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Hospital Data Reporting on Postpartum Hemorrhage: Under-Estimates Recurrence and Over-Estimates the Contribution of Uterine Atony

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Abstract (250 words)

Objectives: This study aimed to explore whether recording of a prior adverse pregnancy outcome in a medical record increases the likelihood that recurrence of the same event is reported in population data.

Methods: Using a random sample of 294 women who had first and second pregnancies in NSW, and a postpartum hemorrhage (PPH) reported for at least one pregnancy, we compared 'coded' recurrence rates in hospital data with those obtained from medical record audit. 'Coded' recurrence in a second pregnancy was also compared for women with or without a documented history of prior PPH.

Results: We found a 'coded' recurrence rate of 18.5% and a 'true' rate (according to medical record audit) of 28.4%. The 'coded' rate of recurrence among women who had a documented history of PPH was 27.4% compared to 19.1% among those where the previous PPH was not noted in the second pregnancy medical record. 'True' reporting of a uterine atony cause for postpartum hemorrhages in first and second births was 37.9% and 34.0% while 'coded' hospital data reporting was 79.8% and 73.9% respectively.

Conclusions: Our study results indicate that a history of postpartum hemorrhage may be an even stronger risk factor for subsequent PPH than previously demonstrated. A recorded history of PPH was associated with a higher likelihood of reporting a subsequent PPH, however in such cases recurrence rates approximate true recurrence. The contribution of uterine atony as a cause of postpartum hemorrhage is over-estimated using population health data.

Keywords: recurrence, postpartum hemorrhage, validation, uterine atony

INTRODUCTION

Administrative or population health data, such as birth or hospital discharge data, are increasingly being used to investigate maternal health outcomes.^{1,2} Developments in record linkage of population data have enabled researchers to follow pregnancy outcomes among individuals over time. For example, population data have been used to estimate the recurrence risk of miscarriage,³ stillbirth,⁴ preterm birth,^{3,5} breech presentation,⁶ preeclampsia⁷ and postpartum hemorrhage⁸. The management of a new pregnancy in parous women takes into account previous pregnancy complications which would typically be documented in the current pregnancy record.

Validation studies of reporting in population health data find variable ascertainment of diagnoses and procedures during pregnancy and childbirth.⁹ However, systematic bias in reporting has rarely been explored. There is some evidence that more severe conditions or those associated with adverse outcomes are more likely to be reported in population data.¹⁰ It is also possible that a history of an adverse outcome affects reporting of events that occur in a current pregnancy. The authors hypothesised that recording of a prior adverse pregnancy outcome, such as postpartum hemorrhage, in a pregnancy record might increase the likelihood that recurrence of the same event is reported in the discharge summary and population data.

Uterine atony involves the failure of the uterus to contract after delivery and is the main cause of postpartum hemorrhage.¹¹ Recent studies have used population health data to ascertain uterine atony,^{12,13} however the validity of hospital data for reporting uterine atony has not been established.

Therefore, the aims of this study were: (1) To compare postpartum hemorrhage recurrence rates abstracted from medical records ('the gold standard') with that obtained from coded hospital

discharge data for the same women; (2) to determine whether postpartum hemorrhage (PPH) is more likely to be reported in coded data when a prior PPH was noted in the medical record; and (3) to investigate the accuracy of population health data reporting of uterine atony.

METHODS

New South Wales (NSW) is the most populous Australian state with a population of ~ 6.9 million and 90,000 births per annum in over 100 hospitals, ranging from small rural hospitals to tertiary centres. Australian maternity care has features of the British and American systems; all women are covered by national health insurance which provides free maternity care for public patients in public hospitals but about one-third take out private medical insurance or pay for private obstetric care. The study population was a random sample of women giving birth between January 2002 and December 2006 to at least two babies (first and second) in a single Area Health Service in NSW and who experienced a postpartum hemorrhage at either birth as identified in the NSW Admitted Patient Data Collection. These data include discharge summaries for all hospitalizations in the state. The selected Area Health Service serves approximately one-sixth of the state's population.

Details of each pregnancy were identified in three sources of health data – medical records of 300 randomly selected women ('audit data'), NSW Midwives Data Collection data which includes information on all births including maternal demographic and pregnancy factors, and labor and delivery outcomes ('birth data') and Admitted Patient Data collection ('hospital data') diagnoses and procedures coded using the International Classification of Diseases (ICD10-AM) and Australian Classification of Health Interventions data.^{14,15} 'True PPH' diagnoses were

determined from the audit data, 'documented history of PPH' was determined from second pregnancy audit data and 'coded PPH' was determined from hospital data.

Audit data was collected by five trained abstractors visiting each of 11 hospitals and was entered on to a standard data abstraction form. Abstractors noted clinical details including labor, delivery and pathology results in order to identify if there was evidence of true hemorrhage. Training was conducted on 5% of records and involved abstraction by two people and comparison of audit data. Inter-observer agreement was $\geq 96\%$ for the 39 data items.

PPH was defined in coded hospital data using ICD10-AM code 'O72' according to the Australian Coding Standards.¹⁶ That is, where blood loss ≥ 500 ml after vaginal birth or ≥ 750 ml after caesarean section and/or where a diagnosis of postpartum hemorrhage was recorded by the attending clinician (obstetrician, general practitioner or midwife). In the audit data, PPH could be assigned in the absence of a clinical diagnosis (on blood loss alone). PPH due to uterine atony was identified in coded hospital data using ICD10-AM code 'O72.1' and in audit data where the words 'atony' or 'atonic' were used or where descriptions indicated a failure of the uterus to contract.

The PPH recurrence risk in a 2nd pregnancy, based on hospital data, is estimated at 15%. However, PPH has been demonstrated to be under-ascertained in the hospitalization data (sensitivity 74%). Based on varying assumptions about PPH recurrence risk ranging from 10% (if the 15% recurrence risk was over-estimated because of higher ascertainment in the 2nd pregnancy) to 25% (if under-ascertainment was uniform regardless of prior events), we estimated that 300 women with 2 consecutive pregnancies and who had suffered a PPH would allow us to determine the true recurrence risk with a 95% confidence interval of $<\pm 6\%$.

The study sample characteristics, labor and delivery outcomes and treatment of postpartum hemorrhage were obtained from the audit data. Postpartum hemorrhage rates from the audit and coded hospital data were calculated per 100 births with 95% confidence intervals (CIs). Blood loss comparisons (between women) were undertaken using Wilcoxon Mann-Whitney tests. Ascertainment of PPH in the coded hospital data was compared to audit data. The ascertainment rate represents the proportion of postpartum hemorrhage cases that were correctly identified as such in the coded hospital data. Conventional reporting characteristics (sensitivity, specificity, negative and positive predictive value) could not be calculated for this sample because sampling was based on the occurrence of a PPH in at least one of the pregnancies and does not capture information on the rate of unreported 'true' PPH in the general population.

Ethics approval for data linkage and sampling was granted by the NSW Population and Health Services Research Ethics Committee (REC). Ethics approval for conduct of the study was granted by the Northern Sydney Central Coast Area Health Service Human REC for public hospitals and individual ethics committees, patient care review committees or medical advisory committees for each of the private hospitals.

RESULTS

Of the 600 birth records, 588 records representing both pregnancies for 294 women were available for analysis. Complete records were not available for two women, audit data for another woman were for second and third births, and linked hospital data were missing for another 3 women.

Births occurred in 7 public hospital and 4 private hospitals. The majority of births were singleton births (98.3%) in public hospitals (81.3%). The average age of women at their first birth

was 29.1, with a slightly higher proportion of second births at private hospitals (19.0 vs 18.4%) (Table 1). A comparison of the study sample (at first birth) with the wider state birthing population showed that the study sample included a higher proportion of women aged 20-34 years, giving birth in public hospitals, and large babies but had similar proportions of multiple pregnancies. Smoking status in the hospitals studied was lower than that reported across the state.

Postpartum hemorrhage as reported in the audit data (gold standard)

Based on review of medical records we identified 322 (54.8%) 'true' postpartum hemorrhages, including 71 (22.1%) that met the blood loss definition for postpartum hemorrhage but where the diagnosis was not recorded in the medical records by the attending clinicians. There were 16 records (2.7%) with no details about total blood loss. Ten (63%) of these 16 records were caesarean deliveries and 10 were from private hospitals.

One hundred and twenty one women had only a first birth postpartum hemorrhage, 105 women only had a second birth postpartum hemorrhage and 48 women (16.3%) had a postpartum hemorrhage after both births (ie 96 hemorrhages). This represents a true recurrence rate of 28.4% (CI 22.1-35.6) (Figure 1).

Postpartum hemorrhage recorded in coded hospital data

Coded hospital reporting identified 303 (94.1%) of the 322 'true' postpartum hemorrhages following birth, and an additional 23 births (7% of all PPH identified in hospital data) which were not verified as postpartum hemorrhages on review of the medical records. According to the coded hospital data, there were 141 women with only a first birth postpartum hemorrhage, 121 women with a second birth postpartum hemorrhage and 32 women with a postpartum hemorrhage after both births. This represents a recurrence rate of 18.5% (CI 13.4-24.9) (Figure 1).

There was no difference in the proportion of ‘true’ postpartum hemorrhages identified in coded data following second compared to first births (94.1%, CI 91.0-96.2).

Documented history of postpartum hemorrhage

Documented history of PPH was associated with the severity of the previous postpartum hemorrhage; higher blood loss at first birth was associated with documentation in the following pregnancy ($p < .0001$). Thirty-three (68.8%) of the 48 women with true postpartum hemorrhage recurrence had notes in their second birth record indicating a history of postpartum hemorrhage. Women who had changed hospitals for their second birth were less likely to have notes indicating a history of prior postpartum hemorrhage (55.6% vs 68.8%). Using coded hospital data, the rate of recurrence among women who had a documented history of postpartum hemorrhage in their medical record was 27.4% (CI 19.8-36.5) compared to 19.1% (CI 11.3-30.4) among those where the previous PPH was not recorded, however confidence intervals overlapped. These rates are higher than the coded recurrence rate above since they do not include false positive reports of PPH at a first pregnancy.

Atonic postpartum hemorrhage

Based on audit data, the most common primary cause of true postpartum hemorrhage at a first or second postpartum hemorrhage was uterine atony (35.9% and 33.3% of first and second postpartum hemorrhages respectively). These proportions increased to 37.9% and 34.0% of first and second PPHs where any atony was identified (Figure 2). Using coded hospital data to determine the cause of PPH, the number of false positives of uterine atony was greater than the true cases (136 vs 100). Consequently, reliance on population reporting of atonic hemorrhage over-estimates the proportion of first and second PPHs due to atony as 79.8% and 73.9%. The ‘true’ recurrence of hemorrhage due to uterine atony was 15.1% but this estimate is based on only 6 true cases.

Variation of reporting by mode of delivery and hospital type

Stratification of postpartum hemorrhage reporting among specific risk groups revealed a trend towards better reporting among vaginal births than caesarean births and private hospitals compared to public hospitals, although confidence intervals for ascertainment among public and private hospitals overlapped. Among all pregnancies, postpartum hemorrhage ascertainment for vaginal deliveries was 96.3% (CI 93.1-98.1) while for caesarean deliveries it was 82.9% (CI 73.4-89.6). Postpartum hemorrhage ascertainment for public hospitals compared to private hospitals were 92.3% (CI 88.6-94.9) and 96.2% (CI 87.0-98.9) respectively.

Variation across hospitals in the recording of PPH was identified during data abstraction – the location of blood loss information was included in one or more of the following: clinical notes, labor and delivery forms, operative reports and discharge summaries. Blood loss amounts required for a diagnosis of PPH also varied with one hospital recording any hemorrhage of 500 mls or more as a PPH, while other hospitals appeared to use the ICD10-AM definition which differentiates between mode of delivery (≥ 500 mls for vaginal births, ≥ 750 mls for Caesarean sections).

DISCUSSION

Our study indicates population health reporting of postpartum hemorrhage under-estimates recurrence. Using medical record audit, it was identified that the postpartum hemorrhage recurrence rate in the study population was 28.4% (22.1-35.6). The coded hospital data, among the same population, reported a recurrence rate of 18.5 (13.4-24.9), slightly higher than (but not significantly different from) a previous population-based study for which the reported recurrence rate was 14.8 (14.0-15.6).⁸

Our study also demonstrated that the postpartum hemorrhage recurrence reporting showed a trend towards greater accuracy where notes were present in the medical records to indicate a history of postpartum hemorrhage. Only 69% of women who had postpartum hemorrhage following both of the births captured in this study had their prior history noted in the second pregnancy notes. If a woman had changed hospitals for the second birth, she was less likely to have her postpartum hemorrhage history recorded. Given that in many cases a postpartum hemorrhage is an unexpected event and the consistently reported increased risk where a history of prior hemorrhage is present, it is important that a history of prior hemorrhage is noted in medical records. The observed hospital variation in blood loss amounts used to report hemorrhage, as well as variation in the places that hemorrhage can be recorded in medical records (eg. operative notes, clinical notes and discharge summaries) also highlight the need for standardisation of medical record reporting for hemorrhage across hospitals.

As previously demonstrated,¹⁷ there was under-reporting of postpartum hemorrhage following caesarean section compared to vaginal births. Potential reasons for this under-reporting include: the varying blood loss definition of hemorrhage for vaginal and caesarean deliveries in Australia,¹⁸ the difficulty of estimating blood loss in the uterine cavity at caesarean section and variation in staff attending operative and vaginal births. Visual estimation of blood loss has previously been demonstrated to be inaccurate.^{19,20} There is some suggestion that blood loss is over-estimated at low volumes and under-estimated at high volumes.²⁰

It appears that the contribution of uterine atony to postpartum hemorrhage as measured by population health data is over-estimated. Medical record data from our study indicated that uterine

atony is the primary cause of between 35-40% of postpartum hemorrhage cases whereas population data reporting, based on the ICD code to which atony is assigned, indicated that uterine atony was the cause of 75-80% of postpartum hemorrhages. While other studies have reported on atonic hemorrhage using specific hemorrhage categories within the broader postpartum hemorrhage ICD code,^{13,21} the results of our study indicate misclassification is present among these specific sub-codes. This is consistent with other diagnoses such as hypertension and diabetes where broader categories are more reliably reported than specific sub-categories.⁹ Although used to report atonic hemorrhage, the specific subcode could also include other causes of PPH including tears and other immediate hemorrhage.²¹ Based on these results the authors conclude that ICD codes assigned for atonic hemorrhage are not specific enough to be used to report population rates of atonic PPH.

A limitation of this study was that information was recorded on birth hospital admissions only and therefore readmissions for hemorrhage would not have been captured. This is likely to have resulted in some under-estimation of secondary hemorrhages. Comparisons of the study population with the wider state (using smoking status as a proxy) indicate that the study may over-represent women of high socio-economic status. However, there has been no evidence to date indicating that socio-economic status among developed countries has an effect on hemorrhage risk and therefore the results of this study should be generalizable to other developed country populations. While our study demonstrated a higher recurrence rate based on medical records compared to population data, the confidence intervals overlap slightly.

Designing studies to investigate reporting of recurrent events is challenging. In order to sample sufficient records to identify recurrence a random sample is not feasible. For this study we investigated medical records for women with a postpartum hemorrhage identified in population health data following either a first or second birth. The sensitivity of reporting is likely to be high

given that many of the records for a given pregnancy (but not all) will have been selected from the population data and therefore some 'true' PPHs will have been missed. This is demonstrated by the high ascertainment of PPH: 94.1% in our study compared to 58.6% and 73.8% in other validation studies.^{22,23} Despite higher ascertainment of PPH in our sample, the population data recurrence rate (18.5%) was comparable to the 14.8% rate from another published study.

This study adds to a growing literature that indicates variation in reporting of diagnoses in population data. Our results indicate recorded history influences the reporting of postpartum hemorrhage. Concordant with previous studies we also demonstrate variation in reporting across public and private settings, and mode of delivery.^{24,25} As noted in another study, despite under-recording in medical records of history of diagnosis, recurrence risks are well estimated when documented history (as opposed to examining the prior record) is used to identify previous history.²⁶ In contrast to the suggestion by Green et al that cross-sectional reporting of previous pregnancy outcomes (in their case caesarean section) will overestimate the true repeat rate, we found that recurrence risk of PPH was accurately reported when documented history of PPH was used.²⁷

To our knowledge this study is the first validation study to investigate reporting of recurrent events. Our study results indicate that a history of postpartum hemorrhage may be an even stronger risk factor for subsequent hemorrhage than previously demonstrated. A recorded history of postpartum hemorrhage showed a trend towards making it more likely that a subsequent hemorrhage will be reported, however in such cases recurrence rates approximate true recurrence.

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Table 1. Sample characteristics

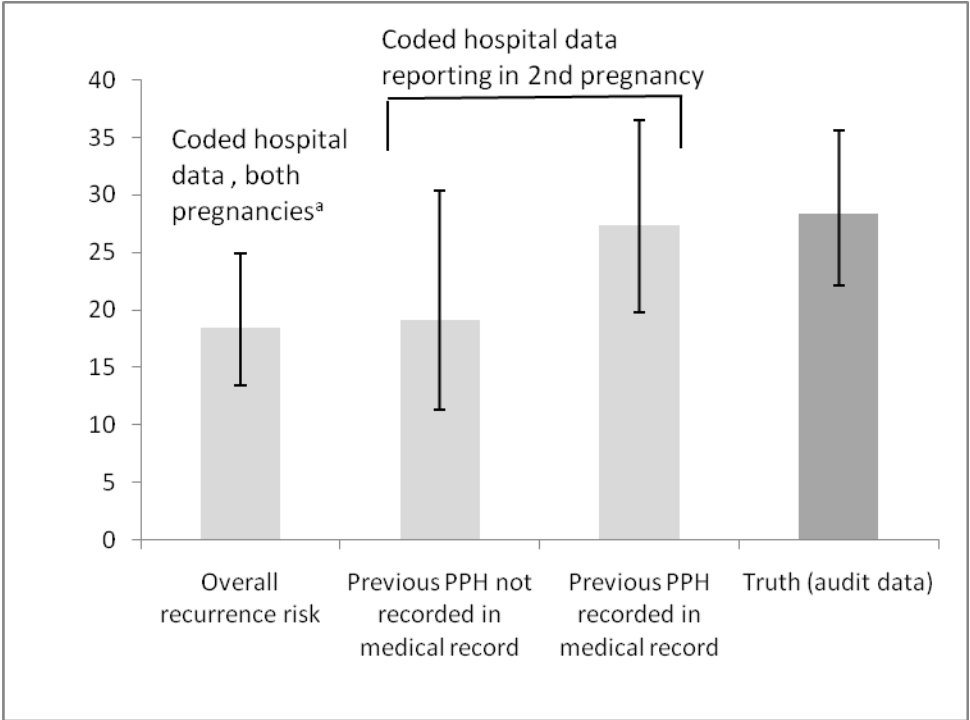
	First birth n = 294	Second birth n = 294
Age at birth (mean)	29.1	31.2
BMI at birth (mean) ^a	25.7	26.6
Birth hospital		
- public	240 (81.6)	238 (81.0)
- private	54 (18.4)	56 (19.0)
Multiple birth	4 (1.4)	6 (2.0)
Gestational age (wk)		
20-31	3 (1.0)	6 (2.0)
32-36	13 (4.4)	13 (4.4)
≥37	278 (94.6)	275 (93.5)
Birthweight (g)		
<1500	2 (0.7)	4 (1.4)
1500-2499	13 (4.4)	9 (3.1)
2500-3499	126 (42.9)	115 (39.1)
≥3500	153 (52.0)	166 (56.5)
Smokers ^b	6.8	6.9
Mode of delivery		
Vaginal	157 (53.4)	183 (62.2)
Instrumental	63 (24.8)	17 (5.8)
Caesarean with labour	62 (21.1)	25 (8.5)
Caesarean no labour	12 (4.1)	69 (23.5)
Third or fourth degree tear and/ or episiotomy ^c	47 (21.4)	22 (11.0)
Postpartum hemorrhage	169 (57.5)	153 (52.0)

^a Weight and height were only available for 195 (66.3%) first births and 192 (65.3%) second births

^b Estimated from smoking status reported in birth data by the hospitals in our sample

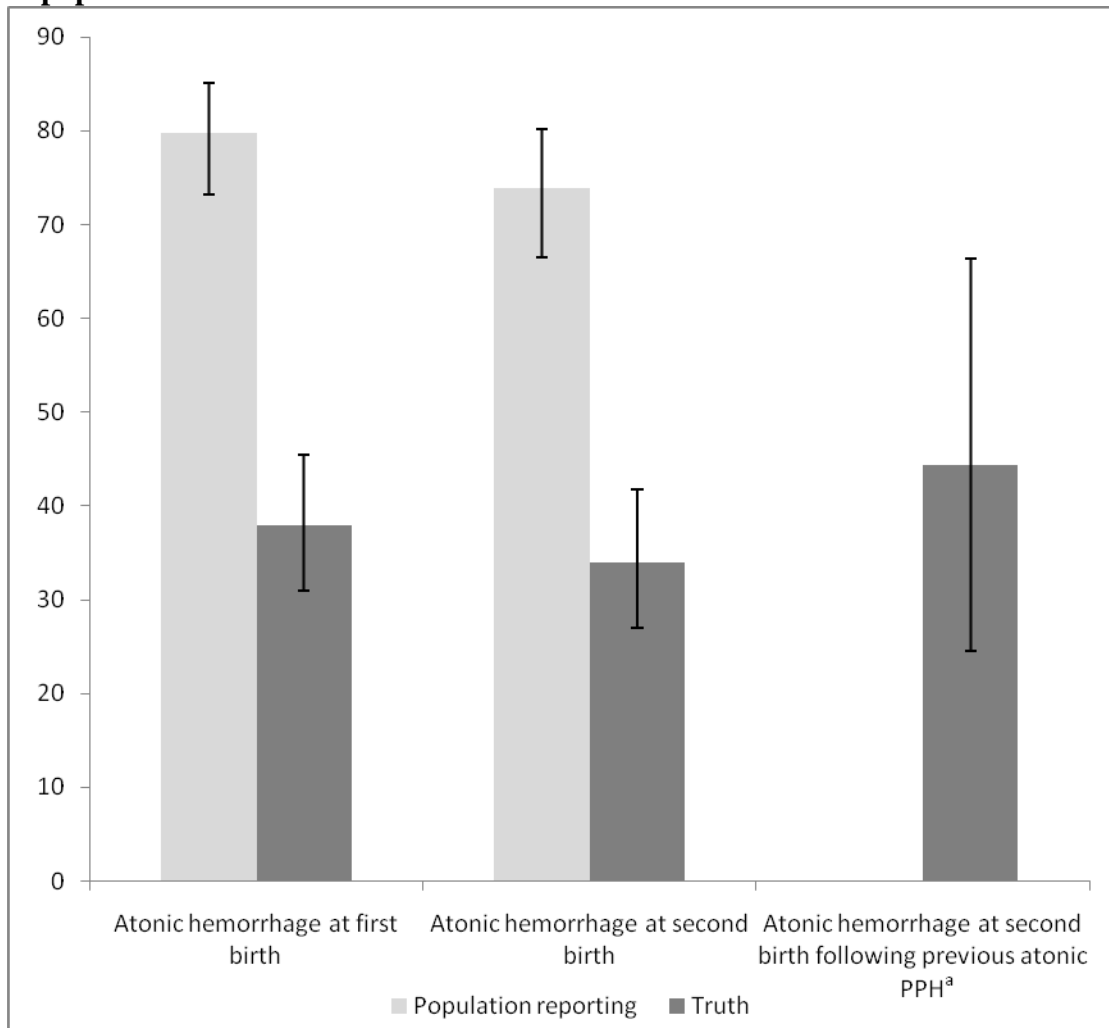
^c Percent of vaginal or instrumental deliveries

Figure 1. Postpartum hemorrhage recurrence rates, coded hospital data reporting compared to truth (audit data)



^a Includes some false positive identification of PPH in first pregnancies

Figure 2. Proportion of postpartum hemorrhages with an atonic cause (by parity) as reported in population data and audit data



^a Where there was a true previous atonic PPH