criteria, and together contribute 43.6% of the overall CS rate. In addition, the largest contribution of previous CS to the overall CS rate underscores the importance of mode of birth for the first birth.[22] For example, breech presentation, a strong indication for CS and low variation, is avoidable in almost one-third of such births through external cephalic version.[23] If variation in practice was reduced to that of hospitals in the lowest 20% for each Robson group, this would equate to a 3.6% lower overall CS rate (from 30.9 to 27.3 per 100 births). Over 80% of this decrease is contributed by the five risk-based groups that account for the majority of hospital variation and total caesareans.

An international study examining varation in CS rates in more than 47,000 births from tertiary referral centres in nine countries also identified wide between-institutional variation for women with spontaneous cephalic labour at term via the Robson classification.[10] However, that study did not take into account case-mix factors which could potentially bias the comparative evaluation. A recent study that accounted for socio-demographic and clinical characteristics of the mother and fetus demonstrated reduced variation in hospital CS rates for nulliparous women.[11] Furthermore, a UK study investigating variation in CS rates among National Health Service maternity units found the rates of intrapartum caesarean varied more than the rates of pre-labour caesarean after adjusting for maternal and clinical risk factors, suggesting that future studies should consider analysing intrapartum and pre-labour caesareans separately.[24]

The strengths of this study are the use of longitudinally linked population-based data with sufficient numbers of caesareans to explore hospital variation even in smaller subpopulations (e.g., women with multi-fetal pregnancies), and the availability of reliably collected and validated labour and birth data. Furthermore, the use of multilevel modelling for risk adjustment allowed inclusion of hospitals with a small number of births and accounting for similarities of births within hospitals. In addition, the same case-mix factors were used to ensure the risk adjustment was consistent across the Robson groups. However, there is lack of information on clinical or non-medical factors (such as hospital or individual management styles and practices, clinicians' attitudes, cultural background and maternal request) that may influence CS.[25] Some of this additional information can be addressed via record linkage to other data sources (e.g., hospital data) in subsequent studies where a wide range of maternal, clinical and hospital factors are available. This initial study sought to understand CS practice variation; further work is required to determine whether any relationship exists with birth outcomes.

CONCLUSION

Reduction in overall CS rates is not an impractical goal. The range of hospital CS rates in NSW shows that lower rates of caesarean are attainable. This study is a first step in shedding light on the underlying heterogeneity of CS practice among hospitals. The study highlights that nulliparous women at term and women with previous CS, multi-fetal pregnancies or preterm birth may be priority targets for achieving clinical practice changes. Further investigation through record linkage studies and clinical audits is worthwhile.

REFERENCES

1. Kennedy PJ, Leathley CM, Hughes CF. Clinical practice variation. *Med J Aust*. 2010;193(8):S97-S99.
2. Australian Institute of Health and Welfare. Australia's mothers and babies 2009. Canberra: AIHW, 2010. (Perinatal statistics series no. 25. Cat. no. PER 52.) http://www.aihw.gov.au/publication-detail/?id=10737420870 (accessed Feb 2013).
3. Oragnisation for Economic Co-Operation and Development. OECD health data 2010. http://stats.oecd.org/ (accessed Feb 2013).
4. Royal College of Obstetricians and Gynaecologists. Making sense of commissioning Maternity Services in England–some issues for Clinical Commissioning Groups to consider. London: RCOG, 2012. www.rcm.org.uk/EasySiteWeb/GatewayLink.aspx?alId=207370 (accessed Feb 2013).
5. US Department of Health and Human Services. Healthy People 2010: Understanding and improving Health. 2nd ed. Washington, DC: US Government Printng Office, 2000. http://www.healthypeople.gov/2010/document/html/volume2/16mich.htm (accessed June 2013)
6. Glantz JC. Obstetric variation, intervention, and outcomes: doing more but accomplishing less. *Birth*. 2012;39(4):286-290.
7. Australian Government. Improving maternity services in Australia – A discussion paper from the Australian Government. Canberra, 2008. http://www.health.gov.au/internet/main/publishing.nsf/Content/maternityservicesreview-discussionpaper (accessed Feb 2013).
8. Coonrod DV, Drachman D, Hobson P, Manriquez M. Nulliparous term singleton vertex cesarean delivery rates: institutional and individual level predictors. *Am J Obstet Gynecol.* 2008;198(6):694.e1-e11.
9. Stivanello E, Rucci P, Carretta E, Pieri G, Seghieri C, Nuti S, Declerce E, Taglioni M, Fantini MP. Risk adjustment for inter-hospital comparison of caesarean delivery rates in low-risk deliveries. *PLoS One*. 2011;6(11):e28060.
10. Brennan DJ, Robson MS, Murphy M, O'Herlihy C. Comparative analysis of international cesarean delivery rates using 10-group classification identifies significant variation in spontaneous labor. *Am J Obstet Gynecol*. 2009;201(3):308. e1-e8.
11. Colais P, Fantini MP, Fusco D, Carretta E, Stivanello E, Lenzi J, Pieri G, Perucci CA. Risk adjustment models for interhospital comparison of CS rates using Robson's ten group classification system and other socio-demographic and clinical variables. *BMC Pregnancy Childbirth*. 2012;12(1):54.
12. Roberts CL, Rowlands IJ, Nguyen M. The contribution of maternal age to increasing caesarean section rates. *Aust N Z J Obstet Gynaecol*. 2012;52(3):308-309.
13. NSW Department of Health. Guide to role delineation of health services 3rd ed. Sydney: NSW Department of Health, 2002. http://trove.nla.gov.au/version/19954236 (accessed Feb 2013).

14. Roberts CL, Bell JC, Ford JB, Morris JM. Monitoring the quality of maternity care: how well are labour and delivery events reported in population health data? *Paediatr Perinat Epidemiol*. 2009;23(2):144-152.
15. Taylor LK, Pym M, Bajuk B, Sutton L, Travis S, Banks C. Validation study: NSW Midwives Data Collection 1998. *NSW Public Health Bulletin Supplemtary Series*. 2000;11(1):97-99.
16. Robson MS. Classification of caesarean sections. *Fetal Matern Med Rev*. 2001;12(1):23-39.
17. Rabe-Hesketh S, Skrondal A. Multilevel and longitudinal modelling using Stata 2nd ed. United States of America: Stata Press, 2008.
18. Mohammed MA, Manktelow BN, Hofer TP. Comparison of four methods for deriving hospital standardised mortality ratios from a single hierarchical logistic regression model. *Stat Methods Med Res*. 2012.
19. Gibberd R, Pathmeswaran A, Burtenshaw K. Using clinical indicators to identify areas for quality improvement. *J Qual Clin Pract*. 2000;20(4):136-144.
20. Simpson JM, Evan N, Gibberd RW, Heuchan AM, Henderson-Smart DJ, Australian and New Zealand Neonatal Network. Analysing differences in clinical outcomes between hospitals. *Qual Saf Health Care*. 2003;12(4):257-262.
21. Torloni MR, Betran AP, Souza JP, Widmer M, Allen T, Gulmezoglu M, Merialdi M. Classifications for cesarean section: a systematic review. *PLoS One*. 2011;6(1):e14566.
22. Roberts CL, Algert CS, Ford JB, Todd Al, Morris JM. Pathways to a rising caesarean section rate. *BMJ Open*. 2012;2(5):e001725.
23. Hofmeyr GJ., Kulier R. External cephalic version for breech presentation at term. *Cochrane Database Syst Rev*. 2012;(10):CD000083.
24. Bragg F, Cromwell DA, Edozien LC, Gurol-Urganci I, Mahmood TA, Templeton A, Van der Meuleb JH. Variation in rates of caesarean section among English NHS trusts after accounting for maternal and clinical risk: cross sectional study. *BMJ*. 2010;341:c5065.
25. Stavrou EP, Ford JB, Shand AW, Morris JM, Roberts CL. Epidemiology and trends for caesarean section births in New South Wales, Australia: A population-based study. *BMC Pregnancy Childbirth*. 2011;11(1):8.

Table 1: Maternal and pregnancy characteristics of the study population

	Caesarean section				
	Yes (*N* = 56,695)		No (*N* = 126,615)		TOTAL (*N* = 183,310)
	n	*col %*	*n*	*col %*	*n*
Maternal characteristics*					
Maternal age					
<20 years	1,112	2.0	5,136	4.1	6,248
20–24 years	5,047	8.9	19,446	15.4	24,493
25–29 years	13,359	23.6	36,472	28.8	49,831
30–34 years	19,194	33.9	39,511	31.2	58,705
35–39 years	14,338	25.3	21,985	17.4	36,323
≥40 years	3,645	6.4	4,065	3.2	7,710
Country of birth of the mother					
Australia or New Zealand	39,538	69.7	89,168	70.4	128,706
Asia	9,105	16.1	18,991	15.0	28,096
Other	8,052	14.2	18,456	14.6	26,508
Pregnancy characteristics†					
Nulliparity					
Yes	25,447	44.9	53,310	42.1	78,757
No	31,248	55.1	73,305	57.9	104,553
Onset of labour					
Spontaneous	13,238	23.3	89,359	70.6	102,597
Induced	10,603	18.7	37,256	29.4	47,859
No labour	32,854	57.9	0	0.0	32,854
Previous caesarean section					
Yes	23,500	41.4	4,787	3.8	28,287
No	33,195	58.6	121,828	96.2	155,023
Fetal presentation					
Cephalic	49,536	87.4	125,949	99.5	175,485
Breech	6,199	10.9	547	0.4	6,746
Face/brow/shoulder/transverse	960	1.7	119	0.1	1,079
Multi-fetal pregnancies					
Yes	1,821	3.2	855	0.7	2,676
No	54,874	96.8	125,760	99.3	180,634
Gestational age					
Preterm (<37 weeks)	5,169	9.1	5,639	4.5	10,808
Term (≥37 weeks)	51,526	90.9	120,976	95.5	172,502
Smoking during pregnancy					
Yes	5,229	9.2	15,890	12.5	21,119
No	51,466	90.8	110,725	87.5	162,191
Diabetes					
Yes	4,529	8.0	6,687	5.3	11,216
No	52,166	92.0	119,928	94.7	172,094
Hypertension					
Yes	5,600	9.9	8,182	6.5	13,782
No	51,095	90.1	118,433	93.5	169,528
Type of maternity care					
Private hospital, private patient	18,478	32.6	26,726	21.1	45,204
Public hospital, public patient	31,584	55.7	89,958	71.0	121,542
Public hospital, private patient	6,633	11.7	9,931	7.8	16,564

* Factors used as specified to adjust for case-mix

† Factors used in the Robson classification with adjustment by stratification

Table 2: Caesarean section rates by Robson Ten Group Classification, New South Wales, 2009–2010

Robson group	Births by CS (*n*)	Total births (*n*)	Observed CS rate (*row %*)	Contribution of group to overall CS rate (*col* %)	Index of variation in CS rates[a]	% change in variance among hospitals[b]	20th centile CS rate (*row %*)
1. Nulliparous women with a single cephalic pregnancy at ≥37 weeks gestation in spontaneous labour	6,307	40,774	15.5	11.1	Medium	-19.7	12.7
2. Nulliparous women with a single cephalic pregnancy at ≥37 weeks gestation who either had labour induction or pre-labour caesarean section.	13,257	29,174	45.4	23.4	High	-36	39.6
3. Multiparous women (without a previous caesarean section) with a single cephalic pregnancy at ≥37 weeks gestation in spontaneous labour.	1,106	47,449	2.3	2	Low	6	2.1
4. Multiparous women (without a previous caesarean section) with a single cephalic pregnancy at ≥37 weeks gestation who either had labour induction or pre-labour caesarean section.	3,713	22,777	16.3	6.5	Medium	-11.8	13.1
5. All multiparous women with at least one previous caesarean section and a single cephalic pregnancy at ≥37 weeks gestation.	20,642	25,089	82.3	36.4	High	-17.3	73.3
6. All nulliparous women with a single breech pregnancy at all gestations.	3,265	3,375	96.7	5.8	Low	-35.8	96.4
7. All multiparous women with a single breech pregnancy at all gestations.	2,399	2,576	93.1	4.2	Medium	-43.7	91.8
8. All women with multi-fetal pregnancies at all gestations, including women with previous caesarean sections.	1,821	2,676	68	3.2	High	5.5	58.6
9. All women with a single pregnancy with a transverse lie at all gestations, including women with previous caesarean sections.	863	979	88.2	1.5	Medium	-5.1	85.8
10. All women with a single cephalic pregnancy at <37 weeks gestation, including women with previous caesarean sections.	3,323	8,441	39.4	5.9	High	-19	34.2
TOTAL	56,696	183,310	30.9	100			

[a] Index of variation in CS rates among hospitals after adjustment for case-mix.

[b] Proportional change in variance among hospitals from the crude to the adjusted model, that is when case-mix was accounted for.

Supplementary Figure 1: Study flow diagram