



# The impact of post-intubation hypotension on length of stay and mortality in adult and geriatric patients: a cohort study

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## Abstract

**Objective** To evaluate the association between standard post-intubation hypotension (<90 mmHg) and in-hospital mortality. Secondary objectives were to evaluate the association of post-intubation hypotension and length of stay and to assess the impact of increasing post-intubation hypotension threshold to 110 mmHg on hospital length of stay and 48 h-mortality in patients aged  $\geq 65$  years.

**Methods** *Design and setting:* A cohort of patients admitted in a level-1 trauma centre emergency department (ED) between November 2011 and July 2016. *Inclusion criteria:* aged  $\geq 16$  with available pre-intubation vital signs, intubation performed in  $\leq 3$  attempts with no surgical access needed. *Measures:* Prospective electronic data collection was used for clinical data. *Main outcome:* 48-h in-hospital mortality. *Secondary outcome:* hospital length of stay. *Analyses:* Univariate and multivariate analyses.

**Results** A total of 586 patients were included. The mean age was  $56.3 \pm 18.8$  years and 37% were aged  $\geq 65$  years. Within 60 min of intubation, 224 (38%) patients had at least one systolic blood pressure measure <90 mmHg and 164 (28%) had at least two measures. The <110 mmHg threshold showed a total of 377 patients (64%) had at least one systolic blood pressure measure <110 mmHg and 286 (49%) had at least two measures. We found no significant difference in the risk of mortality overall and in stratified-age groups and no association with increased hospital length of stay using both post-intubation hypotension thresholds.

**Conclusion** Post-intubation hypotension was recorded in one out of three patients in the ED but we found no association between post-intubation hypotension and 48-h in-hospital mortality overall in adults or geriatric patients.

**Keywords** Hypotension · Intubation · Emergency medicine

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## Résumé

**Objectif** Évaluer l'association entre l'hypotension post-intubation selon le seuil standard (<90 mmHg) et la mortalité hospitalière. Les objectifs secondaires étaient d'évaluer l'association entre l'hypotension post-intubation et la durée de séjour et d'évaluer l'impact d'augmenter le seuil d'hypotension post-intubation à 110 mmHg sur la durée de séjour à l'hôpital et la mortalité à 48 heures chez les patients âgés de  $\geq 65$  ans.

**Méthodes** *Devis et contexte:* Une cohorte de patients admis au département d'urgence d'un centre de traumatologie de niveau 1 entre 06/2011 et 05/2016. **Critères d'inclusion:** âge  $\geq 16$  ans avec signes vitaux pré-intubation disponibles, intubation réalisée en  $\leq 3$  tentatives sans accès chirurgical. **Mesures:** Les données cliniques ont été



colligées électroniquement de façon prospective. **Issue primaire:** Mortalité hospitalière à 48 heures. **Issue secondaire:** durée du séjour à l'hôpital. **Analyses:** Analyses univariées et multivariées.

**Résultats** Un total de 586 patients ont été inclus. L'âge moyen était de  $56,3 \pm 18,8$  ans et 37% étaient âgés de  $\geq 65$  ans. Dans les 60 min suivant l'intubation, 224 (38%) patients avaient au moins une mesure de tension artérielle systolique  $< 90$  mmHg et 164 (28%) avaient au moins deux mesures. Avec le seuil de  $< 110$  mmHg, un total de 377 patients (64%) avaient au moins une mesure de tension artérielle systolique  $< 110$  mmHg et 286 (49%) en avaient au moins deux. Nous n'avons constaté aucune différence significative dans le risque de mortalité dans l'ensemble et dans différentes strates d'âge, et aucun lien avec l'augmentation de la durée du séjour à l'hôpital en utilisant les deux seuils d'hypotension post-intubation.

**Conclusion** L'hypotension post-intubation a été enregistrée chez un patient sur trois au département d'urgences mais nous n'avons trouvé aucune association entre l'hypotension post-intubation et la mortalité hospitalière à 48 heures, que ce soit dans une population adulte ou chez les patients âgés.

### Clinician's capsule

#### What is known about the topic?

Post-intubation hypotension is a common complication of endotracheal intubation.

#### What did this study ask?

Is there an association between post-intubation hypotension ( $< 90$  mmHg) and 48-h mortality and hospital length of stay?

#### What did this study find?

We found no association between post-intubation hypotension and 48-h in-hospital mortality and with increased hospital length of stay.

#### Why does this study matter to clinicians?

Clinicians should prepare for and prevent potential post-intubation hypotension following ED intubation, but its impact on patient outcomes remains limited.

post-intubation hypotension and 48-h in-hospital mortality. Secondary objectives were to evaluate the association of post-intubation hypotension and hospital length of stay, and to assess the impact of increasing post-intubation hypotension threshold to 110 mmHg on hospital length of stay and 48 h-mortality in patients aged  $\geq 65$  years.

## Methods

### Study design and setting

This study used the ED software database (Reascribe® (Logibec, Canada)), which prospectively and automatically recorded data on patients with endotracheal intubation performed in the resuscitation room of the CHU de Québec-Université Laval (Hôpital de l'Enfant-Jésus) (level-I university-affiliated trauma centre) between November 2011 and July 2016. The CHU de Québec-Université Laval Research Ethics Board approved this study.

### Selection of participants

Patients were included in our analyses if they were aged  $\geq 16$  years with available pre-endotracheal intubation vital signs ( $\leq 30$  min of intubation). We excluded patients who necessitated  $\geq 3$  intubation attempts and/or surgical access and those who did not receive any medication before being intubated (i.e.: crash intubation).

### Measurements

Clinical variables during intubation and vital signs were prospectively recorded using the Reascribe® (Logibec, Canada) software, which automatically records blood pressure every 2–3 min. Trained research assistants (6 medical students and 1 clinical research assistant) collected socio-clinical data from patient charts using a standardized data collection form: admission diagnosis, reason for intubation, usual medications and medications used for intubation, cardiopulmonary interventions, resuscitation

## Introduction

Endotracheal intubation is a critical procedure for airway management in the emergency department (ED). Post-intubation hypotension is a common complication of endotracheal intubation [1]. Several potential post-intubation hypotension causes have already been identified in the literature: a decrease in venous return resulting from the positive pressure ventilation, a decrease in the sympathetic tone as a result of the correction of hypoxemia, loss of spontaneous respiration, an underlying condition, the effect of different sedatives and neuromuscular blockage agents used for endotracheal intubation.

Hypotension in the ED was linked to a higher rate of in-hospital mortality in adult patients [2]. Post-intubation hypotension with rapid sequence intubation was also found to be the most common adverse event, and was more likely to occur in older patients [3]. A 2015 report showed that changing the hypotension threshold from 90 to 110 mmHg could improve mortality prediction in older adults.[4].

room blood vitals sign measures and patient disposition. Comorbidities were quantified using the Charlson comorbidities index.

## Outcome

The main outcome measure of this study was 48-h in-hospital mortality. Mortality information was collected using the province's official medical death certificate (SP3) form in the patients' electronic medical file.

Secondary outcome measure was hospital length of stay, which was calculated from the moment patients left the resuscitation room and were admitted into the hospital to the moment they were discharged.

## Analysis

Univariate analyses were performed for sociodemographic data and measured outcomes. Continuous characteristics variables were compared using T tests and categorical characteristics were compared using chi-square tests. We assessed four definitions of post-intubation hypotension within 60 min of intubation: at least one systolic blood pressure < 90 mmHg, at least two systolic blood pressure < 90 mmHg, at least one systolic blood pressure < 110 mmHg, at least two systolic blood pressure < 110 mmHg. A logistic regression was used to model the risk of mortality according to each systolic blood pressure threshold (90/110 mmHg) in the overall sample for primary outcome. This risk was further modelled according to three patient age groups. Patients were categorized as 18–64 years old 65–74 years old and  $\geq 75$  years old. These models were adjusted for sex and comorbidities.

Assuming a 23% prevalence of post-intubation hypotension, a sample size of 570 patients would be sufficient to detect an OR of 1.85 at the 5% level with 80% power. All analyses were performed using SAS software, version 9.4 (SAS Institute, Inc., Cary, NC).

## Results

### Clinical and sociodemographic characteristics

A total of 586 patients were included. Mean age was  $56.3 \pm 18.8$  years and older adults (aged  $\geq 65$  years) represented 37.4% of our cohort. The median time spent in the resuscitation room was 60 min. The median number of available systolic blood pressure measurements per patient was 17. Altered level of consciousness (including neurological cases) was the most frequent reason for intubation in the resuscitation room (52.6%), followed by trauma (17.4%) and respiratory failure (15.4%). Neuromuscular blocking agents

and propofol were the most used medication for intubation (75.8% and 65.5%, respectively). Online resource 1 shows the characteristics of our cohort.

### Main outcome

Within 60 min of intubation, 224 patients (38%) had at least one systolic blood pressure measure < 90 mmHg recorded and 164 (28%) had at least two. At 48 h post-intubation, 28 (13%) patients with at least one systolic blood pressure measure < 90 mmHg died and 22 (13%) patients with at least two measures under the threshold died.

Alternatively, a total of 377 patients (64%) had at least one systolic blood pressure measure < 110 mmHg within 60 min of intubation and 286 (49%) had at least two measures. At 48 h post-intubation, 35 patients (9%) and 32 patients (11%) with at least one and two blood pressure measures < 110 mmHg died, respectively. No statistically significant difference in the risk of mortality and odds ratios (OR) were found, as shown in Table 1.

### Secondary outcome

The median hospital length of stay for patients with at least one and at least two systolic blood pressure measures of < 90 mmHg was 7.0 (IQR 3.0–21.0) and 7.0 (IQR 3.0–23.0) days, respectively. No statistically significant difference in hospital length of stay was found when comparing those two groups with post-intubation hypotension with their counterparts who did not develop post-intubation hypotension ( $p=0.7$ ,  $p=0.7$ ). The median hospital length of stay for those with least one and two systolic blood pressure measures of < 110 mmHg was 7.0 (IQR 3.0–21.0) and 8.0 (IQR 3.0–21.0) days, respectively. The difference between those two groups of patients with post-intubation hypotension and those who did not have post-intubation hypotension was also non-statistically significant ( $p=0.1$ ,  $p=0.3$ ).

## Discussion

### Interpretation of findings

Our results suggest that the risk of in-hospital mortality within 48 h of intubation is not different in adult and geriatric patients with at least one or at least two measures < 90 mmHg or < 110 mmHg. No difference in length of stay was found between patients who experienced post-intubation hypotension and those who did not according to our four definitions.

**Table 1** Mortality at 48 h in patients with post-intubation hypotension within 60 min of intubation. (a) Patients with at least one systolic blood pressure measure < 90 or < 110. (b) Patients with at least two systolic blood pressure measures < 90 or < 110

(a)					
Post-intubation hypotension status <sup>a</sup>	<i>p</i>	OR <sup>b</sup> [95% CI]	Age category	<i>p</i>	OR <sup>c</sup> [95% CI]
Systolic blood pressure ≥ 90 ( <i>n</i> = 362) (reference)	0.12	1.0	65–74 years old	0.10	
			≥ 75 years old	0.35	
			18–64 years old	0.12	1.0
Systolic blood pressure < 90 ( <i>n</i> = 224)	0.13	1.05 [0.57–1.92]	65–74 years old	0.17	1.5 [0.6–3.9]
			≥ 75 years old	0.10	0.8 [0.3–2.5]
			18–64 years old	0.05	
Systolic blood pressure ≥ 110 ( <i>n</i> = 209) (reference)	0.15	1.0	65–74 years old	0.12	
			≥ 75 years old	0.42	
			18–64 years old	0.08	1.0
Systolic blood pressure < 110 ( <i>n</i> = 377)	0.10	0.65 [0.35–1.2]	65–74 years old	0.14	1.9 [0.8–4.6]
			≥ 75 years old	0.11	1.4 [0.6–3.7]
			18–64 years old	0.11	
(b)					
Post-intubation hypotension status <sup>a</sup>		Age category	<i>p</i>		OR <sup>d</sup> [95% CI]
Systolic blood pressure ≥ 90 ( <i>n</i> = 422) (reference)		18–64 years old	0.05		
		65–74 years old	0.08		1.0
		≥ 75 years old	0.33		
Systolic blood pressure < 90 ( <i>n</i> = 164)		18–64 years old	0.12		
		65–74 years old	0.22		1.19 [0.64–2.23]
		≥ 75 years old	0.10		
Systolic blood pressure ≥ 110 ( <i>n</i> = 300) (reference)		18–64 years old	0.04		
		65–74 years old	0.09		1.0
		≥ 75 years old	0.35		
Systolic blood pressure < 110 ( <i>n</i> = 286)		18–64 years old	0.09		
		65–74 years old	0.17		1.02 [0.56–1.87]
		≥ 75 years old	0.12		

<sup>a</sup>Model was adjusted for sex and Charlson comorbidity score

<sup>b</sup>OR computed for patients with or without post-intubation hypotension

<sup>c</sup>OR computed for age categories when post-intubation hypotension is present

<sup>d</sup>OR computed for patients with indicated post-intubation hypotension only, 18–64 years old as reference

## Comparison to previous studies

Recent work in the intensive care unit has shown that prolonged post-intubation hypotension could increase mortality (OR: 7.00 for each average hypotension time unit) [5]. Our results do not reflect such previous findings; this could be attributed to a difference between the ED setting and an ICU/postoperative setting and the brief episode of

post-intubation hypotension experienced by our patients. Regarding the relationship between age and post-intubation hypotension, some authors found that older patients are at higher risk of developing post-intubation hypotension, but did not assess the relationship between post-intubation hypotension, mortality and length of stay [6]. In 2020, Maheshwari et al. showed that age was an independent predictive factor of post-intubation hypotension but

no relation with mortality or length of stay was reported [7]. Other authors determined that the complication rate was similar in older patients than in adults aged < 65 years [8]. Oyetunji et al. attempted to determine which hypotension threshold best predicted mortality in older patients (50–150 mmHg) [9]. They have identified that 117 mmHg could be the best predictor for mortality in patients  $\geq$  65 years old. The delay between the intubation and the systolic blood pressure measures and the delay between the intubation and mortality are unclear in this study.

Our team previously explored the relationship between the definition and the incidence of post-intubation hypotension. We concluded that the incidence is dependent of the definition used for post-intubation hypotension. We also concluded that the first 5 min after intubation are where most post-intubation hypotension occur. Unfortunately, our small sample did not allow us to analyze the relationship between the different definitions and the mortality rate [10].

### Strengths and limitations

The main strength of our study is that vitals, medication used for intubation and other information are recorded automatically and in real time instead of using retrospective data collection forms.

Our study has limitations. First, the external validity of our results may have been limited by the fact that all patients came from a level-I trauma centre. Second, our main outcome, 48-h mortality, is undeniably impacted by subsequent care provided to the patient in the ICU and, therefore, the casual inference with post-intubation hypotension may be affected. Even though we reached our cohort sample size, the number of included older patients may have been inadequate to detect a possible association.

### Clinical implications

Emergency physicians are trained to prepare for critical situations during endotracheal intubation, especially post-intubation hypotension. Although, our results show that one patient out of three has a post-intubation hypotension episode, the impact of this episode on post-ED clinical outcomes are unlikely. Emergency physicians should continue to ensure appropriate preparedness to potential post-intubation hypotension when performing endotracheal intubation.

### Research implications

Post-intubation hypotension is not associated with increased 48-h in-hospital mortality in the general critical patient

intubated in the ED. We found no association between age and the systolic blood pressure thresholds, but future research may focus on specific targeted subgroup of patients that may benefit from post-intubation hypotension prevention.

### Conclusion

We found no association between post-intubation hypotension and 48-h in-hospital mortality in all patients nor in the geriatric sub-group. The occurrence of post-intubation hypotension also was not linked to an increased hospital length of stay.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s43678-022-00305-0>.

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**Availability of data and material** Available upon reasonable request.

### Declarations

**Conflict of interest** None.

**Ethics approval** This project was approved by the CHU de Québec-Université Laval Research Ethics Board (#2012–1659).

**Consent to participate** No consent was required.

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