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Multivariable risk model for postpartum re-presentation with hypertension: development phase

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ABSTRACT

Objectives Postpartum hypertension is one of the leading causes of re-presentation to hospital postpartum and is associated with adverse long-term cardiovascular risk. Postpartum blood pressure monitoring and management interventions have been shown to reduce hospital re-presentation, complications and long-term blood pressure control. Identifying patients at risk can be difficult as 40%–50% present with de novo postpartum hypertension. We aim to develop a risk model for postpartum re-presentation with hypertension using data readily available at the point of discharge.

Design A case–control study comparing all patients who re-presented to hospital with hypertension within 28 days post partum to a random sample of all deliveries who did not re-present with hypertension. Multivariable analysis identified risk factors and bootstrapping selected variables for inclusion in the model. The area under the receiver operator characteristic curve or C-statistic was used to test the model's discriminative ability.

Setting A retrospective review of all deliveries at a tertiary metropolitan hospital in Melbourne, Australia from 1 January 2016 to 30 December 2020.

Results There were 17 746 deliveries, 72 hypertension re-presentations of which 51.4% presented with de novo postpartum hypertension. 15 variables were considered for the multivariable model. We estimated a maximum of seven factors could be included to avoid overfitting. Bootstrapping selected six factors including pre-eclampsia, gestational hypertension, peak systolic blood pressure in the delivery admission, aspirin prescription and elective caesarean delivery with a C-statistic of 0.90 in a training cohort.

Conclusion The development phase of this risk model builds on the three previously published models and uses factors readily available at the point of delivery admission discharge. Once tested in a validation cohort, this model could be used to identify at risk women for interventions to help prevent hypertension re-presentation and the short-term and long-term complications of postpartum hypertension.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Targeted interventions to monitor and manage postpartum blood pressure can reduce hospital re-presentation, complications and long-term blood pressure in at-risk patients. Overall, 40%–50% of patients who present with postpartum hypertension have no previous hypertension diagnosis, making accurate recruitment difficult. Three previous studies have published risk models for postpartum hypertension but they use factors that are not readily available at the point of hospital discharge in many health services.

WHAT THIS STUDY ADDS

⇒ The development phase of a model to predict the risk of postpartum hospital re-presentation with hypertension using data readily available at the point of discharge.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Once externally validated, this model could be used to recruit for postpartum hypertension risk reduction interventions.

INTRODUCTION

Postpartum hypertension is one of the leading potentially preventable causes of re-presentation to hospital post partum.[1–5]

The hypertensive disorders of pregnancy (HDP) affect 5%–10% of pregnancies and are a major cause of maternal morbidity and mortality and increased lifetime cardiovascular risk.[6–9] HDP is an umbrella term including chronic or essential hypertension, gestational hypertension, pre-eclampsia, eclampsia, haemolysis with elevated liver enzymes and low platelets, masked hypertension and white coat hypertension.[6]

Low-dose aspirin taken prior to 20 weeks gestation has been shown to reduce the risk of pre-eclampsia in patients identified as being at risk based on maternal risk factors.[10–12]

Hypertension occurring post partum is an increasingly recognised cause of maternal morbidity including hospital readmission, headache, volume overload, stroke, posterior reversible encephalopathy syndrome, eclampsia, acute kidney injury, hepatic haematoma or rupture and coagulopathy.[1 4 9 13 14]

Uncontrolled hypertension post partum also increases the risk of chronic hypertension and associated long-term cardiovascular risk.[8 15]

Targeted interventions to optimise postpartum blood pressure (BP) have been shown to reduce BP, readmissions and complications in the short-term and also to reduce long-term BP. This may present an opportunity to mitigate long-term cardiovascular risk with a short-term intervention.[4 16–18]

Previous interventions have recruited patients with a known hypertension diagnosis, but 40%–50% of the patients who re-present with postpartum hypertension have no previous HDP diagnosis, or de novo postpartum hypertension, hence the need for a risk model.[8 16]

Several retrospective studies have identified risk factors for hypertension readmission including age, body mass index (BMI), race, nulliparity, HDP diagnosis and BP readings during the delivery admission.[19–21]

Three studies have developed risk models for hypertensive postpartum readmission. None of these models have been externally validated. All three models use race as a risk factor.[19–21] Race information is not routinely collected at our health service and many others. Moreover, recent publications have called into question the appropriateness of using race in clinical algorithms.[22]

Building on the previously published models, this study aims to undertake the development phase of a multivariable model to identify patients at risk of postpartum hospital re-presentation with hypertension using information readily available at the point of hospital discharge.

METHODS

After approval by the Northern Health Ethics Committee, we performed a case–control study comparing patients who re-presented to hospital with hypertension post partum to those who did not. Information on all deliveries from 1 January 2016 to 31 December 2020 at a tertiary metropolitan teaching hospital in Melbourne, Australia, was collected using the decision support unit (DSU) discharge summary coding database and was verified using a structured manual electronic medical records search.

Cases: postpartum hospital re-presentations with hypertension

We considered the definition of a case to be: all patients who re-presented to hospital within 28 days post partum, with either hypertension as the primary diagnosis, or if the investigation or treatment of hypertension was a significant part of the presentation. Re-presentations included presentations to the emergency department and those admitted to the ward.

To identify the cases, we first identified all patients who re-presented to hospital within 28 days post partum for any cause.

The International Classification of Diseases 10th revision (ICD-10) codes for all re-presentations were reviewed and those considered to be potentially related to hypertension were selected for a manual electronic medical records search (online supplemental file 1). We included codes that were clearly hypertension related such as 'pre-existing hypertension complicating pregnancy, childbirth and the puerperium' and 'severe pre-eclampsia' and also included those that were more loosely related such as 'diseases of the circulatory system in pregnancy, childbirth and the puerperium'. We identified 45 ICD-10 codes potentially related to hypertension from within our database.

A manual electronic medical records search of all of these patients identified re-presentations considered to be related to hypertension with either hypertension as the primary diagnosis or if the investigation or treatment of hypertension was a significant part of the admission (figure 1).

In addition to this, the medical records of all ambulatory care hospital in the home (HITH) patients who re-presented to the emergency department were also manually reviewed. These patients are considered admitted to the hospital and, therefore, are not flagged as re-presentations in the DSU database (figure 1).

The HITH programme provides up to twice daily nursing care in the home. Around 5% of all patients are referred post partum mostly for the management of vacuum-assisted closure dressings for caesarean wounds, the delivery of intravenous antibiotics or subcutaneous enoxaparin for those unable to self-inject.

Controls: random sample of all deliveries that did not result in re-presentation with hypertension

The control cohort is a random sample of all patients who did not meet the case definition as defined above.

The control cohort comprised a random sample of n=134 patients for each year of the study (N=670 total).

We performed a manual medical records search on all of the controls. One control was excluded due to duplicate patient/episode, while 4 were excluded as hypertension re-presentations, leaving a total of 665 in the control cohort. Of the five patients removed, there were one from 2016, one from 2017, one from 2018 and two from 2020. Patients were only excluded from the control group if they were duplicates or they met the definition of a case, as defined above, and were included in the case group.

The sample size for each year of the study period was determined to provide an estimated margin of error of ±5% in the prevalence of HDP per year and equates to a case:control ratio of approximately 1:9. The random sample was selected for each year using a random number generator and ranking of samples.

Data collection

Deidentified demographic and medical data for both groups were collected using a manual search of electronic medical records with a structured data collection tool. This was used in addition to information from the birthing outcomes summary system and discharge

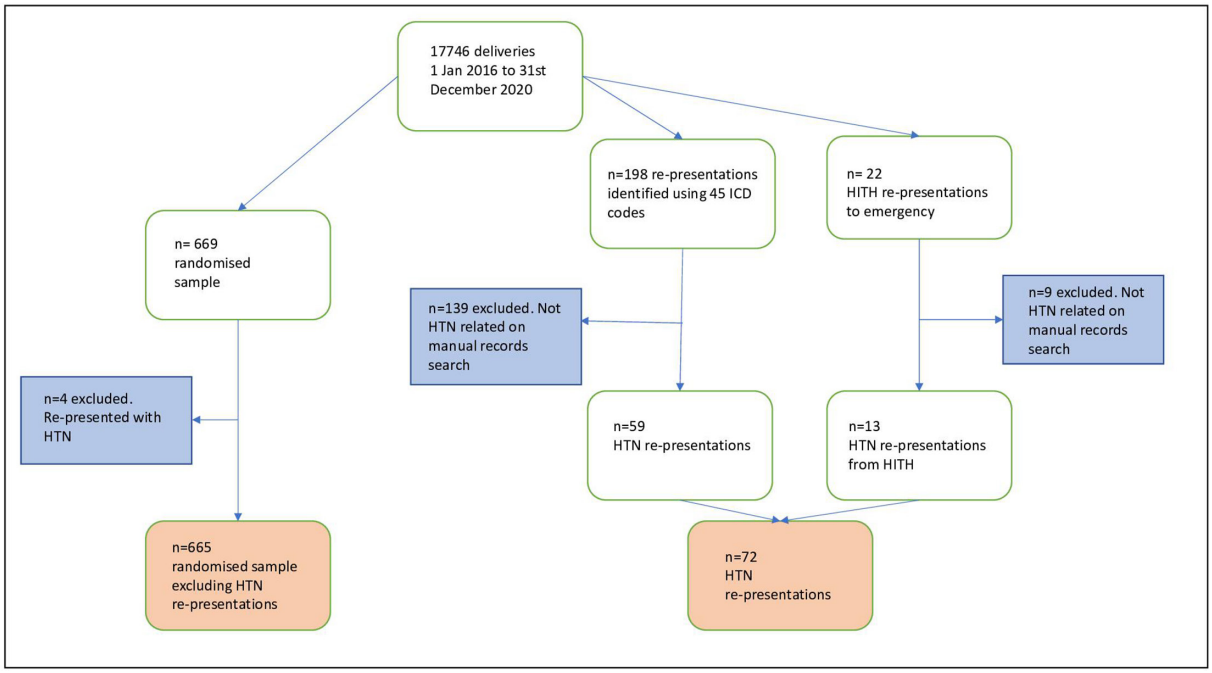

Figure 1 Flow chart for selection of randomised sample controls (left) and hypertension re-presentation cases (right). ICD, International Classification of Disease; HITH, hospital in the home; HTN, hypertension.

summary coding data. The accuracy of coding data was verified with a comparison to manual data collection for the diagnosis of HDP. Three clinicians reviewed the medical records for the re-presentations and randomised sample looking for evidence of documentation of a hypertensive disorder of pregnancy throughout the record and this was compared with the discharge summary coding database in order to verify the accuracy of coding. There was cross-over for a sample of cases to calibrate the clinicians' data collection. Uncertain cases were discussed and consensus formed with the research team.

Fifteen factors considered to be clinically relevant and reproducible at the point of discharge were selected a priori for consideration in the analysis. These factors included: maternal age (categorised as <25, 25–29, 30–34 and ≥35), BMI, grouped HDP: (chronic hypertension, gestational hypertension and pre-eclampsia), peak systolic BP (SBP) and diastolic BP (DBP) during the delivery admission, change in SBP between the last antenatal visit and the peak in the delivery admission, three or more readings of SBP>139 mm Hg or DBP>89 mm Hg, emergency or elective caesarean, gestation at delivery (weeks) (<37, 37–38.9, 39–40.9 and >41), antenatal aspirin prescription and birth weight (categorised: <2950, 2950–3289, 3290–3599 and ≥3600 g).

Statistical analysis

Descriptive analysis was conducted to compare the hypertension re-presentation cases with the no hypertension re-presentations control cohort.

Continuous variables were compared using Student's t-test and discrete variables with Pearson's χ^2. Fifteen variables considered to be clinically significant were selected for a priori for consideration in multivariable analysis.

Based on the sample size available for the case–control study, up to seven variables could be included in the multivariable model, without overfitting. A bootstrapping resampling with replacement method was used to rank the 15 variables selected for consideration based on probability of inclusion for 1000 simulated models. This guided the order of inclusion of variables into the multivariable model in a manual forwards stepwise process, with only statistically significant variables included in the final multivariable model.

The predictive performance and discriminative ability of the model were assessed using the C-statistic via the receiver operating characteristic curve. Statistical analysis was performed using STATA statistical software: release V.17 (StataCorp), with a $p<0.05$ considered to indicate statistical significance.

The first author had full access to all the data and took full responsibility for its integrity and data analysis.

RESULTS

From 1 January 2016 to 31 December 2020, there were 17 746 deliveries at Northern Health. 656 deliveries (3.7%) resulted in re-presentation to hospital, for any cause, within 28 days post partum.

Of the 656 re-presentations, the use of ICD-10 codes identified 198 re-presentations that were potentially related to hypertension, and following a manual electronic medical records search, we identified 59 hospital re-presentations related to hypertension (figure 1).

Twenty-two patients were admitted under the HITH programme who re-presented to emergency. A manual electronic medical records search identified 13 with a re-presentation due to hypertension, resulting in a total

of 72 patients who re-presented to hospital with hypertension within 28 days post partum (0.4% of all 17 746 deliveries).

Testing the accuracy of coding data

An assessment of the accuracy of discharge summary coding for the diagnosis of all grouped HDP diagnoses compared with manual medical records audits found that: to discharge summary coding there was a sensitivity of 92% and specificity of 98%.

Comparison of characteristics

We compared the 72 patients who were readmitted with hypertension to the 656 controls. Patients who were readmitted with hypertension were of greater mean age,

Table 1 Comparison of characteristics based on hypertension re-presentation status, n (%) unless otherwise indicated

Factor	No hypertension Re-presentation	Hypertension Re-presentation	P value
N	665	72	
Maternal age, mean (SD)	30.1 (4.9)	32.2 (5.2)	<0.001
BMI, median (IQR)	26.0 (22.0–30.0)	31.0 (24.0–38.0) (n=71)	<0.001
Parity=0	263 (39.5%)	32 (44.4%)	<0.001
Interpreter	81 (12.2%)	8 (11%)	<0.001
Indigenous	15 (2.3%)	0	<0.001
Refugee	15 (2.3)	0	<0.001
Hypertension diagnosis			
All HDP	34 (5.1%)	35 (48.6%)	<0.001
Chronic hypertension	6 (0.9%)	6 (8.3%)	<0.001
Gestational hypertension	10 (1.5%)	18 (25.0%)	<0.001
Pre-eclampsia	19 (2.9%)	20 (27.8%)	<0.001
HELLP	0 (0.0%)	2 (2.8%)	0.009
Gestational diabetes	147 (22.2%)	23 (31.9%)	0.062
Peak SBP, median (IQR)	130.5 (123.0–140.0) (n=656)	150.0 (140.5–162.0)	<0.001
Peak DBP, median (IQR)	81.0 (75.0–88.0) (n=656)	92.0 (85.0–100.0)	<0.001
Change in SBP, median (IQR)	15.0 (6.0–25.0) (n=648)	22.5 (12.5–31.0) (n=68)	<0.001
≥3 BP readings in hypertensive range	81 (12.2%)	48 (66.7%)	
Aspirin prescription	9 (5.1%)	22 (30.6%)	<0.001
Antihypertensives on discharge from delivery admission	15 (2.3%)	34 (47.2%)	<0.001
Length of stay delivery admission, median (IQR)	2.4 (1.9–3.2) (n=665)	3.3 (2.7–4.9) (n=72)	<0.001
Days between discharge and re-presentation		3.1 (1.4, 5.1)	
Re-presentation (days post partum)	n/a	6.4 (5.0, 8.3)	
Re-presentation length of stay (days)	n/a	1.5 (1.0–2.7)	
Hospital in the home	30 (4.5%)	18 (25.0%)	<0.001
Birth weight, median (IQR)	3300 (2970–3600) (n=665)	3185 (2855–3570) (n=72)	0.13
Gestation (days), median (IQR)	274 (267–280) (n=665)	270 (266–276) (n=72)	0.003
	39 weeks and 1 day	38 weeks and 4 days	
Emergency caesarean	116 (17.4%)	27 (37.5%)	<0.001
Elective caesarean	90 (13.5%)	15 (20.8%)	0.092
Socioeconomic indexes for areas			0.39
First quartile	144 (21.7%)	12 (16.7%)	
Second quartile	311 (46.8%)	40 (55.6%)	
Third quartile	184 (27.7%)	19 (26.4%)	
Fourth quartile	26 (3.9%)	1 (1.4%)	

BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; HDP, hypertensive disorders of pregnancy; HELLP, haemolysis, elevated liver enzymes and low platelets; n/a, not applicable; SBP, systolic blood pressure.

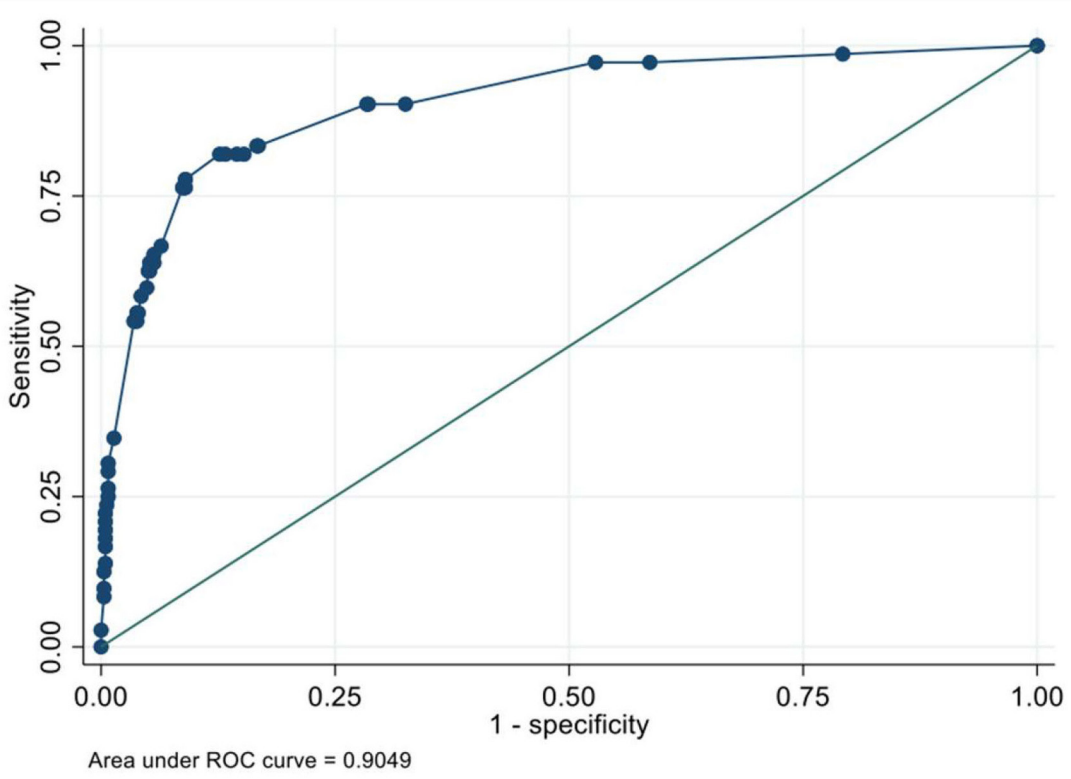

Figure 2 ROC curve. Variables included gestational hypertension, pre-eclampsia, grouped median peak systolic blood pressure in the delivery admission >=3 hypertensive blood pressure readings in the delivery admission, elective caesarean delivery and aspirin prescription. ROC, receiver operating characteristic.

median BMI and only 48.6% had a previous diagnosis of HDP (table 1).

The readmitted patients had a significantly higher peak SBP during their delivery admission with a median of 150 mm Hg compared with 131 mm Hg and were more likely to have sustained elevated BP with three or more hypertensive BP readings (66.7% vs 12.2%, p<0.001) (table 1).

The median duration of re-presentation to hospital was 1.5 days with 53 of the 72 patients staying more than 24 hours (table 1).

The year-to-year rates of re-presentation with hypertension from 2016 to 2020 were 0.2%, 0.4%, 0.4%, 0.3%, 0.8% of all deliveries, respectively. There was an increase in aspirin prescription over the study period starting with 0.9%, 1.0%, 1.2%, 2.3% and 3.1%. There was also an increase in the proportion of the re-presentations being prescribed aspirin with 12.5%, 15.4%, 33.3%, 50.0% and 34.6% yearly from 2016 to 2020 compared with 0.7%, 0.7%, 0.7%, 1.5% and 3.0% in the patients who did not re-present with hypertension.

Multivariable model

Fifteen factors were considered for multivariable analysis based on their statistical significance and clinical relevance based on previous studies.[1 19–21 23]

Bootstrapping identified six variables for inclusion in the final model with a C-statistic of 0.904 (95% CI 0.863 to 0.944) (figure 2). The factors included in the final multivariable model were gestational hypertension (OR 5.27, 95% CI 1.49 to 18.67), pre-eclampsia (OR 3.57, 95% CI 1.36 to 9.38), peak SBP during delivery admission (peak SBP 150+: OR 8.19, 95% CI 2.29 to 29.29 vs <125 as reference category), 3 or more hypertensive BP readings during delivery admission (OR 2.57, 95% CI 1.05 to 6.29), antenatal aspirin use (OR 19.44, 95% CI 5.79 to 65.33) and elective caesarean (OR 2.41, 95% CI 1.10 to 5.28) (table 2). While patients who re-presented with hypertension were more likely to have had an emergency (37.5%) rather than elective (20.5%) caesarean, the inclusion of elective caesarean led to a higher performing multivariable model due to emergency caesarean being more strongly connected to other factors such as peak SBP and a diagnosis of pre-eclampsia.

DISCUSSION

We confirmed findings from previous studies that women who re-present with hypertension are older, of greater BMI, more likely to have an existing diagnosis of HDP, higher peak SBP during the delivery admission, more likely to be prescribed aspirin and to have a caesarean delivery (table 1).[1–4 19–21 23 24]

Our study also showed that hypertension re-presentation patients had a greater median increase in SBP from the most recent antenatal visit to the delivery admission peak SBP (22.5 mm Hg vs 15 mm Hg) and were more

Table 2 Multivariable model

Factor	OR	95% CI	P value
Gestational hypertension	5.27	1.49 to 18.67	0.010
Pre-eclampsia	3.57	1.36 to 9.38	0.010
Median, peak SBP group			
<125	1	–	–
125–131.9	1.29	0.36 to 4.57	0.698
132–139.9	2.86	0.80 to 10.29	0.108
140–149.9	3.84	1.14 to 12.97	0.030
150+	8.19	2.29 to 29.24	0.001
Unknown	–	–	–
≥3 BP readings with >139 SBP or >89 DBP	2.57	1.05 to 6.29	0.038
Elective caesarean	2.41	1.10 to 5.28	0.028
Aspirin	19.44	5.79 to 65.33	<0.001

BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic Blood pressure.

likely to have 3 or more hypertensive BP readings during the delivery admission (66.7% vs 12.2%) (table 1).

We present a potential risk model for postpartum hypertension re-presentation using six factors readily available at the point of discharge (table 2). The model discriminates between those who are readmitted with hypertension and those who are not with a C-statistic of 0.9 in a training cohort.

There are three previously published risk models with C-statistics ranging from 0.83-0.85 in training cohorts. Our model had a C-statistic 0.9, which suggests it may be more reliable but these findings need external validation.[19–21] (figure 2).

Four of the six factors in our model are also included in the previously published models. These are gestational hypertension, pre-eclampsia, peak SBP in the delivery admission and elective caesarean.[19–21] Being conducted on a different continent, this study expands on the generalisability of a similar model to different populations.

In addition to these factors, we have included a measure of sustained hypertension (≥3 hypertensive BP readings in the delivery admission) and aspirin prescription. These may have provided additional means of identifying patients who are at risk of postpartum hypertension.

In our health service, aspirin is initiated according to a guideline based on a risk model first published in 2013.[10] This guideline recommends aspirin for antenatal women <20 weeks with one high risk or two moderate risk factors for pre-eclampsia at was initiated at our health service in 2017 (online supplemental file 2). Aspirin has likely been identified as a risk factor for re-presentation not due to an effect of the medication itself, which is used to reduce the risk of pre-eclampsia, but because patients are being selected for aspirin prescription due to their underlying risk factors.[12]

We reported a rate of hypertension re-presentation at 0.4% of all deliveries and ranging from 0.2% to 0.8% during the study period. This is consistent with previously reported rates ranging from 0.4% to 1.3%.[19 21] We also confirmed the previously reported finding that close to half (51.4%) of postpartum hypertension re-presentations do not have a previous diagnosis of HDP (de novo postpartum hypertension).[25]

We also found that patients who re-presented with hypertension were more likely to have been admitted under the HITH programme with 18 of 72 (25.0%) re-presentations being admitted under HITH compared with 30 of the 665 (4.5%) patients who did not re-present with hypertension.

This is likely due to shared risk factors between the indications for HITH (wound complications, infections and the need for therapeutic or prophylactic anticoagulation) and postpartum hypertension including increased age, BMI and comorbidities.[23] BP monitoring or management was not an indication for HITH. The HITH patients also have regular monitoring of their BP at their home visits and may have increased opportunity to discover hypertension and be referred to hospital. At the time of the study, there was no formal escalation pathway for managing postpartum hypertension in the community.

LIMITATIONS

Being a retrospective study limits the accuracy of our patient selection and the data collection. The HDP are clinical diagnoses and we are limited by the accuracy of clinical documentation and the subsequent interpretation by non-clinical coding staff.

The lack of matching of the controls to cases by time of delivery for inclusion may limit the accuracy of the model as there was an increased rate of re-presentation and also more aspirin prescription in the later years of the study. Matching on other variables would not be applicable as we were looking for differences in characteristics in order to determine risk. The most comprehensive previously published risk model was conducted over a similar time period and also did not match for the time of delivery.[21]

The selection of the randomised sample prior to identifying and removing the cases duplicates meant that the final randomised sample was reduced to 665 from 670, which may reduce the accuracy compared with what was initially intended.

To externally validate this risk model for use, it should be tested in a validation cohort in another health service.

The model also favours patients who have had antenatal care prior to 20 weeks and have had the opportunity to be prescribed aspirin. For the external validation, using the result of the aspirin prescription guideline (online supplemental file 2) instead of aspirin prescription would ensure we capture patients regardless of their gestation at first contact with the health service. We were unable to do this in our study due to the information not being reliably available retrospectively.

The rate of postpartum hypertension may be underestimated as there is no formal recommendation for postpartum BP monitoring for non-hypertensive patients prior to 6 weeks post partum.

While there are several studies that look at trends in postpartum BP in patients admitted to hospital and at home BP in patients with known hypertension, there is a paucity of evidence looking at BP in the postpartum period for women without a previous diagnosis of hypertension who are not admitted to hospital.[8 9 16 26] The rate of re-presentation with postpartum hypertension we reported was 0.4%. This is at the lower end of the previously reported re-presentation rate of 0.4%–1.3% and may suggest that patients are presenting to other health services but we do not have a centralised database to access this information.

FUTURE DIRECTIONS

The next phase is an external validation of the model, to validate the findings and set weightings and thresholds. Once validated, the model could be used to help target women for programmes to reduce the risk of readmission and the short and long-term complications of postpartum hypertension.

There is further work to be done in understanding de novo postpartum hypertension. This includes looking at the prevalence in patients who do not re-present to hospital and to understanding if diagnosing and managing this condition could have an impact on lifetime cardiovascular risk in addition to patients with known HDP.

CONCLUSION

We present the development phase of a risk model for postpartum re-presentation to hospital with hypertension using information readily available at the point of discharge. After external validation, the model could be used to identify women at risk of re-presentation to hospital and the short and long-term complications of postpartum hypertension.

Contributors DL was the supervisor for all stages of the project. HEM developed the research question, formed and managed the database, coordinated the medical records search, engaged the statistician and wrote the paper. HEM is the guarantor. NO and GY worked on the manual medical records search and were involved in reviewing and discussing the writing of the paper. GY contributed to the literature review and the data analysis. MT did the statistical analysis.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

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Data availability statement Data are available on reasonable request.

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Supplement 1, ICD-10 Codes for Re-Presentations Potentially Related to Hypertension

E87.7	Fluid overload
E88.0	Disorders of plasma-protein metabolism, not elsewhere classified
G40	Epilepsy
G40.4	Other generalised epilepsy and epileptic syndromes, without mention of intractable epilepsy
G43.9	Migraine, unspecified
G44.2	Tension-type headache
G971	Other reaction to spinal and lumbar puncture, headache
H53.4	Visual field defects
H53.8	Other visual disturbances
H57.1	Ocular pain
I10	Essential (primary) hypertension
I21.4	Acute subendocardial myocardial infarction
I42.0	Dilated cardiomyopathy
I50.0	Congestive heart failure
I67.4	Hypertensive encephalopathy
I67.8	Other specified cerebrovascular diseases
I95.2	Hypotension due to drugs
I95.8	Other hypotension
I95.9	Hypotension, unspecified
N17.9	Acute kidney failure, unspecified
N19	Unspecified kidney failure
O10	Pre-existing hypertension in pregnancy, childbirth and the puerperium
O11	Pre-eclampsia superimposed on chronic hypertension
O14.1	Severe pre-eclampsia
O14.2	HELLP syndrome
O14.9	Pre-eclampsia, unspecified
O15.2	Eclampsia in the puerperium
O16	Unspecified maternal hypertension
O268	Kidney disorders in pregnancy, childbirth and the puerperium
O89.4	Spinal and epidural analgesia induced headache during the puerperium
O90.3	Cardiomyopathy in the puerperium
O90.4	Postpartum acute kidney failure
O99.4	Diseases of the circulatory system in pregnancy, childbirth and the puerperium
O99.4	Diseases of the circulatory system complicating pregnancy, childbirth and the puerperium
R03.0	Elevated blood pressure reading without diagnosis of hypertension
R07.1	Chest pain on breathing
R07.2	Precordial pain
R07.3	Other chest pain
R07.4	Chest pain, unspecified
R42	Dizziness and giddiness
R51	Headache
R55	Syncope and collapse
R57.0	Cardiogenic shock
T88.5	Headache due to anaesthesia

Y52.1	Calcium-channel blockers causing adverse effects in therapeutic use

Supplement 2, ICD-10 (international classification of diseases 10th revision) codes within the re-presentations database potentially related to post-partum hypertension. Used to select for manual medical record review.

Supplement 2, Northern Health, Antenatal Booking Checklist and Risk Assessment, last update 05/08/2021

Indications for Aspirin + Calcium < 16 weeks (Still commence if 16 – 20 weeks) Aspirin 150mg nocte + Calcium 1500mg daily until 36 weeks : ***Midwife to initiate at first visit**			
❑ 1x High Risk Factor **OR**		❑ ≥ 2 Moderate Risk factors	
Hypertensive disorders: HT, previous pre-eclampsia or HELLP		Maternal age ≥40 years	
Chronic kidney disease		BMI ≥ 35	
BMI ≥ 40		Family Hx of pre-eclampsia	
Early GDM / T1 or T2 DM		Assisted reproduction -IVF	
Early onset (<34wks) FGR in previous pregnancy		Multiple pregnancy	
Autoimmune disease		PAPP-A <0.40	
Antiphospholipid Syndrome			

Supplement 2, Risk assessment tool for antenatal aspirin prescription at Northern Health. HT = hypertension, HELLP = haemolysis, elevated liver enzymes and low platelets, BMI = body mass index, GDM = gestational diabetes mellitis, FGR = fetal growth restriction, IVF = invitro fertilisation, PAPP-A = pregnancy associated plasma protein A.