The final version of this paper was published in *NSW Public Health Bulletin* 2014; 24(4):153-158

Reporting postpartum haemorrhage with transfusion: a comparison of NSW birth and hospital data

Authors: Jillian A Patterson, Christine L Roberts, Lee K Taylor, Jane B Ford

Abstract: (195 words) Aim, Methods, Results and Conclusion

Postpartum haemorrhage rates have been increasing in NSW and internationally, and blood transfusion is required in severe cases. Using routinely collected, administrative data provides a convenient method with which to monitor trends in both postpartum haemorrhage and transfusion use in its management. In order for this to be feasible however, the reliability of reporting of the conditions needs to be assessed.

This study uses linked data to compare the reporting of PPH with transfusion as reported in the NSW Admitted Patients Data Collection (hospital data), with the same information obtained from the Perinatal Data Collection (birth data), for births in NSW between 2007 and 2010.

The rate of postpartum haemorrhage requiring blood transfusion was 1.0% based on the hospital data and 1.1% from birth data, with a rate of 1.7% if identifying cases from either source. Agreement between the two sources improved from fair to moderate over the time period.

Postpartum haemorrhage requiring transfusion recorded in the birth data shows only moderate agreement with hospital data, so caution is recommended when using this variable for analysis. Linkage of both datasets is recommended to identify postpartum haemorrhage with transfusion until further validation work has been undertaken.

Word count: 1950 words

Acknowledgements

Jillian Patterson was supported by a NHMRC Partnership Grant, 1027262. Christine Roberts is supported by a NHMRC Senior Research Fellowship (#1021025). Jane Ford is supported by an ARC Future Fellowship (#120100069). We thank the NSW Ministry of Health for access to the population health data and the NSW Centre for Health Record Linkage for linking the data sets.

Introduction

An important application of population health data is identifying and monitoring trends in adverse outcomes, which may require further investigation or intervention.[1-3] In maternal health, one commonly monitored adverse outcome of childbirth is severe postpartum haemorrhage (PPH). Postpartum haemorrhage involves excessive blood loss post-childbirth. Severity of PPH is commonly defined by quantity of blood lost, however this can be difficult to estimate,[4] so blood product transfusion has become widely used as a marker of severe maternal morbidity associated with childbirth. In combination with routinely collected population data collections this marker has been used to monitor changes in morbidity over time, providing a timely and cost effective way of monitoring trends. [5, 6] In order for a marker to be a good indicator of the health of the population, it needs to be reported reliably and in a timely fashion.[7-10]

Currently, local studies reporting PPH requiring transfusion use hospital diagnosis and procedure codes recorded in hospital separation data.[11] While ascertainment of both PPH (Sensitivity 73.8%, specificity 98.9%) and transfusion (Sens 83.1%, spec 99.9%) is relatively high,[12] hospital data are not the best source of birth data. Identifying birth admissions from hospital records relies on the presence of a diagnosis code identifying a live or stillbirth, which differs in reliability when there are multiple births and according to birth outcome and has been shown to miss some births identified in legislated birth data.[13, 14] Additionally, hospital data lack detail on parity, gestation and obstetric history which are important risk factors for PPH. Use of hospital records requires linkage to the birth data to accurately identify hospitalisations related to a pregnancy or birth. This

affects the timeliness of the data, with linked births and hospitals data available 12-18 months later than birth data alone. Birth records, collected by midwives at the time of birth are more timely, available after 12 months, and do not require linkage in order to identify births. In 2007, NSW birth data collections included a new variable 'PPH requiring transfusion'. The reliability of this variable has not yet been assessed. This project compares the reporting of PPH and blood transfusion in the hospital records with the new variable in the birth data.

Methods

Births were identified from the Perinatal Data Collection ('birth data'), a statutory collection of all births in NSW of at least 20 weeks gestation or 400g birthweight. Hospital birth admissions were identified from the Admitted Patient Data Collection ('hospital data') which is a census of all public and private hospital separations in NSW, containing information on procedures and diagnoses, coded according to the 10th revision of the International Classification of Diseases, Australian Modification (ICD10-AM), and the Australian Classification of Health Interventions (ACHI). Probabilistic record linkage between the birth and hospital data was carried out by the NSW Centre for Health Record Linkage. All women giving birth in NSW hospitals between 2007 and 2010, where a corresponding hospital birth record was available, were included in this study. Of the 371,224 linked birth records, 205 (0.1%) were missing information on birth data reporting of PPH requiring transfusion.

The birth data is collected by the attending midwife or medical practitioner including demographic and medical information on the mother, as well as information on the

labour, delivery and infant. PPH requiring transfusion is recorded if there was a "postpartum haemorrhage requiring transfusion of whole blood or packed cells".[15]

In the hospital data, blood transfusion was defined as a record of transfusion of packed cells or whole blood in any of the first 20 procedure codes in the maternal birth admission. Similarly, PPH according to the hospital data was defined as a diagnosis of PPH in any of the first 20 diagnosis fields. PPH in women requiring transfusion has a sensitivity of 92.5%.[12] Hospitals were categorised by location, public/private status and annual number of deliveries.

As neither hospital nor birth data could be considered a 'gold standard' for PPH and transfusion reporting, we assessed agreement based on kappa statistics, and compared characteristics of discordant cases. Kappa statistics were classified as follows: near perfect (81-100), excellent (61-80), moderate (41-60), fair (21-40), slight (1-21) and no agreement (<0).

Results

Between 2007 and 2010 there were 370,961 births recorded in the linked hospital and birth data where the birth data field for PPH requiring transfusion was completed. Based on the hospital data the rate of PPH was 7.6%, and the rate of transfusion of packed cells was 1.4%. The rate of PPH requiring blood transfusion was 1.0% based on the hospital data and 1.1% according to the birth data (Table 1). In the hospital data, blood transfusion rates increased from 1.4% in 2007 to 1.5% in 2010 (p=0.006), PPH rates increased from 7.1% to 7.8% (p<0.0001) and the combination of PPH and transfusion increased from 1.0% to 1.1% (p=0.02). In the birth data, PPH with transfusion increased

from 1.2% to 1.3% (p=0.03). When considering identification from either source, the rate of PPH requiring blood transfusion was 1.7%. In hospitals with an average of over 50 births per year, the rates of women with PPH requiring transfusion as recorded in the birth data ranged between (0.13%,5.63%), and in the hospital data between (0,2.31%). The range of differences between birth data and hospital data was (-1.33%,4.24%). Sensitivity analysis was undertaken to determine if concordance differed between vaginal and caesarean births, however rates were similar (data not shown).

Overall the two variables had moderate agreement (kappa=0.45) (Table 2). Agreement tended to increase between 2007 and 2010, and was higher in tertiary and regional hospitals (Table 2). Twenty (17%) of the 116 hospitals reported PPH with transfusion with near perfect agreement. The proportion of hospitals reporting near perfect agreement increased from 15% in 2007 to 31% in 2010, while those reporting slight/fair agreement decreased from 30% in 2007 to 15% in 2010. This increase in agreement was due to increased reporting in the birth data, with the proportion of PPH with transfusion identified in the hospital data alone decreasing from 30.3% in 2007 to 22.9% in 2009, and those reported in both data sources increasing from 20.9% to 36.5% (Table 3).

PPH with transfusion was more likely to be reported only in the birth data than hospital data for private patients (39.6% vs 18.9%), primiparae (29.4% vs 24.9%), pre-labour caesareans (17.5% vs 11.8%) and for births in regional hospitals (47.4% vs 9.7%) (Table 3), and less likely to be reported for multiple births (2.7% vs 4.3%), Caesarean

section with labour (11.2% vs 14.8%) and births at tertiary obstetric hospitals (13.9% vs 63.3%).

Of women reported in the birth data to have had a PPH requiring transfusion, 68% of women were recorded in the hospital data as having a PPH, and 53% were recorded in the hospital data as having received a blood transfusion. Hospital data reporting indicated that 236 (10.0%) of the discordant birth data records indicating a PPH requiring transfusion had occurred may be for haematomas or antepartum/intrapartum bleeding. Sixty-eight (2.9%) of records identified as PPH with transfusion in the birth data had a record of transfusion of another blood product recorded in the hospital data.

Discussion

We compared the new 'PPH requiring transfusion' variable reported in the birth data, with the previously validated PPH with transfusion from the hospital data and demonstrated moderate agreement. PPH with transfusion in the hospital data is known to have sensitivity of 92.5%.[12] Assuming this rate of underreporting in the hospital data, having observed 3805 admissions with PPH and transfusion, we would expect the true number to be around 4114, resulting in a PPH with transfusion rate of 1.1%. In the birth data we observed a similar rate of 1.1%. Considering identification in either source (1.7%) however, would lead to a possible 55% overestimation. We also noted an increase in reliability of the birth data in later years. This was associated with improved reliability in a small number of hospitals, particularly in hospitals with a research interest around postpartum haemorrhage or transfusion.

Differences in the collection of data may explain some of the variation. Birth data is collected by the midwives and clinicians attending the birth, with the variable 'PPH requiring transfusion' being recorded as a check box on an electronic data entry form. In the hospital data, both transfusion and PPH are coded by hospital coders based on notes written in the medical record. PPH can only be coded from the medical record if it is specifically written as such in the notes.

The lower reporting of PPH with transfusion in birth data following more complex birth situations (multiple births, after caesarean section following labour, and at tertiary obstetric facilities) may be related to differences in data recording. Obstetric staff compiling birth data may not have details available of events occurring outside labour ward, whereas medical coding departments may have additional information from operation reports. Validation studies have demonstrated that birth data are more accurately report labour and delivery factors than subsequent events,[7] and that procedures (eg transfusion) are well ascertained in hospital data.[7]

Some of the discordant records may relate to misclassification of transfusion type or timing. A French study compared the reporting of transfusion in a birth database with records from the blood bank,[16] treating the blood bank data as the gold standard, finding sensitivity of 61.4%, and positive predictive value 82.2%, with kappa 0.7. In their study, birth records misclassified as blood transfusion were typically transfusion of another blood product (other than red cells) or other product for bleeding. This was also the case in our study. In the French study, transfusions not recorded in the birth record were for transfusions outside of the obstetric department (ICU, during transfers between

hospitals) or were miscoding. Importantly, the birth data imply that a transfusion occurred post-haemorrhage, however the timing of diagnoses and procedures recorded in the hospital data cannot be ascertained. It is possible that some of the transfusions recorded in the hospital data occurred for antepartum rather than postpartum haemorrhage. An earlier study using NSW hospital data indicated that 75% of obstetric transfusions were for postpartum haemorrhage and a further 8% were for antepartum haemorrhage (occurring prior to birth).[17]

Population health datasets can provide a rich source of data for research, but their usefulness is limited by the quality of the data they contain.[8-10, 12] Previous studies have shown that accepting diagnoses from more than one data source can increase ascertainment, without increasing false positives,[10, 18, 19] however this is not always the case, and this study suggests that identifying PPH with transfusion from either birth or hospital data would result in over-ascertainment of around 55%.

This study used one dataset (hospital data) to validate another dataset (birth data). While this allows for an initial assessment of the reliability of the birth data variable, an ideal assessment would have been to use a 'gold standard' such as medical record review for validation. However, such validation studies are resource intensive and difficult to justify for single, relatively rare outcomes. Previous validation studies have shown that PPH and transfusion are underreported in the hospital data.[12]

We have shown that the new variable "PPH requiring transfusion" being collected on the birth data shows only moderate agreement with hospital data. We would therefore recommend that researchers use the birth data variable with caution until further

validation has been undertaken. Where possible birth data linked with hospital data can be used to identify PPH with transfusion. An advantage of this approach is that, although there is some under-ascertainment, these data have already been validated. The changes in ascertainment over time in the birth data indicate that early years of data collected on PPH requiring transfusion should be excluded from trend analysis, to prevent improved ascertainment being interpreted as a change in incidence.

1. Callaghan WM, Mackay AP and Berg CJ. Identification of severe maternal morbidity during delivery hospitalizations, United States, 1991-2003. *Am J Obstet Gynecol*. 2008; 199: 133 e1-8.
2. Joseph KS, Rouleau J, Kramer MS, Young DC, Liston RM and Baskett TF. Investigation of an increase in postpartum haemorrhage in Canada. *BJOG : an international journal of obstetrics and gynaecology*. 2007; 114: 751-9.
3. Kuklina EV, Meikle SF, Jamieson DJ, et al. Severe obstetric morbidity in the United States: 1998-2005. *Obstet Gynecol*. 2009; 113: 293-9.
4. Stafford I, Dildy GA, Clark SL and Belfort MA. Visually estimated and calculated blood loss in vaginal and cesarean delivery. *Am J Obstet Gynecol*. 2008; 199: 519 e1-7.
5. Quan H, Parsons GA and Ghali WA. Validity of procedure codes in International Classification of Diseases, 9th revision, clinical modification administrative data. *Medical Care*. 2004; 42: 801-9.
6. Singleton S. Data sources and performance measurement. *BMJ*. 335: 730.
7. Lain SJ, Hadfield RM, Raynes-Greenow CH, et al. Quality of data in perinatal population health databases: a systematic review. *Medical Care*. 2012; 50: e7-20.
8. Schoendorf KC and Branum AM. The use of United States vital statistics in perinatal and obstetric research. *American Journal of Obstetrics & Gynecology*. 194: 911-5.
9. Yasmeen S, Romano PS, Schembri ME, Keyzer JM and Gilbert WM. Accuracy of obstetric diagnoses and procedures in hospital discharge data. *Am J Obstet Gynecol*. 2006; 194: 992-1001.
10. Lydon-Rochelle MT, Holt VL, Nelson JC, et al. Accuracy of reporting maternal in-hospital diagnoses and intrapartum procedures in Washington State linked birth records. *Paediatric and Perinatal Epidemiology*. 2005; 19: 460-71.
11. Ford JB, Roberts CL, Simpson JM, Vaughan J and Cameron CA. Increased postpartum hemorrhage rates in Australia. *Int J Gynaecol Obstet*. 2007; 98: 237-43.
12. Lain SJ, Roberts CL, Hadfield RM, Bell JC and Morris JM. How accurate is the reporting of obstetric haemorrhage in hospital discharge data? A validation study. *Australian & New Zealand Journal of Obstetrics & Gynaecology*. 48: 481-4.
13. Taylor LK, Travis S, Pym M, Olive E and Henderson-Smart DJ. How useful are hospital morbidity data for monitoring conditions occurring in the perinatal period? *Aust N Z J Obstet Gynaecol*. 2005; 45: 36-41.
14. Bentley J, Ford J, Taylor L, Irvine K and Roberts C. Investigating linkage rates among probabilistically linked birth and hospitalization records. *BMC Med Res Methodol*. 2012; 12: 149.
15. New South Wales Perinatal Data Collection Manual. In: Health NDo, (ed.). 2011 Edition ed. 2011.
16. Sagot P, Mourtialon P, Benzenine E, et al. Accuracy of blood transfusion in postpartum hemorrhage to assess maternal morbidity. *European journal of obstetrics, gynecology, and reproductive biology*. 2012; 162: 160-4.
17. Roberts CL, Ford JB, Thompson JF and Morris JM. Population rates of haemorrhage and transfusions among obstetric patients in NSW: a short communication. *Australian & New Zealand Journal of Obstetrics & Gynaecology*. 2009; 49: 296-8.
18. Callaghan WM, Kuklina EV and Berg CJ. Trends in postpartum hemorrhage: United States, 1994-2006. *Am J Obstet Gynecol*. 2010; 202: 353 e1-6.
19. Roberts CL, Bell JC, Ford JB and Morris JM. Monitoring the quality of maternity care: how well are labour and delivery events reported in population health data? *Paediatric and Perinatal Epidemiology*. 23: 144-52.

Table 1 Concordance of PPH with transfusion cases identified from hospital data or birth data

		Hospital data Yes	No	Total
Birth data	Yes	1800(0.5%)	2371(0.6%)	4171 (1.1%)
	No	2005(0.5%)	364785(98.3%)	366790 (98.9%)
	Total	3805(1.0%)	367156 (99.0%)	370961 (100%)

Table 2 Agreement between birth data and hospital data

Group	Kappa	Agreement
Overall	44.6 (43.2,45.9)	Moderate
Mode of delivery		
Vaginal Deliveries	44.3 (42.7,45.9)	Moderate
Caesarean Deliveries	45.3 (42.7,47.)	Moderate
Year		
2007	36.6 (33.9,39.3)	Fair agreement
2008	36.3 (33.4,39.1)	Fair agreement
2009	43.9 (41.1,46.7)	Moderate
2010	59.2 (56.8,61.7)	Moderate
Hospital type		
Tertiary Obstetric	48.9 (46.8,51.1)	Moderate
Regional	46.7 (44.2,49.1)	Moderate
Urban/other	35.9 (31.7,40.0)	Fair agreement
Private	37.0 (33.9,40.2)	Fair agreement
Volume		
20-499	45.3 (41.6,48.9)	Moderate
500-999	46.0 (42.5,49.5)	Moderate
1000+	44.2 (42.6,45.8)	Moderate

Table 3 Comparison PPH with transfusion codes identified in either the birth data, hospital data or both.

	Variable	Both N (%)	Hospital data only N (%)	Birth data only N (%)	p value
Overall		1800 (100.0)	2005 (100.0)	2371 (100.0)	
Year*					
	2007	376 (20.9)	546 (27.2)	719 (30.3)	<.0001
	2008	335 (18.6)	556 (27.7)	589 (24.8)	
	2009	432 (24.0)	559 (27.9)	519 (21.9)	
	2010	657 (36.5)	344 (17.2)	544 (22.9)	
Age					
	<20 years	100 (5.6)	95 (4.7)	124 (5.2)	0.0371
	20-24	259 (14.4)	330 (16.5)	335 (14.1)	
	25-29	460 (25.6)	532 (26.5)	609 (25.7)	
	30-34	530 (29.4)	573 (28.6)	740 (31.2)	
	35-39	357 (19.8)	373 (18.6)	480 (20.2)	
	40+	94 (5.2)	102 (5.1)	83 (3.5)	
Multiple birth					
	Yes	78 (4.3)	87 (4.3)	63 (2.7)	0.003
	No	1722 (95.7)	1918 (95.7)	2308 (97.3)	
Primip					
	Yes	468 (26.0)	500 (24.9)	696 (29.4)	0.0026
	No	1332 (74.0)	1505 (75.1)	1675 (70.6)	
Gestational age					
	20-32	77 (4.3)	82 (4.1)	67 (2.8)	0.0059
	33-36	142 (7.9)	159 (7.9)	149 (6.3)	
	37+	1560 (86.7)	1732 (86.4)	2130 (89.8)	
Delivery type					
	Normal vaginal delivery	894 (49.7)	996 (49.7)	1238 (52.2)	0.1512
	Caesarean section (total)	512 (28.4)	533 (26.6)	680 (28.7)	0.2586
	CS- No Labour	234 (13.0)	237 (11.8)	415 (17.5)	<.0001
	CS-Labour	278 (15.4)	296 (14.8)	265 (11.2)	<.0001
	Instrumental (total)	404 (22.4)	472 (23.5)	465 (19.6)	0.0048
	Forceps	198 (11.0)	222 (11.1)	192 (8.1)	0.0008
	Vacuum	206 (11.4)	250 (12.5)	273 (11.5)	0.531
Private patient in public hospital					
	Yes	172 (9.6)	210 (10.5)	193 (8.1)	0.0275
	No	1628 (90.4)	1795 (89.5)	2178 (91.9)	
Hospital Group					
	Tertiary obstetric	779 (43.3)	1269 (63.3)	330 (13.9)	<.0001
	Regional	594 (33.0)	195 (9.7)	1125 (47.4)	
	Urban/other	154 (8.6)	373 (18.6)	169 (7.1)	
	Private	273 (15.2)	168 (8.4)	747 (31.5)	

* Column (first) and row (second) percentages are presented. All other reported percentages are column percentages

Figure 1 Study population for comparison of reporting of postpartum haemorrhage (PPH) with transfusion between birth and hospital data