

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Profile of trauma mortality and trauma care resources at rural emergency departments and urban trauma centres in Quebec: a population-based retrospective cohort study
AUTHORS	Fleet, Richard; Lauzier, François; Tounkara, Fatoumata; Turcotte, Stéphane; Poitras, Julien; Morris, Judy; Ouimet, Mathieu; Fortin, Jean-Paul; Plant, Jeff; Légaré, France; Dupuis, Gilles; Turgeon-Pelchat, Catherine

VERSION 1 - REVIEW

REVIEWER	Molly Jarman Center for Surgery and Public Health, Department of Surgery, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, United States of America
REVIEW RETURNED	03-Jan-2019

GENERAL COMMENTS	<p>This is a well written paper examining differences in injury mortality in Quebec, Canada for patients treated at rural emergency departments, compared to urban trauma centers. The results of this study are consistent with findings from studies of rural injury mortality in the United States. Overall, this is important work as it highlights the impact of geographic barriers to care in a health care system with universal financial access to care. There are several limitations/concerns regarding methodology and results as presented.</p> <p>It is not clear if the effects noted are the result of urban/rural differences, or trauma center/emergency department differences. How many excluded hospitals were urban emergency departments, and did you examine injury mortality in the urban/emergency department setting?</p> <p>What are the triage guidelines/protocols in Quebec? Specifically, do EMS providers always transport rural patients to rural EDs first, or do some rural injury patients go directly to urban trauma centers?</p> <p>The introduction notes the proportion of rural EDs that are >150 kilometers from at Level 1/2 trauma center, and 150 km was used as the cutoff for categorizing distance in the descriptive statistics, but the distance cut off for classification is listed as 50 minutes by ground transport, and Figure 1 describes trauma center influence area as a 55 km radius. How were these distances selected? In the regression analysis, were transfer patients considered rural/ED or urban/trauma center? Did any any transfer patients die</p>
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	<p>during the transfer interval? If so, how where these patients coded?</p> <p>The rationale for injury severity and mechanism is not clear. Nearly all patients with ISS > 25 will die, and ISS categorization 25-49 and ≥ 50 is not informative. Likewise, ISS categorization of 0-14 does not adequately reflect mortality differences for patients with minor vs. severe isolated injury. Standard ISS categorization is 1-9, 10-15, 16-24, and ≥ 25.</p> <p>For penetrating injury in the regression model, it is not clear which patients were included in the "any" group.</p> <p>Was there evidence of colinearity between ISS, mechanism, penetrating injury, and cranio-cerebral trauma?</p> <p>16-64 and ≥ 65 years are very broad for age categories - consider using narrower bands.</p> <p>Did you examine an overall model for mortality at rural vs. urban hospitals, regardless of time of death?</p> <p>The methods mention calculating ICCs for hierarchical/multilevel regression models, but ICCs are not presented in the results.</p> <p>Use of STROBE guidelines is noted in the manuscript, but there is no mention of research ethics review, approval, or exemption.</p>
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REVIEWER	Søren Mikkelsen Professor, Consultant, MD, PhD The Prehospital Research Unit, Region of Southern Denmark Odense University Hospital DK 5000 Odense C
REVIEW RETURNED	08-Jan-2019

GENERAL COMMENTS	<p>Comments regarding the manuscript: Profile of trauma mortality and trauma care resources at rural emergency departments and urban trauma centres in Quebec: a population-based retrospective cohort study by Fleet et al.</p> <p>The objectives of the study were to examine mortality rates among trauma patients treated at rural emergency departments and urban trauma centres across the province of Quebec, and to compare trauma care resources and services between these settings.</p> <p>9.0% of the trauma patients were treated in a rural EDs and 91.0% were treated at an urban centre. Mortality rates were higher in rural EDs compared to urban trauma centres. The authors describe that they controlled for potential confounders and subsequently found that the odds of prehospital or ED mortality were over 3 times greater for patients treated in a rural ED (OR 3.44, 95% CI 1.88-6.28).</p> <p>Data source was Quebec Trauma Registry Information System containing information on victims of unintentional traumatic injuries, victims who died on arrival at the ED or during ED stay, and victims who were hospitalized in a trauma centre in Quebec. The findings reported by the authors are not ground breaking. Similar observations have been made previously.</p> <p>General comments: To a large extent, the authors disregard the potential influence of the prehospital emergency medical system(s) servicing the</p>
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	<p>area(s). Furthermore, the reader is left without a deeper understanding of the prehospital triage (if any). Are there situations in which the patients are transported to more advanced EDs, by-passing other nearer but less equipped EDs? Are the qualifications of the care providers the same all around the province of Quebec? This is information a non-Quebecian reader probably would like to have.</p> <p>Specific comments:</p> <p>The authors state that the trauma registry does not capture the time interval from the 911 call to ambulance arrival at the scene. This, the authors state, precluded their ability to calculate total prehospital times. This is, unfortunately, a serious weakness of the study. By being unable to supply information on both the quality of the prehospital care as well as the time it takes from time of injury to the arrival of the prehospital service provider, confounders may be introduced. This may weaken the conclusion that the authors draw.</p> <p>In general, time issues are important here. Both response time and time spent at the scene and transport time are potential confounders. The sentence: "After controlling for potential confounders..." in the abstract may be stretching it a bit. No time-related confounders seem to have been entered into the discussion.</p> <p>The authors state that all trauma cases occurring in Quebec during the study period and involving transport directly to a rural ED or an urban trauma centre were eligible. Did the authors include patients that might have been declared dead at the scene? Does every traumatized patient receive treatment until admission to hospital or may the EMS care giver declare the dead at the scene?</p> <p>Does the EMS provider have the opportunity to transfer a patient directly to a more advanced ED? If so, this may influence the results.</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Reviewer Name: Molly Jarman

Institution and Country: Center for Surgery and Public Health, Department of Surgery, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, United States of America

Please state any competing interests or state 'None declared': None declared

This is a well written paper examining differences in injury mortality in Quebec, Canada for patients treated at rural emergency departments, compared to urban trauma centers. The results of this study are consistent with findings from studies of rural injury mortality in the United States. Overall, this is important work as it highlights the impact of geographic barriers to care in a health care system with universal financial access to care. There are several limitations/concerns regarding methodology and results as presented.

It is not clear if the effects noted are the result of urban/rural differences, or trauma center/emergency department differences. How many excluded hospitals were urban emergency departments, and did you examine injury mortality in the urban/emergency department setting?

Response 1: We thank Reviewer 1 for their comments. Our main objective was to compare trauma mortality in level 1/2 trauma centres with that observed in rural hospitals. Thus, we did not include urban hospitals that were not designated as trauma centres and we did not examine injury mortality in the urban/emergency department setting. In Québec, when there is a trauma, EMS providers generally bypass urban non-trauma hospitals in favor of level 1/2 trauma centres (please see Response #2 below). We have revised the Methods section of the manuscript (page 6) to add more information regarding the trauma system in Quebec in a subsection with the heading “Setting”. While it is possible that a trauma patient may walk in to an urban non-trauma centre, these consultations would most likely be for relatively minor traumatic injuries.

What are the triage guidelines/protocols in Quebec? Specifically, do EMS providers always transport rural patients to rural EDs first, or do some rural injury patients go directly to urban trauma centers?

Response 2: During the period this study was conducted (2009-2013), the transport triage criteria used by all EMS providers within the province of Quebec were based on a combination and adaptation of the prehospital index (PHI; Koehler et al., 1986) and high-velocity impact (HVI) (Institut national d'excellence en santé et en services sociaux (INESSS). Avis sur les critères de triage préhospitalier en traumatologie. Rapport rédigé par André Lavoie en collaboration avec Gilles Bourgeois et Jean Lapointe. ETMIS 2013; 9(8): 1-46. See INESSS. Summary – Notice regarding field trauma Criteria. ETMIS 2013; 9(8) :1-2 at https://www.inesss.qc.ca/fileadmin/doc/INESSS/Rapports/Traumatologie/INESSS_Summary_Regarding_Field_Trauma_Criteria_EN.pdf for an English summary). More precisely, EMS providers across the province had to calculate the PHI score (based on physiological response and injury mechanism) and transport any casualty with a score ≥ 4 directly to a trauma centre (level 1 or 2). The presence of any significant HVI mechanism also results in direct transport to a trauma centre. This bypass rule was applicable only if the trauma centre was situated within a limit of 45 minutes of transport time, limiting its application in rural areas. The EMS providers also had to follow the PHI “noncumulative 5” rule, which assumes that casualties who score 5 (i.e., lack of vital signs) for any element of the PHI must be transported to the nearest centre (regardless of trauma designation) for initial stabilization.

In 2016, the province introduced a new scale of prehospital triage in traumatology based on the CDC-ACSCOT, 2011 (Center for Disease Control and Prevention – American College of Surgeon – Committee on Trauma). Among other changes, this new triage system abolished the “noncumulative 5” rule and extended the territorial coverage of trauma centres to within 60-minutes of transport time (INESSS, 2016, Échelle Québécoise de triage préhospitalier en traumatologie (adaptée du protocole CDC-ACSCOT, 2011) Phase 1 du plan de déploiement sur le territoire québécois en bref. Available in French only at https://www.inesss.qc.ca/fileadmin/doc/INESSS/FECST/Publications/EQTPT/Echelle_quebecoise_de_triage_prehospitalier_en_trauma_EN_BREF.pdf). We have revised the Methods section (page 6) to include more information regarding the triage guidelines/protocols in Quebec.

The introduction notes the proportion of rural EDs that are >150 kilometers from at Level 1/2 trauma center, and 150 km was used as the cutoff for categorizing distance in the descriptive statistics, but the distance cut off for classification is listed as 50 minutes by ground transport, and Figure 1 describes trauma center influence area as a 55 km radius. How were these distances selected?

Response 3: We thank the Reviewer for this comment. It made us realize that we had made an error in the Introduction of the manuscript. We meant to reference one of our previous publications in order to give the reader an idea of the distance between rural EDs and urban trauma centres in Quebec. The cutoff should have been <300km, and the proportions were 44% and 54% of rural EDs located greater than 300 km from a level 1 or level 2 trauma centre, respectively. We have revised the Introduction (page 5) to make this change. We have also modified Table 1 (page 10) to include the proportion of rural EDs that are ≤150km, 150 to 300km, or >300km from a level 1 or level 2 trauma centre.

In Quebec, there is no formal helicopter EMS system involved in on-location evacuation of trauma victims. EMS providers operate ground ambulance. For the purpose of the present study, we used a cutoff of 50-minutes by ground transport as the inclusion/exclusion criteria for rural EDs. This cut-off was chosen in order to be beyond the “golden hour” limit (60-minutes), considering a recommended 10-minutes margin for times estimated by GoogleMap (Wallace, D. J., Kahn, J. M., Angus, D. C., Martin-Gill, C., Callaway, C. W., Rea, T. D., ... & Seymour, C. W. (2014). Accuracy of prehospital transport time estimation. *Academic Emergency Medicine*, 21(1), 9-16). We have clarified this in the “Study definitions and inclusion criteria” subsection of the Methods (page 7). The 55km radius indicated in the Figure 1 was used only to illustrate the 50-minutes criteria on the map; it has been clarified in the legend.

In the regression analysis, were transfer patients considered rural/ED or urban/trauma center? Did any transfer patients die during the transfer interval? If so, how where these patients coded?

Response 4: Transfer patients were considered “rural” in the regression analysis. There were 113 transfer patients (3%) who died during the transfer interval; these patients were specifically identified in the database. We have included this information in the “Trauma mortality” subsection of the Results (page 13).

The rationale for injury severity and mechanism is not clear. Nearly all patients with ISS > 25 will die, and ISS categorization 25-49 and ≥ 50 is not informative. Likewise, ISS categorization of 0-14 does not adequately reflect mortality differences for patients with minor vs. severe isolated injury. Standard ISS categorization is 1-9, 10-15, 16-24, and ≥ 25.

Response 5: We have changed the classification as requested in the text (page 13) and in Table 2 (page 12), Table 3 (page 13), and Supplementary Material Table 1.

For penetrating injury in the regression model, it is not clear which patients were included in the “any” group.

Response 6: “Any” means “none” according to the penetrating injury regional variable. We have clarified this in Table 3 and Supplementary Table 1 by changing “any” to “none”.

Was there evidence of colinearity between ISS, mechanism, penetrating injury, and cranio-cerebral trauma?

Response 7: There was no evidence of collinearity between these variables. The highest polychoric correlation between these 4 variables was between ISS and cranio-cerebral trauma (a correlation of 0.65). This was insufficient to remove either of these variables from the regression for evidence of multicollinearity.

16-64 and ≥ 65 years are very broad for age categories - consider using narrower bands.

Response 8: The purpose of this categorization was to highlight major age groups: children/adolescents (0-15 years), adults (16-64 years old), and the elderly (≥ 65 years old).

Did you examine an overall model for mortality at rural vs. urban hospitals, regardless of time of death?

Response 9: We tested an "overall model" for mortality. It would have been interesting to carry out a Kaplan-Meier/Cox model analysis taking into account the time of death in relation to the date of the traumatic event. However, we did not have access to reliable data on the time of death. In order to perform this analysis, it would have been necessary to link records from the Quebec Trauma Registry with another database.

The methods mention calculating ICCs for hierarchical/multilevel regression models, but ICCs are not presented in the results.

Response 10: We have reported ICCs in the legend at the bottom of Table 3 (page 14).

Use of STROBE guidelines is noted in the manuscript, but there is no mention of research ethics review, approval, or exemption.

Response 11: Research ethics approval was mentioned in the Methods section (page 7) as shown below:

“Ethical approval was obtained from the CISSS Chaudière-Appalaches Research Ethics Committee (Project MP-2016-003).”

Reviewer: 2

Reviewer Name: Søren Mikkelsen

Institution and Country: Professor, Consultant, MD, PhD. The Prehospital Research Unit, Region of Southern Denmark. Odense University Hospital. DK 5000 Odense C

Please state any competing interests or state 'None declared': None declared

Comments regarding the manuscript:

Profile of trauma mortality and trauma care resources at rural emergency departments and urban trauma centres in Quebec: a population-based retrospective cohort study by Fleet et al.

The objectives of the study were to examine mortality rates among trauma patients treated at rural emergency departments and urban trauma centres across the province of Quebec, and to compare trauma care resources and services between these settings.

9.0% of the trauma patients were treated in a rural EDs and 91.0% were treated at an urban centre. Mortality rates were higher in rural EDs compared to urban trauma centres. The authors describe that they controlled for potential confounders and subsequently found that the odds of prehospital or ED mortality were over 3 times greater for patients treated in a rural ED (OR 3.44, 95% CI 1.88-6.28).

Data source was Quebec Trauma Registry Information System containing information on victims of unintentional traumatic injuries, victims who died on arrival at the ED or during ED stay, and victims who were hospitalized in a trauma centre in Quebec.

The findings reported by the authors are not ground breaking. Similar observations have been made previously.

General comments:

To a large extent, the authors disregard the potential influence of the prehospital emergency medical system(s) servicing the area(s). Furthermore, the reader is left without a deeper understanding of the prehospital triage (if any). Are there situations in which the patients are transported to more advanced EDs, by-passing other nearer but less equipped EDs?

Response 12: We thank Reviewer 2 for their comments. We have provided more information regarding the prehospital triage system in Quebec in our Response 2 to the comments from Reviewer 1, and in the manuscript in the Methods section is a subsection with the heading "Setting" (page 6).

Are the qualifications of the care providers the same all around the province of Quebec? This is information a non-Quebecian reader probably would like to have.

Response 13: The qualifications of the care providers (physicians, nurses, paramedics, etc.) are the same all around the province. We have revised the Methods section (page 6) to include this information. In Quebec, EMS are primarily provided by primary care paramedics (PCPs). PCPs are now required to complete a 3-year professional college degree (after high-school but before University). The scope of practice of PCPs include: cardiopulmonary resuscitation, bag-valve-mask ventilation, semiautomatic external defibrillation, and supraglottic airway device placement. PCPs can administer five medications: aspirin, nitroglycerin, salbutamol, epinephrine, and glucagon. They are

not authorized to start an IV. Since 2016, a 60-credit university degree for training advanced care paramedics has been offered by University of Montreal.

Specific comments:

The authors state that the trauma registry does not capture the time interval from the 911 call to ambulance arrival at the scene. This, the authors state, precluded their ability to calculate total prehospital times. This is, unfortunately, a serious weakness of the study. By being unable to supply information on both the quality of the prehospital care as well as the time it takes from time of injury to the arrival of the prehospital service provider, confounders may be introduced. This may weaken the conclusion that the authors draw.

In general, time issues are important here. Both response time and time spent at the scene and transport time are potential confounders. The sentence: "After controlling for potential confounders..." in the abstract may be stretching it a bit. No time-related confounders seem to have been entered into the discussion.

Response 14: As we mentioned in the Discussion section of the manuscript (page 15), we did not disregard the potential influence of prehospital EMS time. We had planned to examine the prehospital data as described in the study protocol (Fleet R, Tounkara FK, Ouimet M, et al. Portrait of trauma care in Quebec's rural emergency departments and identification of priority intervention needs to improve the quality of care: a study protocol. *BMJ Open*. 2016;6(4):e010900). Yet, to our surprise, data on prehospital times were missing for approximately 50% of trauma cases in the Quebec Trauma Registry. Moreover, we found numerous instances where a case did have a prehospital time documented but the time was clearly inaccurate (e.g., time between 2 and 365 days).

At the time this study was conducted, EMS times were entered manually and extracted from EMS paper data forms and paper trauma data entry documents completed by the ED physician. From our understanding and clinical experience (RF), times were retrospectively entered and often estimated. Moreover, several important time intervals (e.g., time from = 911 call to dispatch and arrival of EMS at the scene) were simply unavailable in this database. Altogether, it was impossible to reliably study the impact of prehospital times. We have since held multiple discussions with the managers of the Quebec Trauma Registry, and we have made several recommendations for improving the reliability of the data in this registry. As this is an important limitation of this study, we have revised the Abstract (page 3) to highlight this limitation, and we have emphasized this limitation in the Discussion section (page 15).

The authors state that all trauma cases occurring in Quebec during the study period and involving transport directly to a rural ED or an urban trauma centre were eligible. Did the authors include patients that might have been declared dead at the scene? Does every traumatized patient receive treatment until admission to hospital or may the EMS care giver declare the dead at the scene?

Response 15: Deaths at the scene are not included in the Quebec Trauma Registry. We have added this information to the "Study definition and inclusion criteria" subsection of the Methods (page 7).

Does the EMS provider have the opportunity to transfer a patient directly to a more advanced ED? If so, this may influence the results.

Response 16: Please refer to our Response 2 to the comments from Reviewer 1 regarding the prehospital triage system in Quebec.

VERSION 2 – REVIEW

REVIEWER	Molly Jarman, PhD, MPH Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA
REVIEW RETURNED	22-Apr-2019

GENERAL COMMENTS	Thank you for your thoughtful responses to reviewer comments. All of my concerns have been addressed with the current revisions. I agree with Dr. Mikkelsen concerns regarding accounting for pre-hospital time; however, this is a common limitation in the field as data on pre-hospital intervals is often incomplete/inaccurate. I believe this is an acceptable limitation in the context of the triage protocols now described in the introduction, and the limitation is appropriately addressed in the discussion.
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REVIEWER	Søren Mikkelsen The Prehospital Research Unit, Region of Southern Denmark Odense University Hospital DK 5000 Odense C
REVIEW RETURNED	17-Apr-2019

GENERAL COMMENTS	In my opinion, the authors have addressed all the points that were left unanswered in the first version of the manuscript. I find the manuscript considerably better.
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