Centre universitaire de santé McGill

McGill University Health Centre

L'Unité d'évaluation des technologies et des modes d'intervention en santé (UETMIS) du Centre Universitaire de Santé McGill (CUSM)

20 February 2024

Management of Severe Hypertension in Pregnancy and Postpartum at the McGill University Health Centre

Health Technology Assessment Report
Evaluation of Current Practice: Impact Assessment
Report no. 95

Report prepared for the Technology Assessment Unit (TAU) of the McGill University Health Centre (MUHC)

by

Thiphavone Oudanonh, Eva Suarthana, MD, PhD, and Nisha Almeida, PhD

Mission Statement

The MUHC Health Technology Assessment Unit (TAU) advises hospital administrators and clinical teams in difficult resource allocation decisions. Using an approach based on independent, critical evaluations of the available scientific evidence and a transparent, fair decision-making process, novel and existing medical equipment, drugs and procedures used by healthcare professionals are prioritized on a continuous basis ensuring the best care for life with the best use of resources.

Impact Assessment Reports

Impact assessment reports are undertaken to evaluate the impact of a change in practice on patient outcomes and performance indicators. They include statistical analyses of data issuing from local quality improvement initiatives. They are reviewed by the Manager of TAU and the Chair of the Policy Committee, but are not submitted to or approved by the Policy Committee, and contain no recommendations.

Declaration of Conflicts of Interest

Members of TAU's research staff and policy committee declare no conflicts of interest.

Suggested Citation

Thiphavone Oudanonh, Eva Suarthana, Nisha Almeida. Montreal (Canada): Management of Severe Hypertension in Pregnancy and Postpartum at the McGill University Health Centre. Technology Assessment Unit (TAU) of the McGill University Health Centre (MUHC); February 20, 2024. Report no 95.

REPORT REQUESTOR

TAU received a request from Dr. Isabelle Malhamé from the Department of Medicine of the McGill University Health Centre in March 2023 to conduct statistical analyses to evaluate the impact of their quality improvement intervention at the MUHC for the management of severe hypertension during pregnancy and postpartum.

DISCLAIMER

The Technology Assessment Unit ("TAU") of the McGill University Health Centre ("MUHC") was created in order to prepare accurate and trustworthy evidence to inform decision-making and when necessary to make policy recommendations based on this evidence. The objective of the TAU is to advise the hospitals in difficult resource allocation decisions, using an approach based on sound, scientific technology assessments and a transparent, fair decision-making process. Consistent with its role within a university health centre, it publishes its research when appropriate, and contributes to the training of personnel in the field of health technology assessment.

The information contained in this report may include, but is not limited to, existing public literature, studies, materials, and other information and documentation available to the MUHC at the time it was prepared, and it was guided by expert input and advice throughout its preparation. The information in this report should not be used as a substitute for professional medical advice, assessment and evaluation. While MUHC has taken care in the preparation of this report to ensure that its contents are accurate, complete, and up to-date, MUHC does not make any guarantee to that effect. MUHC is not responsible for any liability whatsoever, errors or omissions or injury, loss, or damage arising from or as a result of the use (or misuse) of any information contained in or implied by the information in this report.

We encourage our readers to seek and consult with qualified health care professionals for answers to their personal medical questions. Usage of any links or websites in the report does not imply recommendations or endorsements of products or services.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

SUMMARY

BACKGROUND

Dr. Isabelle Malhamé from the Department of Medicine and her team conducted a quality improvement project at the MUHC for the management of severe hypertension (i.e., sustained blood pressure [BP] elevations [160/110 mm Hg]) during pregnancy and postpartum. The intervention, implemented in September 2021, included institutional protocols to manage severe hypertension and educational activities to train staff on best practices. The primary outcome was time-to-target blood pressure (minutes) i.e. time taken from confirmed severe BP measurement of 160/110 mm Hg to achieve blood pressure < 160/110 mmHg.

OBJECTIVE

In March 2023, TAU received a request from Dr. Malhamé to conduct statistical analyses, including descriptive and interrupted time series (ITS) analyses, to evaluate the impact of their quality improvement intervention on improving time-to-target blood pressure in pregnant women with an obstetric hypertensive emergency.

METHODS

TAU performed standard descriptive analyses and an interrupted time series analysis to evaluate the impact of the intervention on quality indicators for the management of obstetric hypertension before and after intervention. Dr. Malhamé and her team manually extracted data from MUHC's electronic health records (OACIS). TAU helped with data management and verification before conducting the analyses.

The primary outcome was time to target BP, which was defined as the time from confirmed severe blood pressure measurement of ≥160/110 mm Hg to goal blood pressure measurement of < 160/110 mmHg.

We used a segmented interrupted time series (ITS) analysis to compare the average monthly time-to-target blood pressure (BP) before and after implementation of the intervention. An ITS model can evaluate whether there was an immediate impact of the intervention (level change) and a sustained effect over time (slope change).

RESULTS

A cohort of 134 patients (n=56 in pre-intervention and n=78 in post-intervention) diagnosed with an obstetric hypertensive emergency from September 1st, 2020 to August 31st, 2022 were included in the main analysis.

Cross-sectional before/after analysis:

The median (interquartile range [IQR]) of the time-to-target BP was 49.5 (28.0, 69.8) minutes in the pre-intervention and 33.5 (19.8, 65.2) minutes in the post-intervention group. Time-to-target blood pressure within 60 minutes was met in 64.3% of patients in the pre-intervention and 74.4% in the post-intervention group (p=0.209).

ITS analysis:

Before the implementation of the intervention, the average time-to-target BP was approximately 55 minutes per patient per month and was constant over time, i.e. it did not decrease significantly in the pre-intervention period (-0.25 minutes, 95% CI: -3.46, 2.96). An immediate decrease of 21 minutes (95% CI: -52.76, 10.18) in the average time-to-target BP was associated with the intervention, though it was not statistically significant. The upward trend following the implementation of the intervention was also not significant (2.7 minutes, 95% CI: -1.84, 7.23). Similar results were obtained in the post-hoc analyses for the 2 additional outcomes, in the subgroup of women with preeclampsia and in cohort with the extended post-intervention period.

CONCLUDING REMARKS

Our analyses indicate that the intervention was not associated with a significant reduction in time-to-target BP in the post-intervention period. This could be explained by the complexity of implementing educational interventions and sustaining them over time.

Key Takeaways for the MUHC

When evaluating the impact of improvement initiatives, it is important to emphasize the following:

- Necessity of support for knowledge translation and change management activities to sustain change;
- Importance of data infrastructure enabling the prospective collection of electronic data;
- Importance of collecting socio-economic and race/ethnicity data to measure the impact of structural and social determinants of health on patient care.

SOMMAIRE

Contexte

La Dre Isabelle Malhamé du Département de médecine et son équipe ont mené un projet d'amélioration de la qualité au CUSM pour la prise en charge de l'hypertension sévère (c.-à-d. des élévations soutenues de la pression artérielle [160/110 mm Hg]) pendant la grossesse et le post-partum. L'intervention, mise en œuvre en septembre 2021, comprenait des protocoles institutionnels pour gérer l'hypertension sévère et des activités éducatives pour former le personnel aux meilleures pratiques. Le principal résultat était le temps nécessaire pour atteindre la pression artérielle cible (en minutes), c'est-à-dire le temps nécessaire pour atteindre une pression artérielle < 160/110 mm Hg à partir d'une mesure confirmée de la pression artérielle sévère de 160/110 mm Hg.

Objectif

En mars 2023, TAU a reçu une demande de la Dre Malhamé pour effectuer des analyses statistiques, y compris des analyses descriptives et des analyses de séries chronologiques interrompues, afin d'évaluer l'impact de leur intervention d'amélioration de la qualité sur le délai d'atteinte de la pression artérielle cible chez les femmes enceintes présentant une urgence hypertensive obstétricale.

Méthodes

L'équipe de TAU a effectué des analyses descriptives standard et une analyse de séries chronologiques interrompues pour évaluer l'impact de l'intervention sur les indicateurs de qualité de la prise en charge de l'hypertension obstétricale avant et après l'intervention. La Dre Malhamé et son équipe ont extrait manuellement les données des dossiers médicaux électroniques du CUSM (OACIS). L'équipe de TAU a aidé à la gestion et à la vérification des données avant de procéder aux analyses.

Le principal résultat était le temps nécessaire pour atteindre la pression artérielle cible, qui était défini comme le temps écoulé entre la mesure confirmée de la pression artérielle sévère de ≥ 160/110 mm Hg et la mesure de la pression artérielle cible de < 160/110 mm Hg.

Nous avons utilisé une analyse de séries chronologiques interrompues segmentées (ITS) pour comparer le temps mensuel moyen nécessaire pour atteindre la pression artérielle cible avant et après la mise en œuvre de l'intervention. Un modèle ITS peut évaluer s'il y a eu un impact immédiat de l'intervention (changement de niveau) ou un effet soutenu dans le temps (changement de pente).

Résultats

Une cohorte de 134 patientes (n=56 en pré-intervention et n=78 en post-intervention) diagnostiquées avec une urgence hypertensive obstétricale du 1er septembre 2020 au 31 août 2022 a été incluse dans l'analyse principale.

Analyse transversale avant/après :

La médiane (écart interquartile) du temps nécessaire pour atteindre la PA cible était de 49,5 (28,0, 69,8) minutes dans le groupe pré-intervention et de 33,5 (19,8, 65,2) minutes dans le groupe post-intervention. Le temps nécessaire pour atteindre la PA cible dans les 60 minutes a été atteint chez 64,3 % des patientes du groupe pré-intervention et 74,4 % du groupe post-intervention (p=0,209).

Analyse de séries chronologiques interrompues :

Avant la mise en œuvre de l'intervention, le délai moyen pour atteindre la pression artérielle cible était d'environ 55 minutes par patiente par mois et était constant au fil du temps (-0,25 minute, intervalle de confiance (IC) de 95 % : -3,46, 2,96). Une diminution immédiate de 21 minutes (IC de 95 % : -52,76, 10,18) du délai moyen pour atteindre la PA cible a été associée à l'intervention, bien qu'elle ne soit pas statistiquement significative. La tendance à la hausse suivant la mise en œuvre de l'intervention n'était pas non plus statistiquement significative (2,7 minutes, IC de 95 % : -1,84, 7,23). Des résultats similaires ont été obtenus dans les analyses post-hoc pour les 2 résultats supplémentaires, dans le sous-groupe de femmes atteintes de prééclampsie et dans la cohorte avec la période post-intervention prolongée.

Remarques finales

Nos analyses indiquent que l’intervention n’a pas été associée à une réduction significative du délai d’atteinte de la pression artérielle cible dans la période post-intervention. Cela pourrait s’expliquer par la complexité de la mise en œuvre des interventions éducatives et de leur maintien dans le temps.

Principaux points à retenir

Lors de l'évaluation de l'impact des initiatives d'amélioration, il est important de souligner les points suivants :

- La nécessité de soutenir les activités de transfert des connaissances et de gestion du changement pour accompagner le changement ;
- L'importance d'une infrastructure de données permettant la collecte prospective de données électroniques ;
- L'importance de la collecte de données socioéconomiques et de données sur la race et l'ethnicité pour mesurer l'impact des déterminants structurels et sociaux de la santé sur les soins aux patients.

LIST OF ABBREVIATIONS

BP	Blood Pressure
CI	Confidence interval
ITS	Interrupted time series
IQR	Interquartile range
MUHC	McGill University Health Centre
OHE	Obstetrics Hypertensive Emergency
TAU	Technology Assessment Unit

MANAGEMENT OF SEVERE HYPERTENSION IN PREGNANCY AND POSTPARTUM AT THE MCGILL UNIVERSITY HEALTH CENTRE

1. BACKGROUND

Dr. Isabelle Malhamé from the Department of Medicine and her team conducted a quality improvement project for the management of severe hypertension (i.e., sustained blood pressure [BP] elevations [≥160/110 mm Hg]) during pregnancy and postpartum at the McGill University Health Centre (MUHC) (1)(2).

The population, intervention, comparator, and outcome are described below. The intervention was based on a previous study identifying process issues related to the immediate management of obstetrics hypertensive emergency (OHE) at the MUHC (1).

Population	Women with a hypertensive disorder of pregnancy and at least 1 episode of severe hypertension during pregnancy and postpartum at the MUHC were compared before and after implementation of the intervention
Intervention period	Sept 1, 2021- August 31, 2022 Intervention: Institutional protocol to manage severe hypertension and knowledge activities implemented starting September 1st, 2021 as described in Figure 1
Comparator period	Sept 1, 2020- August 31, 2021
Primary Outcome	Time-to-target blood pressure in minutes: time taken from confirmed severe BP measurement of ≥160/110 mm Hg to achieve blood pressure < 160/110 mmHg as a continuous variable and dichotomized using 60 minutes cut-off. Figure 2 illustrates the outcome definitions.

2. REQUEST

In March 2023, TAU received a request from Dr. Malhamé to conduct statistical analyses, including descriptive and interrupted time series (ITS) analyses, to evaluate the impact of their quality improvement intervention.

3. METHODS

3.1 Descriptive analysis

Dr. Malhamé and her team manually extracted data from the OACIS, the electronic health record system at the MUHC. TAU helped with data management and verification before conducting the analyses.

Participant baseline characteristics and outcomes were described in percentages and means with standard deviation (SD) or medians with interquartile range (IQR), as appropriate.

To identify risk factors for non-adherence to best practice guidelines (i.e., achievement of time-to-target blood pressure within 60 minutes), potential predictors defined a priori were compared between patients with and without time-to-target blood pressure within 60 minutes using Chi-square or Fisher's exact test for categorical variables, and Mann-Whitney U test or t-test for continuous variables. Potential predictors examined included parity, smoking status, types and symptoms of the hypertensive disorder of the pregnancy, use of artificial reproductive technology, medical comorbidities, blood pressure values at the time of OHE, timing of OHE in relation to delivery, use of antihypertensive medications prior to hospital admission, and type of antihypertensive therapy administered to treat OHE. Information on smoking status were missing in 11 (8.2%) subjects, while methods of conception was missing in 13 (9.7%) of the subjects. Otherwise, the dataset was complete. Missing values were not included in the analyses. 95% and p-values were computed for each statistic. Statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS, Version 27, 2020, IBM, NY).

3.2 Interrupted time series (ITS) and post-hoc analysis

We used a segmented interrupted time series (ITS) analysis to compare the average monthly time-to-target blood pressure (BP) before and after implementation of the intervention. Interrupted time series methods use aggregate data collected over equally spaced intervals before and after an intervention, with the key assumption that data trends before the intervention can be extrapolated to predict trends had the intervention not occurred (4). An ITS model can evaluate whether there was an immediate impact of the intervention (level change) or a sustained effect over time (slope change).

There are 3 variables in an ITS model: the time variable (change in outcome over time); the intervention variable (pre-intervention period=0 and post-intervention=1), and an

interaction term between the 2 (time x intervention) to detect if the rate of change in outcome (slopes) differed before vs after the intervention.

- **Intervention effect (level change)** variable coefficient: Shows the immediate impact of the intervention.
- **Time effect** variable coefficient: Shows the rate of change for the pre-intervention period (because interaction term is 0 when pre-intervention=0).
- **Post-intervention effect** variable (interaction term): Shows the difference in slopes between pre and post-intervention period.

In our study, we aggregated BP data over each month to obtain time series plots of trends in outcome measures over the 2 time periods (pre and post-intervention).

Given that the clinical team hypothesized that the intervention would have an immediate impact on time-to-target BP, we did not incorporate a time lag following the intervention start date. The small sample size of the study population prevented us from including covariates in the regression models, and hence models were unadjusted. Time-to-target BP was defined as the difference between time of confirmed severe BP and time when BP < 160/110 mmHg (Figure 1). Autocorrelation was verified by examining the autocorrelation function plot.

3.2.1 Post-hoc analyses

Post-hoc analyses were conducted to explore potential explanations of the results:

- Two other outcomes were assessed with the same statistical method:
    - The difference between time of first BP checkup and time of confirmed severe BP (Figure 1);
    - The difference between time from first BP checkup and time when BP < 160/110 mmHg (Figure 1).
- In addition, the 3 outcomes were assessed in a subset of patients with pre-eclampsia (n=110/134) given that women with pre-eclampsia were more prevalent in the post-intervention period.
- Finally, all outcomes were also assessed in a cohort comprising of all patients from the main analysis and patients with a post-intervention period extended up to 30-November 2022.

All analyses were conducted with the software R version 4.3.1.

4. RESULTS

4.1 Cross-sectional before-after analysis

A cohort of 134 patients (n=56 in pre-intervention and n=78 in post-intervention) diagnosed with an obstetric hypertensive emergency from September 1st, 2020 to August 31st, 2022 were included in the main analysis. Median time-to-target BP was 49.5 minutes (IQR [28.0, 69.8]) pre-intervention vs. 33.5 minutes (IQR [19.8, 65.2]) post-intervention (p=0.102). Time-to-target blood pressure within 60 minutes was met in 64.3% of patients in the pre-intervention and 74.4% in the post-intervention group (p=0.209).

4.2 ITS and post-hoc analysis

Before the implementation of the intervention, the average time-to-target BP was approximately 55 minutes per patient per month and there was no significant decrease over time (-0.25 minutes, 95% CI: -3.46, 2.96). An immediate decrease of 21 minutes (95% CI: -52.76, 10.18) in the average time-to-target BP was associated with the implementation of the intervention, though it was not statistically significant (Figure 3). The upward trend following the implementation of the intervention was also not significant (2.7 minutes, 95% CI: -1.84, 7.23). Similar results were obtained in the post-hoc analyses for the 2 additional outcomes, in the subgroup of women with preeclampsia and in cohort with the extended post-intervention period (Table 1).

5. DISCUSSION AND CONCLUDING REMARKS

Our analyses indicate that the intervention was not associated with a significant reduction of the time-to-target BP in the post-intervention period. This could be explained by the complexity in implementing educational interventions and sustaining them over time (Figure 4), including the following factors:

- Measurement error: Measurement and reliable recording of time to target BP could be impacted by presentation of severe disease, cesarean section, type and timing of medication.

- Implicit bias: Patient characteristics such as race/ethnicity, socio-economic status, social deprivation index, and immigration status could impact type and timing of care received care.
- Random error: The ITS analysis for this study was impacted by the low number of data points per month.

6. PRINCIPAL TAKEAWAYS FOR THE MUHC

When evaluating the impact of improvement initiatives, it is important to emphasize the following:

- Necessity of support for knowledge translation and change management activities to sustain change;
- Importance of data infrastructure enabling the prospective collection of electronic data;
- Importance of collecting socio-economic and race/ethnicity data to measure the impact of structural and social determinants of health on patient care.

REFERENCES

1. Trahan MJ, Plourde M, Wou K, Huroy M, Itani R, Pavilanis A, et al. Identifying Targets to Improve the Management of Severe Hypertension in Pregnancy and Postpartum. J Obstet Gynaecol Can. 2023;45(6):402-9.

2. Trahan M-J., Plourde M., Clouatre A., Wou K., Pavilanis A., Fortune R-L., Haas S., Pepin J., Kapellas S., Morency A-M., Aucoin G., Flannery A., Monast P-O., Hassan N., Koolian M., Oudanonh T., Almeida N., Suarthana E., Daskalopoulou S. S., Malhamé I. Improving the Management of Severe Hypertension in Pregnancy and Postpartum. *In preparation*

3. ACOG Committee Opinion No. 767: Emergent Therapy for Acute-Onset, Severe Hypertension During Pregnancy and the Postpartum Period. Obstetrics and gynecology. 2019;133(2):e174-e80

4. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther. 2002;27(4):299-309

FIGURES

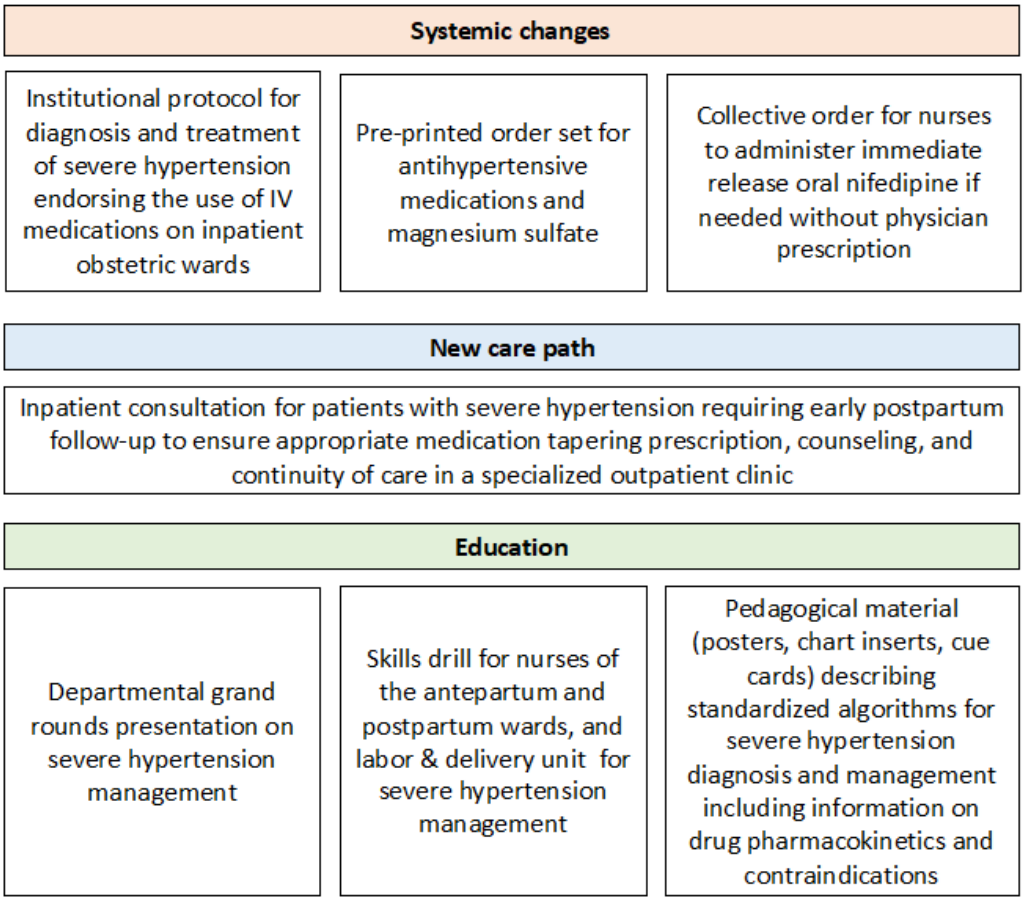

Figure 1. Systemic changes and knowledge activities to manage severe hypertension at the MUHC, starting September 1st, 2021.
Pedagogical materials were circulated after September 2021 and skill drill for nurses were done in May 2022.

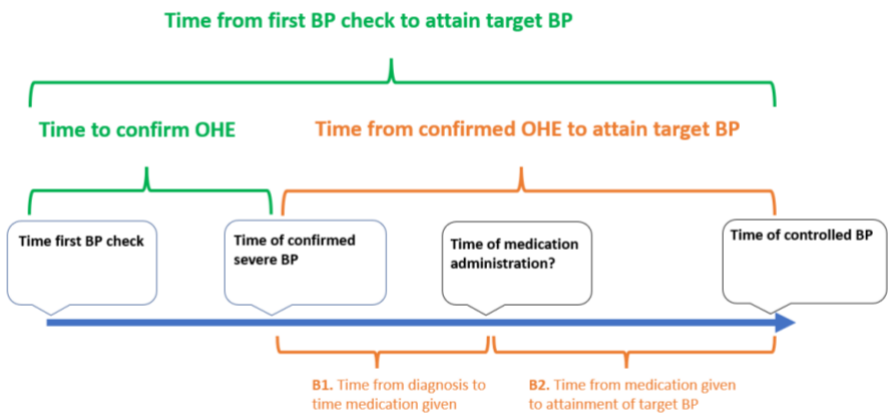

Figure 2. Diagram illustrating the outcome definition
Main outcome (in orange): Time from confirmed obstetrics hypertensive emergency (OHE) to attain target blood pressure (BP). Post-hoc outcomes (in green): Time to confirmed OHE, Time from first BP check to attain target BP.

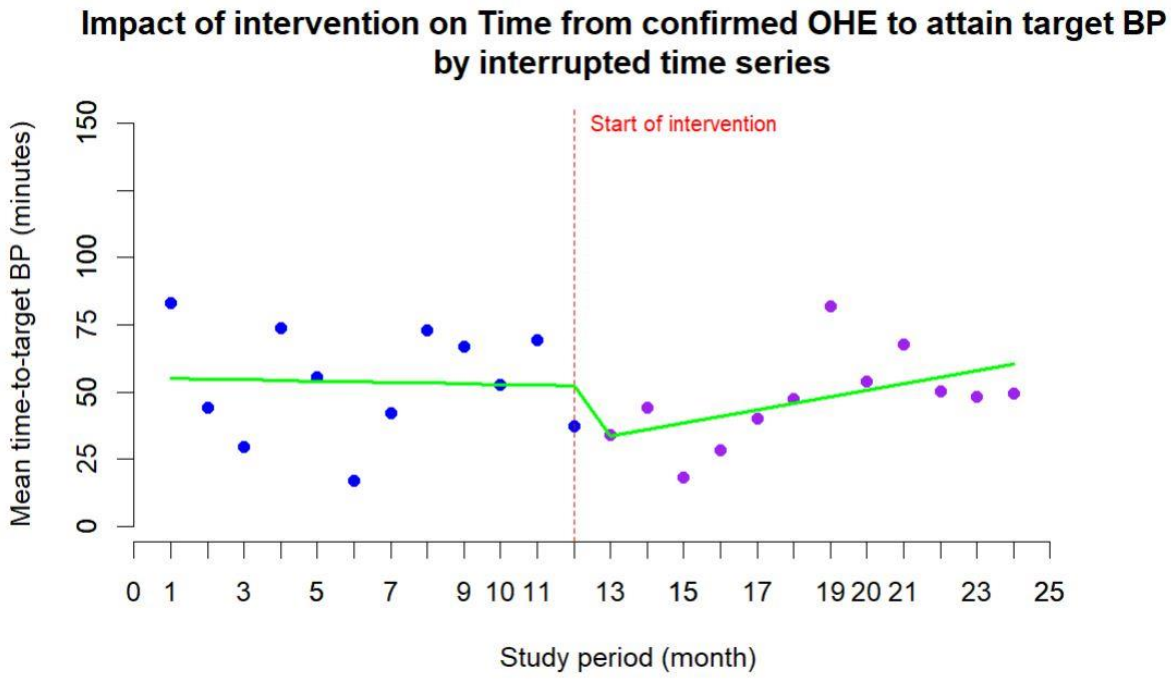

Figure 3. Interrupted time series analysis showing impact of the intervention on time to target blood pressure.

(Published in Trahan M-J, Plourde M, Clouatre A, et al. A quality improvement intervention to optimize the management of severe hypertension during pregnancy and postpartum. Pregnancy Hypertension 2025;39:101192.)

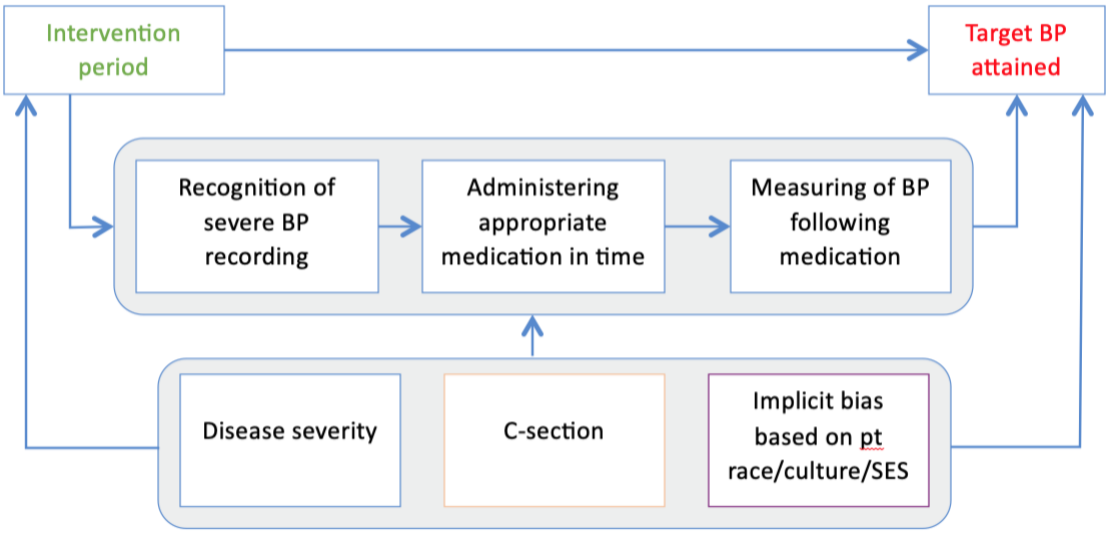

Figure 4 Factors that may influence time to target blood pressure

TABLE

Table 1. Results from the interrupted time series analyses

Outcomes	Level change (Intervention effect)	Slope change (Post-intervention effect)
MAIN ANALYSIS (N=134)		
Time from confirmed OHE to attain target BP	-21.29 minutes (95% CI: -52.760, 10.181) P= 0.174	2.70 minutes (95% CI: -1.837, 7.232) P= 0.229
POST-HOC ANALYSES – Additional outcomes (N=134)		
Time to confirmed OHE	-4.39 minutes (95% CI: -14.713, 5.929) P= 0.385	-0.23 minutes (95% CI: -1.721, 1.254) P= 0.747
Time from first BP check to attain target BP	-25.68 minutes (95% CI: -54.534, 3.173) P= 0.078	2.46 minutes (95% CI: -1.694, 6.621) P= 0.231
POST-HOC ANALYSES – Women with pre-eclampsia (N=110)		
Time from confirmed OHE to attain target BP	-21.70 minutes (95% CI: -56.731,13.332) P= 0.211	4.09 minutes (95% CI: -0.962, 9.133) P= 0.107
Time to confirmed OHE	-10.73 minutes (95% CI: -22.183, 0.718) P= 0.065	-0.68 minutes (95% CI: -2.333, 0.967) P= 0.398
Time from first BP check to attain target BP	-32.43 minutes (95% CI: -63.888, -0.975) P= 0.044	3.40 minutes (95% CI: -1.130, 7.935) P= 0.133
POST-HOC ANALYSES – Extended post-intervention period (N=137)		
Time from confirmed OHE to attain target BP	-10.97 minutes (95% CI: -43.084, 21.143) P= 0.486	0.57 minutes (95% CI: -3.807, 4.943) P= 0.790
Time to confirmed OHE	-4.16 minutes (95% CI: -13.796, 5.473) P= 0.380	-0.27 minutes (95% CI: -1.582, 1.043) P= 0.674
Time from first BP check to attain target BP	-15.13 minutes (95% CI: -45.640, 15.376) P= 0.315	0.30 minutes (95% CI: -3.858, 4.455) P= 0.883