UNIVERSITY OF CALGARY

Development of an In-Hospital Standardized Mortality Ratio for Emergency Department Sensitive Conditions

by

Simon Berthelot

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Abstract

Healthcare systems in developed countries are grappling with emergency department (ED) overcrowding. Although a prominent issue yielding many related metrics, accessibility is only one dimension by which to measure ED performance. To gain a broader understanding of healthcare performance and to adequately measure it in the ED setting, a more comprehensive approach is required. If valuable process and timeline indicators have to be closely linked with patients' outcomes, the outcomes themselves must also be measured. In direct response to this challenge, **this thesis project aimed to develop and validate an in-hospital standardized mortality ratio specific to emergency sensitive conditions as one tool for measuring ED care performance.**

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SB, ESL, HQ and HTS designed the study and supervised its conduct. SB carried out the statistical analyses and drafted the initial manuscript herein reproduced. SB assumes responsibility for the integrity of the manuscript. The manuscript has not been approved by co-authors yet and has not been submitted for publication.

To my wife, daughter and sons who make my life so meaningful…

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List of Symbols, Abbreviations and Nomenclatures

ED: Emergency Department

HSMR: Hospital Standardized Mortality Ratio

DG: Diagnosis Group

ICD-10-CA: International Classification of Diseases – 10th version – Canada

RAM: RAND/UCLA Appropriateness Method

CAEP: Canadian Association of Emergency Physicians

NENA: National Emergency Nurses Affiliation

CIHI: Canadian Institute for Health Information

CTAS: Canadian Triage and Acuity Scale

Health care is a decade or more behind other high-risk industries in its attention to ensuring basic safety. (…) In 1998, there were no deaths in the United States in commercial aviation. In health care, preventable injuries from care have been estimated to affect between three to four percent of hospital patients. Although health care may never achieve aviation's impressive record, there is clearly room for improvement. To err is human, but errors can be prevented.

Committee on Quality of Health Care in America, Institute of Medicine, To Err is human: Building a Safer Health System

Chapter 1: Introduction

1.1 Overview

Healthcare systems in developed countries are grappling with emergency department (ED) overcrowding[1-3]. Although a prominent issue yielding many related metrics, accessibility is only one dimension by which to measure ED performance[4]. To gain a broader understanding of healthcare performance and to adequately measure it in the ED setting, a more comprehensive approach is required. If valuable process and timeline indicators have to be closely linked with patients' outcomes, the outcomes themselves must also be measured[5]. In direct response to this challenge, **this thesis project aimed to develop and validate an in-hospital standardized mortality ratio specific to emergency sensitive conditions as one tool for measuring ED care performance.**

1.2 The Problems

1.2.1 Adverse Events and Avoidable Errors

Canadian EDs treat more than 12 million patients annually[6]. This high-volume, dynamic and complex environment is prone to errors and quality issues[7]. Reports on adverse events in healthcare have suggested that EDs often have the highest rates of avoidable errors among care locations[8]. In a study reporting on in-hospital adverse events in Utah and Colorado, 94.8% of adverse events related to emergency physicians' work were judged to be directly caused by negligence[9]. Similarly, a Canadian prospective cohort study

conducted in 2010 in two tertiary care centres revealed that 8.5% of 503 high-acuity ED patients (94% of CTAS[1] 1-3) experienced adverse events and that 55.8% of these were deemed preventable[10]. Despite some variation in adverse event rates from one jurisdiction to another, EDs represent a high-risk environment for breaches in quality-of-care. Feasible, reliable and valid indicators are essential to identify sub-optimal performance within EDs and promote appropriate interventions that will yield significant improvements.

1.2.2 An Unbalanced Performance Assessment Approach

For more than a decade, access-to-care and time-sensitive indicators have been ubiquitous in the ED performance assessment literature[11-13]. The over-representation of time-based measures can trace its roots to the ED crowding burden that has become a major threat to patient safety. A compelling body of evidence now associates overcrowding with an increased time to thrombolysis[14], delays in antibiotics administration[14-16] and pain management[14,17,18], patient dissatisfaction[14], and furthermore, an increased in-hospital and out of hospital mortality[14,19,20].

However, after focusing on very restrictive ED length-of-stay targets, many countries are now adopting a more comprehensive performance assessment approach. Literature from these jurisdictions suggests that restrictive waiting time targets have replaced patients' needs as the primary focus for many clinicians and managers, often leading to distorted medical practice and unfavourable outcomes after an ED visit[21,22]. Key healthcare

[1] Canadian Triage and Acuity Scale: scale from 1 to 5 where CTAS 1 means Resuscitation, CTAS 2 Emergent, CTAS 3 Urgent, CTAS 4 Semi-Urgent and CTAS 5 Non urgent.

system stakeholders are now trying to define more balanced sets of indicators by including process, structure and outcome indicators in their performance framework.

Measuring outcomes of emergency patients is challenging since the care episode often continues beyond the emergency room[3]. Patient outcomes ultimately reflect the impact of all structures and processes of care. Moreover, they represent a more meaningful reflection of performance than process measures as they are the real goals of any healthcare system and of all care providers. Few ED performance indicators have been developed and validated to assess patient outcomes[4,23].

1.2.3 Mortality after an Emergency Department Visit

Mortality probably represents one of the most worthy outcomes to monitor in emergency medicine. Existing literature suggests that preventable deaths for admitted[24-27] or discharged[28] patients from ED could be a concerning issue. For one, Nafsi et al. 2007 reported an all-cause in-hospital mortality rate of 2.69% at 7 days after admission from ED, with 12.6% of those deaths being deemed preventable. Similarly, Fry et al. 2005 found a 3.5% in-hospital mortality rate among all hospitalized ED patients, while Lu et al. 2006 estimated that 25.8% of early deaths at 24h after an ED admission were preventable. With 12 000 000 visits annually in Canadian EDs[6] and a mean ED hospitalization rate of 9.5%, that would represent as many as 10 000 ED-related deaths that could potentially be prevented in Canada each year. These studies concordantly underlined in their conclusions the importance of auditing mortality after an ED visit by regular chart reviews. However, this quality assessment method is resource-consuming and inconsistently done. To our

knowledge, there is currently no validated standardized approach to monitor mortality after an episode of ED care.

1.3 The Challenges

1.3.1 Defining Performance in Emergency Medicine

"Performance" is traditionally defined as the degree to which an organization reaches its objectives[29]. Healthcare system performance is most often further subdivided into different domains to facilitate its measurement. For instance, the *Canadian Institute for Health Information* (CIHI) commonly uses 8 dimensions to portray what performance implies[30]: acceptability, accessibility, appropriateness, competence, continuity, effectiveness, efficiency and safety.

Similarly, "quality of care" has been defined in various ways[31]. For one, the Institute of Medicine has defined it as the "degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge"[32]. Overlapping with performance, quality of care is often used interchangeably in the Quality Improvement literature. To address the lack of precision in the current literature, Champagne et al. 2005 proposed the use of performance as a multidimensional and comprehensive term that encompasses, among others, the quality of care provided. In that perspective, "quality of care" is more specifically used to characterize the specific processes of care, meaning all actions related to the direct interaction between a care provider and a patient[29]. Those definitions are still

controversial, but in order to avoid confusion in the course of this text, we will adopt those assumptions and use performance as a generic term describing the assessment of outcomes, processes and structures[25]. Quality of care will be strictly used to reflect processes of care.

Performance and quality in emergency medicine are elusive concepts. Emergency physicians treat a wide spectrum of conditions that can present in unpredictable ways, at any time of the day, and with variable acuity[11]. Thus, the field of emergency medicine is not well defined nor delimited and that fact hampers the performance assessment process in EDs.

Over the past decade, international consensus meetings[33,34] and research initiatives have tried to circumscribe ED performance to precise sets of indicators[13,35-38]. However, until now, there is no definite consensus on which indicators should be included in such a framework[4].

More recently, an evidence-based set of indicators, aimed specifically at assessing ED performance, has been published by the *Institute for Clinical Evaluative Sciences* in Ontario[6]. Proposing previously validated and expert-consensus indicators, one of the 48 retained in the framework involves measuring condition-specific survival rates following ED care; in this case, severe sepsis. The rationale behind assessing survival/mortality after an ED visit could be extended to other emergency-sensitive conditions upon which the ED team's management would be expected to have an impact.

1.3.2 Linking Mortality to Emergency Department Care

Patient mortality is usually remote from ED care[4] and greatly depends on the efficient integration of all involved hospital services, making it virtually impossible to isolate ED influence using a single mortality rate measure. That fact emphasizes that any measure of an ED-related in-hospital mortality rate will have to be subsequently weighted with the relative impact of the other components of the hospital system in which EDs are integrated. Still, many consensus statements and research initiatives have recommended monitoring either the overall or condition-specific mortality rates in patients after an ED visit[24,35,36,39].

1.4 A Possible Solution

1.4.1 Adapting the Canadian Hospital Standardized Mortality Ratio

The *Canadian Institute for Health Information* (CIHI) estimates for each individual Canadian Hospital a *Hospital Standardized Mortality Ratio* (HSMR) derived from the 72 Diagnosis Groups (DG) of the 10th version of the International Classification of Diseases (ICD-10) that account for 80% of in-hospital deaths in Canada[40,41] (Appendix A). More specifically, this ratio calculates, within patients having one of those 72 diagnoses, the observed number of deaths in a hospital during a specific year divided by the expected number of deaths in the same hospital, based on the mortality rates observed in comparable hospitals (4 peer-groups: teaching hospitals and 3 groups of community

hospitals according to case volume) during the reference year (2009-2010). The ratio is then multiplied by 100.

$$\text{HSMR} = \frac{\text{Actual number of deaths among 72 diagnosis groups accounting for 80\% of inpatient mortality}}{\text{Expected number of deaths among 72 diagnosis groups accounting for 80\% of inpatient mortality}} \times 100$$

Hospitals with a HSMR greater than 100 have a mortality rate greater than expected and hospitals with a HSMR less than 100 have a mortality rate lower than anticipated. Furthermore, CIHI has sub-divided the hospital SMR into three additional ratios to evaluate different patient populations (medical, surgical and ICU). However, since those ratios include many conditions not relevant to emergency medicine, **I hypothesized that a mortality ratio specifically capturing the outcomes of patients with emergency-sensitive conditions would better reflect ED care.**

1.4.2 Identifying Emergency-Sensitive Conditions

To adapt the CIHI HSMR to the ED setting, I needed to identify and include in our calculation only diagnoses that are "sensitive" to ED care. More precisely, emergency-sensitive conditions could be defined as diagnoses/conditions that are 1) frequently treated in most EDs and 2) are ED-management dependent for their outcomes[42]. Inspired by the widespread use of ambulatory care sensitive conditions, some have advocated the development of this conceptual model to improve performance assessment in the ED, but to our knowledge, no studies have previously tried to develop the concept of emergency-sensitive conditions.

1.5 Study Objectives

To improve the assessment of patients' outcomes that are influenced by care in the ED setting, this thesis project aimed to develop an in-hospital standardized mortality ratio specific to emergency sensitive conditions. Our study also had the following specific objectives:

1) To develop a list of emergency-sensitive conditions from the list of DGs currently used by CIHI to calculate the Canadian HSMRs;
2) To test the face validity of the list of the emergency-sensitive DGs selected;
3) To develop a risk adjustment model to calculate an ED-sensitive HSMR.

1.6 Overall Study Design

To reach those objectives, we conducted a mixed-methods study, following a three-stage approach:

1) A multidisciplinary expert panel used a RAND/UCLA Appropriateness Method (RAM) to identify emergency-sensitive conditions from the list of the 72 DGs employed by CIHI to calculate the Canadian HSMR;

2) A survey of ED care providers was conducted to test the face validity of the emergency-sensitive conditions identified by the panelists;

3) A new ED-HSMR was calculated and evaluated using the emergency-sensitive conditions identified with the two previous stages and data obtained from CIHI representing 2069405 patient discharges between April 1st 2009 and March 31st 2011.

The next chapters will describe how I achieved this study and detailed the methods employed. This thesis project received approval from the Conjoint Health Ethics Board at the University of Calgary (E-24580).

1.7 Thesis Structure

We propose here a manuscript-based dissertation. From the three study stages described above, three manuscripts have been produced. Two have been accepted for publication in peer-review journals, while submission is pending for the third one.

Chapter two is the reproduction of a published manuscript in *Annals of Emergency Medicine*. It describes the sub-study that led to the identification of emergency-sensitive conditions using a national multidisciplinary panel.

Chapter three is the reproduction of an in-press manuscript accepted for publication in the *Canadian Journal of Emergency Medicine*. It reports the results of the national survey of ED care providers to test the face validity of the emergency-sensitive conditions previously identified with the panel, before using them in the ED-HSMR calculation.

Chapter four is the third manuscript describing the development and validation of the risk-adjustment model allowing for the ED-HSMR calculation.

Finally, **chapter five** highlights the original contribution of this thesis project, identifies research opportunities and suggests future research directions.

Chapter 2

Identifying Emergency-Sensitive Conditions for the Calculation of an Emergency Care In-Hospital Standardized Mortality Ratio

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Simon Berthelot, MD[1,2], Eddy S. Lang, MD[2], Hude Quan, MD PhD[1], Henry T. Stelfox, MD PhD[1,3], on behalf of the *Panel on Emergency-Sensitive Conditions (PESC)**

Affiliations : [1]Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada; [2]Department of Emergency Medicine, University of Calgary, Calgary, Alberta, Canada; [3]Department of Critical Care, University of Calgary, Calgary, Alberta, Canada.

Corresponding author (same author for reprints):

Dr. Simon Berthelot

Department of Emergency Medicine

CHU de Québec – CHUL, 2705 Boul. Laurier, Québec, Qc, Canada, G1V 4G2

siberth@me.com (can be published)

Department(s) and institution(s) to which the work should be attributed:

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* Group authorship – authors listed in alphabetical order at end of manuscript

ABSTRACT

Objectives:

Hospital Standardized Mortality Ratios (HSMR) are used for hospital performance assessment. As a first step to develop a HSMR variant sensitive to the outcome of patients admitted from the emergency department (ED), we identified International Classification of Diseases-10-Canada (ICD-10-CA) Diagnosis Groups (DGs) where high-quality ED care would be expected to reduce in-hospital mortality (emergency-sensitive conditions).

Methods:

To identify emergency-sensitive conditions, we assembled a multidisciplinary panel of emergency care providers and managers (n=14). Using a modified RAND/UCLA Appropriateness Method, three rounds of independent ratings including a teleconference were conducted from May to October 2012. Panelists serially rated DGs included in the Canadian HSMR (n=72) according to the extent ED management influences mortality.

Results:

The panel rated ED care as potentially reducing patient mortality for 37 DGs (e.g., sepsis), morbidity for 43 DGs (e.g., atrial fibrillation) and that timely ED care was critical for 40 DGs (e.g., stroke). Panelists also identified 47 DGs (e.g., asthma) not included in the Canadian HSMR where mortality could potentially be decreased by ED care.

Conclusion:

We identified 37 DGs representing emergency-sensitive conditions that will enable the calculation of a HSMR relevant to emergency care.

INTRODUCTION

Background

The *Hospital Standardized Mortality Ratio* (HSMR) was developed in the United Kingdom (UK) during the mid-1990s. The HSMR is based on patients who died in-hospital from one of the diagnoses that account for 80% of all hospital deaths.[1] It is the ratio of the observed number of deaths in a hospital for these diagnoses in a specific year divided by the number of deaths expected if mortality was similar to patients admitted to comparable hospitals across a country or jurisdiction in a reference year.[1] The HSMR is calculated from administrative health data and has been shown to be a useful tool to monitor in-hospital mortality trends within institutions.[2] The United Kingdom (UK), Sweden, Netherlands, the United States, Australia and Canada now use the HSMR as a measure of hospital performance.

Importance

Monitoring mortality rates is increasingly advocated as a part of emergency department (ED) quality improvement frameworks. Previous studies have estimated in-hospital mortality for patients admitted to hospital through the ED to be between 2.7%[3] and 3.5%.[4] Of these deaths, 12.6%[3] may be preventable. Considering the number of ED visits annually (123.8 million in the United States of America [USA][5] and 12 million in Canada[6]) and the mean hospitalization rate through EDs (13.4% in the USA[5] and 9.5% in Canada[7]), as many as 73 000 ED-related in-hospital deaths in the United States and 5000 ED-related in-hospital deaths in Canada may be preventable. There is currently no

standardized approach to adjust and monitor in-hospital mortality rates after an episode of ED care.

Many jurisdictions report an all-case HSMR or a patient population specific HSMR (e.g., medical, surgical and ICU); however, none of these ratios specifically captures the outcomes of admitted patients with conditions where ED management would be expected to have an impact (emergency-sensitive conditions).

Goals of the investigation

Therefore, as a first step towards developing an ED-HSMR variant based on patients admitted to hospital from the ED, we aimed to identify emergency-sensitive conditions from the list of the 72 International Classification of Diseases-10-Canada (ICD-10-CA) Diagnosis Groups (DGs) accounting for 80% of in-hospital deaths in Canada.

METHODS

STUDY DESIGN

We used a modified RAND/University of California Appropriateness Method (RAM) to identify DGs representing emergency-sensitive conditions.

Selection of the Panelists

We assembled a national multidisciplinary panel (n=14) with diverse backgrounds and expertise relevant to the care of ED patients admitted to hospital. Panelists were

recruited using recommendations from Canadian professional associations in emergency medicine and Nursing and from our research team's personal contacts. Letters of invitation with the time requirements and the program details were sent to nominated panellists (Appendix K). They were asked to suggest other experts in related disciplines.

Rating Instrument

Panelists were asked to independently rate each of the 72 DGs included in the Canadian HSMR using a secure, web-based instrument (Appendix B). For each DG, they were asked three questions:

1. Most of the time, to what extent does ED management impact mortality related to this Diagnosis Group?
2. Most of the time, to what extent does ED management impact morbidity related to this Diagnosis Group?
3. Most of the time, to what extent does this Diagnosis Group require an ED time-sensitive intervention (timely intervention done in the ED that improves patients' outcomes[8])?

By intent, the questions were not restricted to inpatients or to a specific time period after the ED episode of care in order to acquire a comprehensive evaluation of potential emergency-sensitive conditions. The responses to each question were used to generate three non-mutually-exclusive lists of emergency-sensitive DGs related to mortality, morbidity and time-sensitivity.

A rating instrument using the validated nine-point RAM scale, with one representing strong disagreement (ED management does not influence patient outcomes) and nine

representing strong agreement (ED management does influence patient outcomes), was developed.

For each DG, panelists were provided with a medical definition and the ICD-10-CA description. The ICD-10 is characterized by the use of an alphanumeric system (one letter followed by up to three numbers) that allows for nearly twice as many codes as the ICD-9 (based on numbers only at the three-character level). The ICD-10 has been customized by several countries (e.g., Canada and Australia) to further describe numerous diagnosis groups[9]. The USA is scheduled to begin using a customized ICD-10 variant on October 1st 2014[10].

Finally, panelists were invited to provide comments and to suggest other potential emergency-sensitive conditions not included in the DGs used to calculate the Canadian HSMR.

Rating Process

The rating process was conducted between May and October 2012 using three rounds of review. Panelists were presented the DGs using a web-survey and asked to independently rate each DG. In each successive round of reviews, panelists were provided personalized summaries of ratings, anonymous distribution of panelists' answers and median scores from the previous round to enhance the rating process. Round two of the rating process was performed using a teleconference to provide panelists an opportunity to discuss the DGs and to independently rate the DGs using the same web-survey. An

experienced moderator facilitated discussion among the panelists. Answers to issues raised by the panelists during the teleconference about the ICD-10-CA DGs (e.g., clarification of DG definitions) were supplied after consultation with a DG coding specialist. A third and final round of DG rating was then performed by panelists using the same web-survey.

STATISTICAL ANALYSIS

DG ratings were summarized using medians and interquartile ranges (IQR). The median rating was used to classify each DG as "not emergency-sensitive" (median score 1-3), "controversial" (median score 4-6) and "emergency-sensitive" (median score 7-9). Disagreement for a DG was defined as an overall assessment by at least four of the panelists in the "not emergency-sensitive" range (median score 1-3) and at least four of the panelists in the "emergency-sensitive" range (median score 7-9). During sequential rounds of rating, DGs with a median score of one to three were eliminated from further evaluation, and those with a median score of seven to nine were retained in the final lists of emergency-sensitive conditions. DGs with a median score of four to six were retained for review in the subsequent panel rating round. DGs classified as controversial (median score 4-6 or disagreement) after the final round of review were rejected. Analyses were performed using Stata version 12.0 (StataCorp LP, TX, USA). The study received ethics approval from the Conjoint Health Research Ethics Board at the University of Calgary (E-24580).

RESULTS

Characteristics of the participants

Table 1 shows the characteristics of the 14 panelists. Of the 20 nominees offered membership to the panel, 14 (70%) agreed to participate. Reasons to decline participation were reported primarily as a lack of time and schedule conflicts for the date of the teleconference.

Selection of emergency-sensitive conditions

Of the 72 DGs presented (see Figure), the panel rated that ED care could potentially reduce patient mortality for 37 DGs (e.g., I26 pulmonary embolism), morbidity for 43 DGs (e.g., I48 atrial fibrillation) and that timely ED care was critical for 40 DGs (e.g., I64 stroke).

Table 2 reports the final median scores and interquartile ranges by DG for each of the three domains (mortality, morbidity and time-sensitivity). All 37 mortality-related DGs were selected as DGs where ED care may reduce morbidity (Table 3). Similarly, 35 of the 37 mortality-related DGs were selected as being time-sensitive (Table 4).

From the 72 DGs rated, 11 of the 15 diseases of the circulatory system (I-xx, e.g., I46 cardiac arrest) were included as mortality-related emergency-sensitive conditions, while all 17 malignant neoplasms (C-xx, e.g., C50 malignant neoplasm of breast) were excluded. Acute myocardial infarction (I21), shock NEC (R57) and sepsis (A41) received the highest

panel ratings for the mortality domain. Alzheimer's disease (G30), convalescence (Z54) and unspecified dementia (F03) received the lowest panel ratings for the same domain.

Forty-seven additional DGs not included in the Canadian HSMR were suggested by panelists as potential emergency-sensitive conditions (Table 5). These primarily included trauma (n=11, e.g., S12 fracture of the neck), cardiovascular (n=9, e.g., I20 angina pectoris), toxicological (n=8, e.g., T58 toxic effect of carbon monoxide), infectious (n=7, e.g., M01 direct infections of joint) and environmental (n=5, e.g., T68 hypothermia) DGs.

LIMITATIONS

Some of the 72 DGs presented to the panel represent heterogeneous ICD-10-CA codes (e.g., E11 type 2 diabetes mellitus) and it was not feasible to have panelists rate individual codes contained within these DGs. Consequently, the classification process may have produced different results for a few DGs if the incidence of each sub-code (e.g., E11.1 type 2 diabetes mellitus with coma) could have been provided to the panelists. We believe, however, that the sensitivity analysis planned for the development of the ED-HSMR will address this potential limitation by assessing the relative impact of each DG on the ED-HSMR value.

Although the RAM uses standardized procedures that have been successfully used in many studies, it remains a consensus process method where the rating scale, the classification criteria and the disagreement rules are arbitrarily defined. Moreover, RAM's

results depend on the panel composition and although the same process with different panelists may not have produced identical results, it is likely that the emergency-sensitive conditions selected would be similar.

Finally, using administrative dataset to retrospectively identify emergency-sensitive conditions from the ICD-10 codes may represent a challenge since the most responsible diagnosis on hospital discharge may not reflect the clinical diagnosis or the ED presenting complaint. This is a potential limitation of using administrative data for ED performance assessment.

DISCUSSION

Using the RAM, we identified 37 DGs where high-quality ED care (adequate diagnosis and/or appropriate therapy and/or timely care) could reduce mortality of patients admitted to hospital. The identification of emergency-sensitive DGs will enable the calculation of a HSMR specific to emergency care.

The concept of "sensitive conditions" while used in healthcare for more than 30 years has more recently been also applied to emergency care. Rutstein et al. (1976) first described the "sentinel health events" in community health where the incidence of some specific conditions inside a population were considered to be indices of the quality of medical care offered to this population.[11] Billings et al. (1993) applied the notion of "sentinel" diseases to ambulatory care by defining ambulatory care sensitive conditions as

"conditions-diagnoses for which timely and effective outpatient care can help to reduce the risk of hospitalization(…)".[12] Carr et al. (2010) defined emergency care sensitive conditions as conditions for which "high-quality emergency care makes a unique contribution to patient outcomes".[8] In all settings, outcomes of patients with "sensitive conditions" are used as proxies for measuring system performance and quality of care.

We have developed the first lists of emergency-sensitive conditions for three different domains (mortality, morbidity, time-sensitivity). Emergency-sensitive conditions are meant to circumscribe the elusive nature of performance in emergency care and our work offers opportunities for further development of this concept.

The potential utility and impact of this work can be characterized as follows. Firstly, our lists of emergency-sensitive conditions could promote new research initiatives with the goal of identifying research gaps in ED quality measurement. Secondly, local institutions and central authorities could use our lists to define their ED performance assessment framework, guide the development of care protocols or set quality improvement priorities on DGs most dependent on ED care. Thirdly, our work will enable the calculation of a HSMR specific to emergency-sensitive conditions to monitor mortality trends within institutions. The ED-HSMR will be one additional quality measurement tool that can be used with other quality measures to discriminate the relative influence of each hospital department on the outcomes of patients admitted to hospital with emergency-sensitive conditions. We will calculate the ED-HSMR at hospital discharge and at 48 hours after hospital admission to

evaluate the hypothesis that measuring mortality more proximally to the ED episode will better reflect ED impact on patient outcome.

In summary, we identified 37 DGs where high-quality ED care could reduce mortality. The identification of emergency sensitive DGs will enable the calculation of the first in-hospital standardized mortality ratio of emergency care. Evaluation of emergency-sensitive conditions may help improve our understanding of ED performance assessment and guide improvements to patient care.

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Panel on Emergency-Sensitive Conditions Authors (alphabetic order)

Patrick Archambault, MD MSc, Département de médecine familiale et de médecine d'urgence et Division de soins intensifs, Université Laval, Québec, Québec, Canada.

Guillaume Charbonneau, MD, Département de médecine, CSSS de la Vallée-de-la-Gatineau, Maniwaki, Québec, Canada.

James Ducharme, MD CM, Department of Medicine, Division of Emergency Medicine, McMaster University, Hamilton, Ontario, Canada.

Johanne Fiset, RN, Royal Victoria Hospital, McGill University Health Centre (MUHC), Montréal, Québec, Canada.

Ward Flemons, MD, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada.

Morad Hameed, MD, Department of Surgery, Vancouver General Hospital, Vancouver, British Columbia, Canada.

Alex Hoechsmann, MD, Vancouver Island Health Authority, Victoria, British Columbia, Canada.

Grant Innes, MD, Department of Emergency Medicine, University of Calgary, Calgary, Alberta, Canada.

Nadim Lalani, MD CEd, Department of Emergency Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Bruce McLeod, MD, Department of Emergency Medicine, Port-Williams Hospital, Port-Williams, Nova Scotia, Canada.

David Morgan, MD, Disciplines of Emergency Medicine and Family Medicine, Memorial University of Newfoundland, St-John's, Newfoundland, Canada.

Sunita Mulpuru, MD, Division of Respirology, Department of Medicine, University of Ottawa, Ottawa, Ontario, Canada.

Lori Quinn, RN, Vancouver Coastal Health Authority, British Columbia, Canada.

Marcel Rheault, RN, Centre hospitalier régional de Trois-Rivières, Trois-Rivières, Québec, Canada.

Brian Rowe, MD MSc, Department of Emergency Medicine, University of Alberta, Edmonton, Alberta, Canada.

REFERENCES

1. Penfold RB, Dean S, Flemons W, Moffatt M. Do hospital standardized mortality ratios measure patient safety? HSMRs in the Winnipeg Regional Health Authority. *HealthcarePapers.* 2008;8(4):8-24; discussion 69-75.

2. Zahn C, Baker M, MacNaughton J, Flemming C, Bell R. Hospital standardized mortality ratio is a useful burning platform. *HealthcarePapers.* 2008;8(4):50-53; discussion 69-75.

3. Nafsi T, Russell R, Reid CM, Rizvi SM. Audit of deaths less than a week after admission through an emergency department: how accurate was the ED diagnosis and were any deaths preventable? *Emerg Med J.* Oct 2007;24(10):691-695.

4. Fry M, Rhodes-Sutton A. A retrospective chart review of adult mortality characteristics of patients presenting to a principal tertiary emergency department. *Accident and emergency nursing.* Apr 2005;13(2):122-125.

5. Pitts SR, Pines JM, Handrigan MT, Kellermann AL. National trends in emergency department occupancy, 2001 to 2008: effect of inpatient admissions versus emergency department practice intensity. *Ann Emerg Med.* Dec 2012;60(6):679-686 e673.

6. Schull MJ, Hatcher CM, Guttmann A, et al. Development of a Consensus on Evidence-Based Quality of Care Indicators for Canadian Emergency Departments: ICES Investigative Report. *Institute for Clinical Evaluative Sciences.* March 2010.

7. Canadian Institute for Health Information. Bulletin: Highlights of 2008–2009 Inpatient Hospitalizations and Emergency Department Visits. http://www.cihi.ca/CIHI-ext-

portal/internet/en/Document/health+system+performance/indicators/health/RELEASE_18MAY10. Accessed February 25, 2013.

8. Carr BG, Conway PH, Meisel ZF, Steiner CA, Clancy C. Defining the emergency care sensitive condition: a health policy research agenda in emergency medicine. *Ann Emerg Med.* Jul 2010;56(1):49-51.

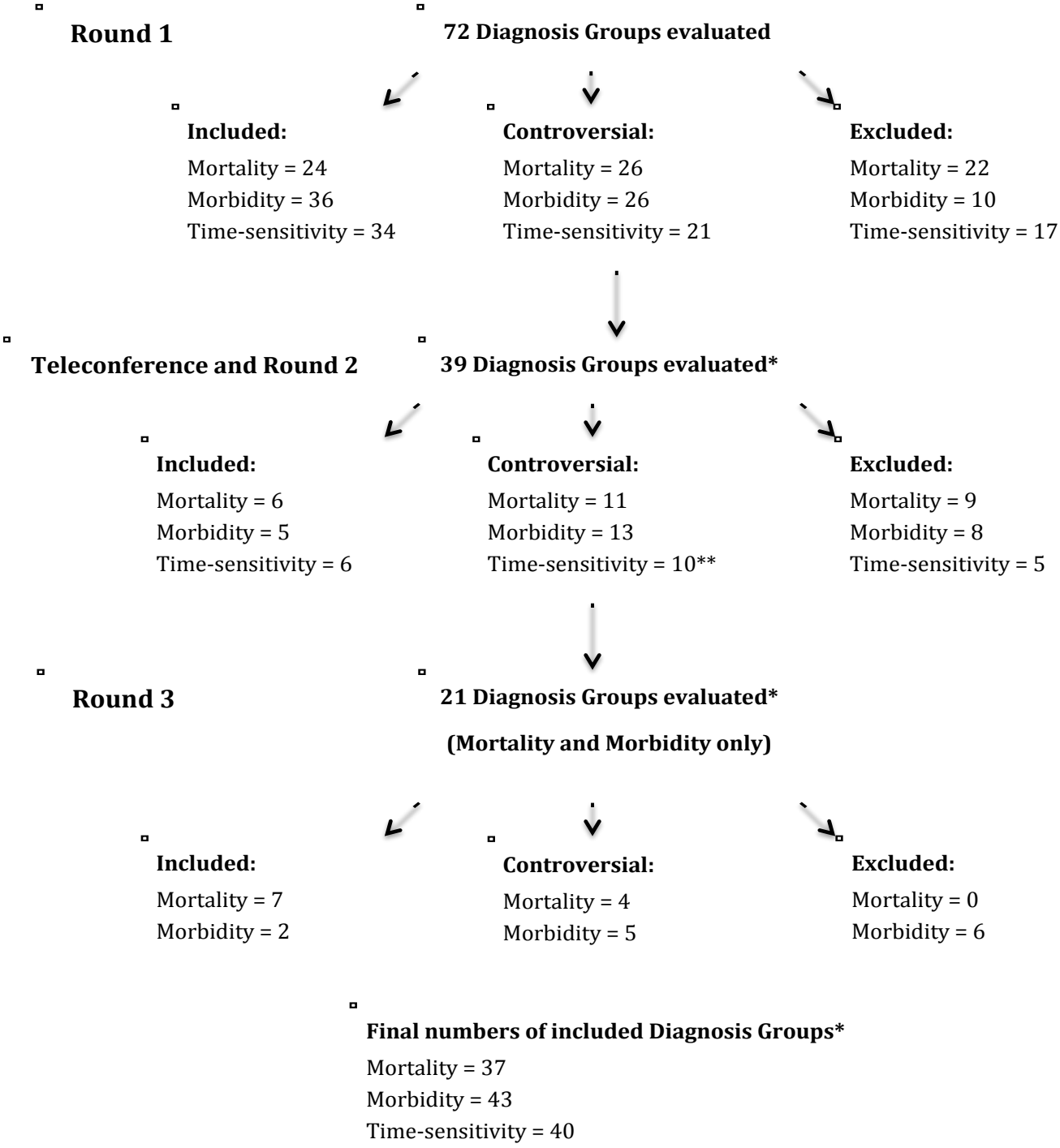
9. Jette N, Quan H, Hemmelgarn B, et al. The development, evolution, and modifications of ICD-10: challenges to the international comparability of morbidity data. *Med Care.* Dec 2010;48(12):1105-1110.

10. American Medical Association. ICD-10 Code Set to Replace ICD-9. 2013; http://www.ama-assn.org/ama/pub/physician-resources/solutions-managing-your-practice/coding-billing-insurance/hipaahealth-insurance-portability-accountability-act/transaction-code-set-standards/icd10-code-set.page. Accessed June 10th, 2013.

11. Rutstein DD, Berenberg W, Chalmers TC, Child CG, 3rd, Fishman AP, Perrin EB. Measuring the quality of medical care. A clinical method. *The New England journal of medicine.* Mar 11 1976;294(11):582-588.

12. Billings J, Zeitel L, Lukomnik J, Carey TS, Blank AE, Newman L. Impact of socioeconomic status on hospital use in New York City. *Health affairs.* Spring 1993;12(1):162-173.

Figure: Flow Chart of the Panel Review



*Some Diagnosis Groups were re-evaluated and/or selected on more than one dimension (non mutually exclusive categories)

**To focus the panel's time on identifying DGs related to mortality, controversial DGs for "Time-sensitivity" were not assessed in the third round and consequently were excluded

Table 1. Characteristics of panelists[*] (n=14)[a]

Male	11
Median number of years of work experience (IQR[b])	7.5 (4, 15)
Expertise	
Emergency Physician	9
Emergency Nurse	2
ED Nurse Manager	1
ED Physician Head	2
Researcher in Emergency Medicine	4
Intensivist	2
General and Trauma Surgeon	1
Internist	1
Rural Family Physician	1
Location of Practice	
Québec	3
Ontario	2
Alberta	2
British Columbia	2
Saskatchewan	1
Nova Scotia	1
Newfoundland and Labrador	1
Northwest Territories	1
Nominating Professional Association	
CAEP[c]	4
NENA[d]	1
CQMF[e]	1
AGIIUQ[f]	1

[*] All data are presented as number and percentage [n (%)] unless otherwise indicated

[a] The second round of reviews (teleconference) was moderated by a university-appointed pulmonary physician with relevant expertise in patient safety and quality improvement.

[b] Interquartile range

[c] Canadian Association of Emergency Physicians

[d] National Emergency Nurses' Affiliation

[e] Collège québécois des médecins de famille

[f] Association des gestionnaires infirmiers et infirmières du Québec

Table 2. Final median panel ratings by Diagnosis Groups for mortality, morbidity and time-sensitivity

Diagnosis Groups	Mortality Median (IQR)	Morbidity Median (IQR)	Time-sensitivity Median (IQR)
A04 Other bacterial intestinal infection	5 (3, 7.5)	7 (6,8)	7 (6, 8)
A41 Sepsis	9 (8, 9)	9 (8, 9)	9 (9, 9)
C15 Malignant neoplasm of oesophagus	3 (1, 4)	3 (2,3)	3 (2, 6)
C16 Malignant neoplasm of stomach	2.5 (1, 5)	3 (2, 4)	3 (1, 5)
C18 Malignant neoplasm of colon	3 (2, 5)	3 (3, 5)	4 (3, 7)
C22 Malignant neoplasm of liver and intrahepatic bile ducts	2.5 (1, 5)	3 (3, 5)	3 (3, 5)
C25 Malignant neoplasm of pancreas	2 (1, 3)	3 (2, 6)	3 (1, 4)
C34 Malignant neoplasm of bronchus and lung	3 (2, 4)	3 (3, 5)	3 (1, 5)
C50 Malignant neoplasm of breast	3 (2, 5)	3 (3, 6)	3 (2, 5)
C61 Malignant neoplasm of prostate	2 (1, 3)	2.5 (1, 5)	2 (1, 5)
C67 Malignant neoplasm of bladder	3 (1, 5)	3 (3, 6)	3 (3, 5)
C71 Malignant neoplasm of the brain	3 (2, 3)	7 (5, 8)	5 (3, 7)
C78 Secondary malignant neoplasm of respiratory and digestive organs	2 (1, 5)	3 (2,5)	2.5 (2, 4)
C79 Secondary malignant neoplasm of other sites	2 (1, 4)	3 (2, 5)	2 (2, 3)
C80 Malignant neoplasm without specification of site	3 (1, 4)	3 (2, 4)	2.5 (1, 4)
C83 Diffuse non-Hodgkin's lymphoma	3 (2, 6)	3 (2, 5)	3 (2, 5)
C85 Other and unspecified types of non-Hodgkin's lymphoma	3 (1, 6)	3 (2, 6)	3 (2, 4)
C90 Multiple myeloma and malignant plasma cell neoplasms	3 (2, 3)	7 (3, 7)*	4 (3, 6)
C92 Myeloid leukemia	3 (2, 4)	7 (3, 7)*	4 (3, 5)
E11 Diabetes Mellitus type 2	7 (6, 8)	7 (6, 7)	6 (4, 7)
E86 Volume depletion	8 (7, 8)	8 (7, 9)	8 (7, 9)
E87 Other disorders of fluid, electrolyte and acid-base balance	7.5 (7, 8)	8 (8, 9)	8 (7, 9)
F03 Unspecified dementia	1.5 (1, 3)	2 (2, 3)	2.5 (2, 4)
F05 Delirium, not induced by alcohol and other psychoactive substances	7 (5, 8)	7 (6, 9)	7 (6, 9)
G30 Alzheimer's disease	1 (1, 2)	2 (2, 4)	2 (1, 3)
G93 Other disorders of brain	7 (3.5, 8)	7 (6.5, 8)	6 (5, 8)
I21 Acute Myocardial Infarction	9 (9, 9)	9 (9, 9)	9 (9, 9)
I24 Other acute ischemic heart disease	8 (7, 9)	9 (7, 9)	8.5 (7, 9)
I25 Chronic ischemic heart disease	4.5 (3, 7)	7 (3, 7)*	4 (3, 7)
I26 Pulmonary embolism	9 (8, 9)	9 (8, 9)	9 (8, 9)
I35 Nonrheumatic aortic valve disorders	3 (3, 4)	7 (3, 7)*	3 (3, 4)
I46 Cardiac arrest	9 (6, 9)	9 (9, 9)	9 (9, 9)
I48 Atrial fibrillation and flutter	7 (3, 8)*	8 (7, 8)	8 (6, 8)
I50 Heart failure	7 (6, 9)	8 (7, 9)	8 (8, 9)
I60 Subarachnoid haemorrhage	8.5 (7, 9)	9 (8, 9)	9 (7, 9)

Table 2. Continued

Diagnosis Groups	Mortality Median (IQR)	Morbidity Median (IQR)	Time-sensitivity Median (IQR)
I61 Intracerebral haemorrhage	8.5 (6, 9)	8.5 (7, 9)	9 (7, 9)
I62 Other non traumatic intracranial haemorrhage	9 (8, 9)	9 (8, 9)	9 (8, 9)
I63 Cerebral infarction	7 (5, 8)	8 (7, 9)	8 (7, 9)
I64 Stroke, not specified as haemorrhage or infarction	7.5 (6, 9)	8.5 (7, 9)	8.5 (7, 9)
I70 Atherosclerosis	2 (1, 4)	3 (1, 6)	2 (1, 4)
I71 Aortic aneurism and dissection	9 (8, 9)	9 (8, 9)	9 (8, 9)
J18 Pneumonia	7 (6, 8)	8 (6, 8)	7.5 (6, 8)
J44 Other chronic obstructive pulmonary disease	8 (8, 9)	7 (6, 8)	7 (6, 8)
J69 Pneumonitis due to solids and liquids	7 (6, 8)	7 (6, 8)	7 (6, 7)
J80 Adult respiratory distress syndrome	8 (7, 9)	9 (8, 9)	9 (8, 9)
J84 Other interstitial pulmonary diseases	2 (2, 3)	3 (2, 6)	7 (5, 7)
J90 Pleural effusion, not elsewhere classified	3 (2, 5)	7 (5, 7)	5 (3, 7)
J96 Respiratory failure, not elsewhere classified	9 (8, 9)	9 (9, 9)	9 (8, 9)
K26 Duodenal ulcer	7 (5, 8)	8 (7, 8)	8 (7, 8)
K55 Vascular disorders of intestine	8 (4, 8)	7 (6, 9)	8 (6, 8)
K56 Paralytic ileus and intestinal obstruction without hernia	7 (4, 8)	8 (7, 9)	8 (6, 9)
K57 Diverticular disease of intestine	7 (5, 8)	8 (7, 8)	7 (6, 8)
K63 Other diseases of intestine	3 (2, 6)	7 (5, 8)	7 (5, 8)
K65 Peritonitis	8 (7, 9)	8.5 (7, 9)	8.5 (8, 9)
K70 Alcoholic liver disease	3 (2, 4)	7 (3, 7)*	4 (2, 6)
K72 Hepatic failure	8 (5, 8)	8 (6, 9)	8 (5, 9)
K74 Fibrosis and cirrhosis of liver	3 (2, 4)	3 (3, 6)	4 (3, 5)
K85 Acute pancreatitis	8 (7, 8)	8 (7, 8)	7.5 (7, 8)
K92 Other diseases of digestive system	8 (7, 8)	7.5 (6, 8)	7 (6, 8)
L03 Cellulitis	7 (6, 8)	7 (4, 7)	7 (5.5, 8)
N17 Acute renal failure	8 (7, 8)	7.5 (6, 8)	7 (5, 8)
N18 Chronic renal failure	3 (2, 5)	3 (2, 6)	3 (2, 5)
N39 Other disorders of urinary system	2 (1, 2)	2 (1, 3)	2 (1, 2)
R53 Malaise and fatigue	2 (1, 2)	2 (1, 3)	2 (1, 3)
R57 Shock, not elsewhere classified	9 (9, 9)	9 (9, 9)	9 (9, 9)
R64 Cachexia	2 (2, 5)	2 (2, 3)	3 (2, 4)
S06 Intracranial injury	8 (7, 9)	8 (7, 9)	8 (7, 9)
S32 Fracture of lumbar spine and pelvis	8 (5, 9)	7 (6, 8)	7.5 (6, 8)
S72 Fracture of femur	8 (7, 8)	8 (7, 9)	7 (6, 8)
T81 Complications of procedures, not elsewhere classified	6 (2.5, 7.5)	8 (5, 8)	7 (5, 8)
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts	7.5 (5, 8)	8 (6, 9)	7.5 (5, 8)
Z54 Convalescence	1 (1, 2)	1 (1, 2)	1 (1, 2)

* Meeting the disagreement criteria (see Methods)

Table 3. List of the Diagnosis Groups for Mortality and Morbidity

Morbidity	*Mortality*	**A41**	Sepsis
		E11	Diabetes Mellitus type 2
		E86	Volume depletion
		E87	Other disorders of fluid, electrolyte and acid-base balance
		F05	Delirium, not induced by alcohol and other psychoactive substances
		G93	Other disorders of brain
		I21	Acute Myocardial Infarction (AMI)
		I24	Other acute ischemic heart disease
		I26	Pulmonary embolism
		I46	Cardiac arrest
		I50	Heart failure
		I60	Subarachnoid haemorrhage
		I61	Intracerebral haemorrhage
		I62	Other non traumatic intracranial haemorrhage
		I63	Cerebral infarction
		I64	Stroke, not specified as haemorrhage or infarction
		I71	Aortic aneurism and dissection
		J18	Pneumonia
		J44	Other chronic obstructive pulmonary disease
		J69	Pneumonitis due to solids and liquids
		J80	Adult respiratory distress syndrome
		J96	Respiratory failure, not elsewhere classified
		K26	Duodenal ulcer
		K55	Vascular disorders of intestine
		K56	Paralytic ileus and intestinal obstruction without hernia
		K57	Diverticular disease of intestine
		K65	Peritonitis
		K72	Hepatic failure
		K85	Acute pancreatitis
		K92	Other diseases of digestive system
		L03	Cellulitis
		N17	Acute renal failure
		R57	Shock, not elsewhere classified
		S06	Intracranial injury
		S32	Fracture of lumbar spine and pelvis
		S72	Fracture of femur
		T82	Complications of cardiac and vascular prosthetic devices, implants and grafts
		A04	Other bacterial intestinal infection
		C71	Malignant neoplasm of the brain
		I48	Atrial fibrillation and flutter
		J90	Pleural effusion, not elsewhere classified
		K63	Other diseases of intestine
		T81	Complications of procedures, not elsewhere classified

Table 4. List of the Diagnosis Groups for Time-Sensitivity

A04	Other bacterial intestinal infection
A41	Sepsis
E86	Volume depletion
E87	Other disorders of fluid, electrolyte and acid-base balance
F05	Delirium, not induced by alcohol and other psychoactive substances
I21	Acute Myocardial Infarction (AMI)
I24	Other acute ischemic heart disease
I26	Pulmonary embolism
I46	Cardiac arrest
I48	Atrial fibrillation and flutter
I50	Heart failure
I60	Subarachnoid haemorrhage
I61	Intracerebral haemorrhage
I62	Other non traumatic intracranial haemorrhage
I63	Cerebral infarction
I64	Stroke, not specified as haemorrhage or infarction
I71	Aortic aneurism and dissection
J18	Pneumonia
J44	Other chronic obstructive pulmonary disease
J69	Pneumonitis due to solids and liquids
J80	Adult respiratory distress syndrome
J84	Other interstitial pulmonary diseases
J96	Respiratory failure, not elsewhere classified
K26	Duodenal ulcer
K55	Vascular disorders of intestine
K56	Paralytic ileus and intestinal obstruction without hernia
K57	Diverticular disease of intestine
K63	Other diseases of intestine
K65	Peritonitis
K72	Hepatic failure
K85	Acute pancreatitis
K92	Other diseases of digestive system
L03	Cellulitis
N17	Acute renal failure
R57	Shock, not elsewhere classified
S06	Intracranial injury
S32	Fracture of lumbar spine and pelvis
S72	Fracture of femur
T81	Complications of procedures, not elsewhere classified
T82	Complications of cardiac and vascular prosthetic devices, implants and grafts

Table 5. Other suggested Diagnosis Groups

G00	Bacterial meningitis, not elsewhere classified
G01	Meningitis in bacterial diseases classified elsewhere
G02	Meningitis in other infectious and parasitic diseases classified elsewhere
G04	Encephalitis, myelitis and encephalomyelitis
G05	Encephalitis, myelitis and encephalomyelitis in diseases classified elsewhere
I20	Angina pectoris
I30	Acute pericarditis
I32	Pericarditis in diseases classified elsewhere
I40	Acute myocarditis
I41	Myocarditis in diseases classified elsewhere
I44	Atrioventricular and left bundle-branch block
I47	Paroxysmal tachycardia
I49	Other cardiac arrhythmias
I74	Arterial embolism and thrombosis
J45	Asthma
K35	Appendicitis
K81	Cholecystitis
M72	Fibroblastic disorders (necrotizing fasciitis)
M01	Direct infections of joint in infectious and parasitic diseases classified elsewhere
N20	Calculus of kidney and ureter
N23	Unspecified renal colic
O00	Ectopic pregnancy
S11	Open wound of neck
S12	Fracture of neck
S14	Injury of nerves and spinal cord at neck level
S15	Injury of blood vessels at neck level
S21	Open wound of thorax
S22	Fracture of rib(s), sternum and thoracic spine
S27	Injury of other and unspecified intrathoracic organs (pneumothorax and hemothorax)
S31	Open wound of abdomen, lower back and pelvis
S36	Injury of intra-abdominal organs
S37	Injury of urinary and pelvic organs (bladder rupture)
T27	Burn and corrosion of respiratory tract
T29	Burns and corrosions of multiple body regions
T31	Burns classified according to extent of body surface involved
T39	Poisoning by nonopioid analgesics, antipyretics and antirheumatics
T40	Poisoning by narcotics and psychodysleptics [hallucinogens]
T42	Poisoning by antiepileptic, sedative-hypnotic and antiparkinsonism drugs
T43	Poisoning by psychotropic drugs, not elsewhere classified
T44	Poisoning by drugs primarily affecting the autonomic nervous system
T46	Poisoning by agents primarily affecting the cardiovascular system
T51	Toxic effect of alcohol
T58	Toxic effect of carbon monoxide
T67	Effects of heat and light
T68	Hypothermia
T74	Maltreatment syndromes
T78	Adverse effects, not elsewhere classified (anaphylactic shock)
T79	Certain early complications of trauma, not elsewhere classified

Chapter 3:

What are Emergency-Sensitive Conditions? A Survey of Canadian Emergency Physicians and Nurses

CJEM Jan 11 2014 (in-press)

Simon Berthelot, MD[1,2], Eddy S. Lang, MD[3], Hude Quan, MD PhD[2], Henry T. Stelfox, MD PhD[2,4]

Affiliations : [1]Département de médecine d'urgence du CHU de Québec, Québec, Québec, Canada; [2]Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada; [3]Department of Emergency Medicine, University of Calgary, Calgary, Alberta, Canada; [4]Department of Critical Care, University of Calgary, Calgary, Alberta, Canada.

Corresponding author (same author for reprints):

Dr. Simon Berthelot

Department of Emergency Medicine

CHU de Québec – CHUL, 2705 Boul. Laurier, Québec, Qc, Canada, G1V 4G2

siberth@me.com (can be published)

Department(s) and institution(s) to which the work should be attributed:

Department of Community Health Sciences, University of Calgary

Département de médecine d'urgence du CHU de Québec

Division of Emergency Medicine, University of Calgary

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ABSTRACT

Objective:

We assembled in a previous study a multidisciplinary Canadian panel and identified 37 International Classification of Diseases-10-Canada Diagnosis Groups (DG) for which emergency department (ED) management may potentially reduce mortality (emergency-sensitive conditions). Before using these 37 DGs to calculate a Hospital Standardized Mortality Ratio (HSMR) specific to emergency care, we aimed to test their face validity with ED care providers.

Methods:

We conducted a self-administered web-survey among Canadian emergency physicians and nurses between November 22nd and December 31st 2012. All members (N = 2507) of the *Canadian Association of Emergency Physicians* and of the *National Emergency Nurses Association* were surveyed. They were asked to agree or disagree (binary response) with the panel classification for each one of the 37 DGs identified as emergency-sensitive conditions as well as provide free text responses to identify missing entities.

Results:

A total of 719 ED providers (719/2507, 29%) completed the survey of which 470 were physicians (470/1407, 33%) and 232 were nurses (232/1100, 21%). Information on professional status was not provided for 17 respondents. Of 37 DGs, 32 DGs (e.g. A41 sepsis) were rated by more than 80% of respondents to be emergency-sensitive conditions. The remaining five DGs (e.g. E11 type 2 diabetes mellitus) were rated by 68.5 to 79.7% of

the respondents to be emergency-sensitive conditions. Respondents suggested an additional 31 diagnoses that may be emergency-sensitive conditions.

Conclusion:

We identified 37 emergency-sensitive DGs that had high face validity with emergency physicians and nurses, which will enable the calculation of an ED-HSMR.

INTRODUCTION

Background

Many consensus statements have recommended monitoring mortality rates in patients after an episode of emergency department (ED) care as part of an ED performance assessment framework[1-5]. To our knowledge, there is currently no validated risk-adjustment model that can be used to monitor mortality after an ED episode.

Since 2007, the Canadian Institute for Health Information (CIHI) has reported a Hospital Standardized Mortality Ratio (HSMR) for each Canadian acute care facility[6]. The HSMR methodology was developed in the 1990s in the United Kingdom to adjust and monitor mortality rates for patients admitted to hospital. Calculated from administrative data, it is the ratio of the observed number of deaths in a hospital in a specific year divided by the number of deaths expected if mortality was similar to patients admitted to comparable hospitals in a reference year. The Canadian HSMR includes patients with one of the 72 International Classification of Diseases-10-Canada (ICD-10-CA) Diagnosis Groups (DG) accounting for 80% of in-hospital mortality in Canada as their most responsible diagnosis on hospital discharge. CIHI calculates an overall HSMR and three additional ratios to further evaluate different patient populations (medical, surgical and ICU). However, none of these ratios focuses on the outcomes of patients admitted to hospital whose ED management would be expected to impact survival.

An expert panel selected from the 72 DGs included in the Canadian HSMR, 37 DGs for which ED management may potentially reduce mortality (emergency-sensitive conditions)[7]. In order to calculate a HSMR variant more sensitive to the ED component of hospital care, further substantiation of this list by a broad spectrum of frontline emergency care providers is warranted.

Study Objectives

1) To test the face validity of the 37 DGs selected by a consensus panel for inclusion in an ED-HSMR with ED care providers; 2) To identify potentially missing diagnoses in the panel's selection.

METHODS

STUDY DESIGN AND POPULATION

We conducted a self-administered cross-sectional web-survey among Canadian emergency physicians and nurses. All members (N = 2507) of the *Canadian Association of Emergency Physicians* (CAEP) and of the *National Emergency Nurses Association* (NENA) were surveyed.

SURVEY CONTENT

The survey instrument was available in English and French, and contained the following domains of questions:

1- Respondents were first invited to provide their demographic characteristics, including gender, years of work experience, profession, type(s) of hospital affiliation and location(s) of practice.
2- Respondents were presented with the 37 emergency-sensitive DGs previously identified by a Canadian multidisciplinary panel using a RAND/UCLA Appropriateness Method (RAM)[7]. They were asked for each DG whether they agreed or disagreed (binary answer) that ED care could reduce mortality for subsequently admitted patients with these diagnoses.
3- Respondents were invited to provide comments or suggest additional emergency-sensitive DGs.

To facilitate the rating process, respondents were provided with relevant definitions (e.g. emergency-sensitive condition) and the ICD-10-CA description for each DG (Appendix C). A summary of the research protocol was available at the end of the questionnaire for participants who wanted additional information.

SURVEY TESTING

The web-survey instrument was pilot tested with 28 emergency care providers (14 physicians and 14 nurses) to assess its relevance, appropriateness, intelligibility and ease of administration[8]. Median completion time among respondents was 5.22 minutes ([Interquartile Range] IQR: 2.98-9.62 minutes). Test/Retest reliability was conducted on fifteen providers (eight physicians, seven nurses) one week apart and showed greater than 80% intra-rater agreement for all DGs. Clinical sensibility was assessed with the same 15 emergency care providers (Appendix D)[9]. The vast majority of respondents reported that

the web-survey tool had good clarity (14/15), good utility (14/15), good discriminability (10/13), high face validity (13/14), high content validity (12/15), and minimal redundancy (14/15).

SURVEY ADMINSTRATION

The survey was administered through the email lists of CAEP and NENA between November 22nd and December 31st 2012, and was available in English or French as per respondents' preference. Compliant with each organization's policy for online survey administration, three reminders for CAEP and none for NENA were sent after the first email invitation. We were not able to track and describe the characteristics of the non-respondents as CAEP and NENA membership lists are confidential. Survey administration and data collection were conducted using the online survey software provided by FluidSurveys version 5.0 (Fluidware corporation, Ontario, Canada).

STATISTICAL ANALYSIS

Survey responses were summarized as percentages of agreement (the proportion of ED care providers agreeing that a DG is emergency-sensitive) with 95% confidence intervals. We specified a priori that a minimum of 50% agreement by survey respondents was required for candidate DGs to be included in an emergency-sensitive condition HSMR variant. The survey response rate was calculated as the proportion of partially or fully completed questionnaires over the total number of invitations sent. Stratified analyses were performed with the following respondents' characteristics: profession (nurses vs. physicians), type(s) of hospital affiliation (academic vs. non academic vs. both), years of

experience ("≤5 years" vs. ">5 and ≤10 years" vs. ">10 years"), and location of practice in Canada (East vs. West vs. Maritimes vs. North). Two-way contingency tables and Fisher's exact tests were used to assess significant differences between the subgroups. A two-sided alpha level of 0.0014 was used after applying a Bonferroni correction to each stratified analysis (0.05/37 comparisons). Respondents' suggestions of additional emergency-sensitive conditions, not included in the 37 DGs, were assessed using qualitative content analysis[10]. Two authors (SB and ESL) independently compiled and categorized the additional emergency-sensitive conditions, then compared and merged their lists and resolved disagreements through discussion. Analyses were performed using Stata version 12.0 (StataCorp LP, TX, USA). The study received ethics approval from the Conjoint Health Research Ethics Board at the University of Calgary (E-24580).

RESULTS

Characteristics of the participants

Table 1 shows the characteristics of the survey respondents. A total of 719 ED providers (719/2507, 29%) completed the survey. Of these respondents, 470 were physicians (470/1407, 33%) and 232 were nurses (232/1100, 21%). Information on the professional status was missing for 17 respondents. Ninety-six percent of the participants (690/719, 96%) completed the survey in English. The majority of respondents practiced in Ontario (34%), British Columbia (16%) and Alberta (16%).

Face-validity survey

All 37 DGs presented in the survey were rated as emergency-sensitive by the respondents (median % of agreement: 92.2%, IQR: 86.7-96.1%) (Table 2). Acute myocardial infarction (I21), shock not elsewhere classified (R57) and sepsis (A41) received the highest percentages of agreement. Thirty-two DGs were rated by more than 80% of respondents to be emergency-sensitive conditions. The remaining five DGs were rated by 68.5 to 79.7% of the respondents to be emergency-sensitive conditions. These included type 2 diabetes mellitus (E11), diverticular disease of intestine (K57), duodenal ulcer (K26), other diseases of digestive system (K92) and hepatic failure (K72).

Stratified Analyses

Stratified analyses showed no difference in survey responses according to respondents' hospital affiliation (academic vs. non-academic vs. both), years of work experience and location of practice in Canada. Statistically significant differences were observed between nurses' and physicians' responses for seven DGs; however survey results for both professions revealed high percentages of agreement for the same DGs (Tables 3 to 6).

Suggested Emergency-Sensitive Diagnoses

Respondents proposed an additional 31 diagnoses that may be emergency-sensitive conditions (Table 7). Toxicological (n=7), obstetrical (n=5), environmental (n=3) and psychiatric (n=3) conditions were most frequently recommended.

DISCUSSION

Using the RAM, we previously identified 37 DGs where ED care (adequate diagnosis and/or appropriate therapy and/or timely care) could reduce mortality of patients admitted to hospital. This national survey of Canadian ED providers demonstrated the selected DGs to have high face validity. Apart from these 37 DGs, 31 additional diagnoses were suggested by the survey respondents as potential emergency-sensitive conditions. The identification of emergency-sensitive DGs will enable the calculation of a HSMR specific to emergency care and help guide quality improvement efforts.

The "sensitive conditions" concept has been used for assessing healthcare system performance since the 1970s. Rutstein et al. first described "sentinel health events" where the incidence of preventable conditions inside a population was used to evaluate the quality of care offered to this community[11]. Billings et al. later defined ambulatory care sensitive conditions as "conditions-diagnoses for which timely and effective outpatient care can help reduce the risk of hospitalization(…)"[12]. Ambulatory care sensitive conditions are now widely used in many jurisdictions as metrics to evaluate primary care. Carr et al. defined emergency care sensitive conditions as conditions for which "high-quality emergency care makes a unique contribution to patient outcomes" and called for the development of a research agenda in the area[13]. To our knowledge, we are the first to develop a list of emergency-sensitive conditions that we will use to calculate an ED-HSMR.

To be a valid measure of ED-related in-hospital mortality, the ED-HSMR has to be derived from diagnoses that are commonly treated in the ED, are frequently associated with in-hospital deaths and are perceived to be clinically relevant to ED care providers. We conducted this national survey to ensure that our ED-HSMR would be calculated with a credible set of emergency-sensitive DGs. This HSMR variant will be calculated with 37 of the 72 DGs included in the CIHI HSMR. Sensitivity analyses will be conducted by including in the ratio calculation other potentially missing DGs identified with the consensus panel and the survey of ED care providers. Emergency-sensitive conditions may also be used as "sentinel" conditions that act as flags for quality problems or trigger performance reviews.

The *hospital standardized mortality ratio* is a risk-adjustment model using indirect standardization to measure in-hospital mortality rates. Although adjusted for the type of institution and for important patient variables such as age, gender, co-morbidities, in-hospital length of stay, transfer and type of admission, this mortality ratio does not account for all possible confounders. Consequently, direct comparisons between hospitals using this metric are usually not recommended[14,15]. The HSMR should be used either as a screening tool to detect significant hospital outliers or as a measure enabling institutions to better track, understand and modify their own mortality trends over years[6]. It should be considered a "big dot" measure designed to prompt more in-depth evaluation with other outcome and process-of-care indicators to better appraise its real meaning. Although still controversial, the HSMR has been reported to be a major incentive for improving care in many institutions[16].

LIMITATIONS

This study has a number of limitations. First, our survey had 719 responses, but a low response rate. Although the response rate raises the question of whether non-responders have similar perceptions of the DGs, the large number of physicians and nurses working in diverse institutions, jurisdictions and geographies that responded and strongly agreed with the panel ratings suggests that there is face validity to the DGs identified. Moreover, our response rate is comparable to what have been reported in previous surveys of healthcare professional society members in Canada and the United States[17,18].

Second, using a Likert scale in our survey would have allowed for more discrimination between the DGs. Asking respondents to apply binary evaluations to a list of conditions proposed to be emergency-sensitive may have encouraged respondents to agree more often than they would have agreed with a more discriminative scale. However, the goal of our survey was to evaluate the face validity of the DG and identify potential DG misclassifications, while keeping the web-survey tool as simple as possible.

Finally, some of the 37 DGs, as defined in the ICD-10-CA, represent heterogeneous conditions and diagnoses. The survey may have produced different results for a few DGs if the incidence of each sub-code (e.g. E11.1 type 2 diabetes mellitus with coma) within the DG (e.g. E11 type 2 diabetes mellitus) was known.

CONCLUSION

In summary, we determined that the 37 emergency-sensitive DGs previously selected by a national expert consensus panel for inclusion in an ED variant HSMR have high face validity. Emergency sensitive conditions may help assess and guide quality improvement efforts in the ED.

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REFERENCES

1. Schull MJ, Guttmann A, Leaver CA, et al. Prioritizing performance measurement for emergency department care: consensus on evidence-based quality of care indicators. *CJEM.* Sep 2011;13(5):300-309, E328-343.

2. Beattie E, Mackway-Jones K. A Delphi study to identify performance indicators for emergency medicine. *Emerg Med J.* Jan 2004;21(1):47-50.

3. Sibbritt D, Isbister GK, Walker R. Emergency department performance indicators that encompass the patient journey. *Qual Manag Health Care.* Jan-Mar 2006;15(1):27-38.

4. Lindsay P, Schull M, Bronskill S, Anderson G. The development of indicators to measure the quality of clinical care in emergency departments following a modified-delphi approach. *Acad Emerg Med.* Nov 2002;9(11):1131-1139.

5. Jones P, Harper A, Wells S, et al. Selection and validation of quality indicators for the Shorter Stays in Emergency Departments National Research Project. *Emergency medicine Australasia : EMA.* Jun 2012;24(3):303-312.

6. Canadian Institute for Health Information. RNMH: Une nouvelle méthode de mesure des tendances relatives à la mortalité hospitalière au Canada. Ottawa 2007.

7. Berthelot S, Lang ES, Stelfox HT, et al. Identifying Emergency-Sensitive Conditions for the Calculation of an Emergency Care Inhospital Standardized Mortality Ratio. *Ann Emerg Med.* April 2014; 63(4):418-24.

8. Burns KE, Duffett M, Kho ME, et al. A guide for the design and conduct of self-administered surveys of clinicians. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne.* Jul 29 2008;179(3):245-252.

9. Cook DJ, Guyatt GH, Jaeschke R, et al. Determinants in Canadian health care workers of the decision to withdraw life support from the critically ill. Canadian Critical Care Trials Group. *JAMA.* Mar 1 1995;273(9):703-708.

10. Zhang Y, Wildemuth B. Qualitative analysis of content. In Applications of Social Research Methods to Questions in Information and Library Science edn. Santa Barbara, CA: Greenwood Press; 2009:308-319.

11. Rutstein DD, Berenberg W, Chalmers TC, Child CG, 3rd, Fishman AP, Perrin EB. Measuring the quality of medical care. A clinical method. *The New England journal of medicine.* Mar 11 1976;294(11):582-588.

12. Billings J, Zeitel L, Lukomnik J, et al. Impact of socioeconomic status on hospital use in New York City. *Health affairs*. 1993 Spring;12(1):162-73. PubMed PMID: 8509018.

13. Carr BG, Conway PH, Meisel ZF, et al. Defining the emergency care sensitive condition: a health policy research agenda in emergency medicine. *Ann Emerg Med.* Jul 2010;56(1):49-51.

14. Ben-Tovim DI, Pointer SC, Woodman R, et al. Routine use of administrative data for safety and quality purposes--hospital mortality. *The Medical journal of Australia.* Oct 18 2010;193(8 Suppl):S100-103.

15. Pouw ME, Peelen LM, Lingsma HF, et al. Hospital standardized mortality ratio: consequences of adjusting hospital mortality with indirect standardization. *PloS one*. 2013;8(4):e59160.

16. Jarman B. In defence of the hospital standardized mortality ratio. *HealthcarePapers.* 2008;8(4):37-42; discussion 69-75.

17. Grava-Gubins I, Scott S. Effects of various methodologic strategies: survey response rates among Canadian physicians and physicians-in-training. *Canadian family physician Medecin de famille canadien.* Oct 2008;54(10):1424-1430.

18. James KM, Ziegenfuss JY, Tilburt JC, et al. Getting physicians to respond: the impact of incentive type and timing on physician survey response rates. *Health Serv Res*. Feb 2011;46(1 Pt 1):232-242.

Table 1. Characteristics of survey respondents*

Characteristics of survey respondents (n=719)	
Sex	
Female	339 (47)
Male	318 (44)
Missing	62 (9)
Profession	
Physicians	470 (65)
Nurses	232 (32)
Missing	17 (2)
Median number of years of work experience (IQR[a])	13 (7, 20)
Missing	19
Survey Language	
English	690 (96)
French	29 (4)
Institution	
Academic	422 (59)
Non academic	132 (18)
Both	149 (21)
Missing	16 (2)
Location of Practice	
Alberta	116 (16)
British Columbia	118 (16)
Manitoba	32 (4)
Newfoundland and Labrador	26 (4)
New Brunswick	22 (3)
Northwest Territories	3 (0)
Nova Scotia	52 (7)
Nunavut	3 (0)
Ontario	242 (34)
Prince Edward Island	6 (1)
Québec	51 (7)
Saskatchewan	37 (5)
Yukon	2 (0)
USA	1 (0)
Missing	8 (1)

* All data presented as number and percentage [n(%)] unless otherwise indicated

[a] Interquartile range

Table 2. Emergency Department Provider Ratings of Diagnosis Groups as Emergency-Sensitive Conditions

Diagnosis Groups	Emergency Sensitive Condition % agreement (95%CI)*
I21 Acute Myocardial Infarction	99.9 (99.2-100.0)
R57 Shock, not elsewhere classified	99.8 (99.1-100.0)
A41 Sepsis	99.7 (99.0-100.0)
E87 Other disorders of fluid, electrolyte and acid-base balance	98.7 (97.5-99.4)
E86 Volume depletion	98.4 (97.2-99.2)
I26 Pulmonary embolism	98.4 (97.2-99.2)
K65 Peritonitis	97.7 (96.2-98.7)
J96 Respiratory failure, not elsewhere classified	97.2 (95.6-98.3)
I46 Cardiac arrest	96.7 (95.1-98.0)
I60 Subarachnoid haemorrhage	96.2 (94.5-97.5)
S06 Intracranial injury	96.1 (94.3-97.5)
N17 Acute renal failure	96.0 (93.8-97.1)
I71 Aortic aneurism and dissection	95.7 (93.9-97.1)
J18 Pneumonia	94.8 (92.9-96.4)
I50 Heart failure	94.2 (92.2-95.8)
J80 Adult respiratory distress syndrome	93.8 (91.7-95.6)
K85 Acute pancreatitis	93.2 (91.0-95.0)
I24 Other acute ischemic heart disease	93.1 (91.0-94.9)
S72 Fracture of femur	92.2 (89.9-94.2)
I62 Other non traumatic intracranial haemorrhage	91.0 (88.6-93.0)
K55 Vascular disorders of intestine	90.5 (87.9-92.6)
I61 Intracerebral haemorrhage	90.4 (88.0-92.6)
J44 Other chronic obstructive pulmonary disease	89.7 (87.1-91.9)
S32 Fracture of lumbar spine and pelvis	89.2 (86.6-91.5)
I63 Cerebral infarction	88.6 (86.0-90.9)
G93 Other disorders of brain	88.1 (85.5-90.5)
F05 Delirium, not induced by alcohol and other psychoactive substances	87.4 (84.7-89.8)
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts	86.7 (83.8-89.2)
J69 Pneumonitis due to solids and liquids	85.4 (82.6-88.0)
I64 Stroke, not specified as haemorrhage or infarction	84.7 (81.7-87.3)
K56 Paralytic ileus and intestinal obstruction without hernia	84.6 (81.6-87.3)
L03 Cellulitis	80.4 (77.1-83.4)
K26 Duodenal ulcer	79.7 (76.4-82.7)
K92 Other diseases of digestive system	78.4 (75.0-81.5)
K72 Hepatic failure	75.5 (72.0-78.8)
K57 Diverticular disease of intestine	73.4 (69.8-76.7)
E11 Diabetes Mellitus type 2	68.5 (64.9-72.0)

* Percentage of ED care providers agreeing with each Diagnosis Group selected by the panel

Table 3. Stratified Analysis of the Survey Results by Profession

Diagnosis Groups	Nurses	MD	p value*
I21 Acute Myocardial Infarction	100.0	99.8	1.00
A41 Sepsis	99.6	99.8	0.55
R57 Shock, not elsewhere classified	99.5	100.0	0.33
E86 Volume depletion	98.7	98.5	1.00
E87 Other disorders of fluid, electrolyte and acid-base balance	98.2	98.9	0.49
I26 Pulmonary embolism	98.2	98.5	0.76
S72 Fracture of femur	97.6	89.9	< 0.001
I46 Cardiac arrest	97.3	96.3	0.65
S06 Intracranial injury	97.1	95.8	0.51
J96 Respiratory failure, not elsewhere classified	97.0	97.2	1.00
N17 Acute renal failure	96.5	95.3	0.54
K85 Acute pancreatitis	96.5	91.8	0.03
K65 Peritonitis	96.4	98.6	0.13
J80 Adult respiratory distress syndrome	96.1	92.8	0.16
I24 Other acute ischemic heart disease	96.0	91.8	0.04
I60 Subarachnoid haemorrhage	95.9	96.4	0.83
I63 Cerebral infarction	95.4	85.3	< 0.001
I64 Stroke, not specified as haemorrhage or infarction	94.9	79.5	< 0.001
I61 Intracerebral haemorrhage	93.6	89.0	0.07
S32 Fracture of lumbar spine and pelvis	93.6	87.7	0.03
I62 Other non traumatic intracranial haemorrhage	93.1	89.6	0.16
K56 Paralytic ileus and intestinal obstruction without hernia	91.6	81.2	0.001
I50 Heart failure	91.4	95.5	0.04
J18 Pneumonia	91.2	96.6	0.005
I71 Aortic aneurism and dissection	90.8	98.0	< 0.001
K55 Vascular disorders of intestine	88.3	91.4	0.249
J69 Pneumonitis due to solids and liquids	87.0	84.6	0.48

Table 3. Continued

Diagnosis Groups	Nurses	MD	p value*
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts	86.8	86.7	1.00
G93 Other disorders of brain	85.8	89.4	0.20
J44 Other chronic obstructive pulmonary disease	84.7	92.1	0.004
K92 Other diseases of digestive system	84.7	75.3	0.007
L03 Cellulitis	82.3	80.1	0.59
K72 Hepatic failure	81.5	72.7	0.02
K26 Duodenal ulcer	81.1	79.1	0.60
F05 Delirium, not induced by alcohol and other psychoactive substances	80.1	91.2	< 0.001
E11 Diabetes Mellitus type 2	77.7	64.0	< 0.001
K57 Diverticular disease of intestine	75.6	72.6	0.44

*Level of significance : $p < 0.0014$ (Fisher's exact test)

Table 4. Stratified Analysis of the Survey Results by Type(s) of Hospital Affiliation

Diagnosis Groups	Not Academic	Academic	Both	p value*
I21 Acute Myocardial Infarction	100.0	100.0	99.3	0.40
R57 Shock, not elsewhere classified	100.0	100.0	99.3	0.40
A41 Sepsis	99.2	100.0	99.3	0.16
I26 Pulmonary embolism	97.7	98.3	99.3	0.58
E86 Volume depletion	97.7	98.3	99.3	0.58
E87 Other disorders of fluid, electrolyte and acid-base balance	97.7	99.3	97.9	0.17
K65 Peritonitis	97.4	97.9	97.0	0.76
S72 Fracture of femur	96.6	90.0	95.5	0.02
I46 Cardiac arrest	95.4	96.5	98.6	0.28
S06 Intracranial injury	94.1	96.8	96.2	0.38
N17 Acute renal failure	94.0	95.0	98.5	0.13
I60 Subarachnoid haemorrhage	93.6	97.3	95.1	0.14
J96 Respiratory failure, not elsewhere classified	93.2	97.7	99.3	0.02
K85 Acute pancreatitis	93.2	92.4	94.8	0.71
J80 Adult respiratory distress syndrome	92.2	93.2	97.1	0.17
I71 Aortic aneurism and dissection	92.1	96.7	96.5	0.09
I50 Heart failure	91.2	95.3	94.4	0.24
I24 Other acute ischemic heart disease	90.9	92.5	92.5	0.40
S32 Fracture of lumbar spine and pelvis	90.7	89.4	87.8	0.76
J44 Other chronic obstructive pulmonary disease	90.5	90.1	88.0	0.74
I63 Cerebral infarction	90.2	88.6	86.7	0.68
J18 Pneumonia	90.2	96.7	93.6	0.01
K55 Vascular disorders of intestine	89.8	91.7	86.5	0.21
I62 Other non traumatic intracranial haemorrhage	89.5	90.9	92.3	0.72
I61 Intracerebral haemorrhage	86.3	91.5	91.7	0.21
I64 Stroke, not specified as haemorrhage or infarction	85.7	85.1	83.2	0.81
J69 Pneumonitis due to solids and liquids	84.9	85.4	84.6	0.97
G93 Other disorders of brain	84.3	88.5	91.0	0.24
F05 Delirium, not induced by alcohol and other psychoactive substances	83.9	89.4	85.4	0.17

Table 4. Continued

Diagnosis Groups	Not Academic	Academic	Both	p value*
K56 Paralytic ileus and intestinal obstruction without hernia	81.9	84.5	86.6	0.61
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts	81.4	88.2	88.1	0.16
L03 Cellulitis	78.8	79.5	83.6	0.56
K26 Duodenal ulcer	78.0	78.0	85.3	0.17
E11 Diabetes Mellitus type 2	74.2	66.9	69.7	0.29
K92 Other diseases of digestive system	73.9	80.5	75.4	0.20
K57 Diverticular disease of intestine	71.8	73.9	72.6	0.88
K72 Hepatic failure	70.3	76.9	75.8	0.35

*Level of significance : $p < 0.0014$ (Fisher's exact test)

Table 5. Stratified Analysis of the Survey Results by Years of Work Experience

Diagnosis Groups	≤ 5 years	5 < x ≤ 10 years	> 10 years	p value*
I21 Acute Myocardial Infarction	100.0	99.3	100.0	0.40
R57 Shock, not elsewhere classified	100.0	99.3	100.0	0.40
E86 Volume depletion	99.2	97.2	98.5	0.43
I26 Pulmonary embolism	99.2	97.9	98.5	0.74
E87 Other disorders of fluid, electrolyte and acid-base balance	99.2	98.6	98.5	1.00
K65 Peritonitis	99.1	97.1	97.6	0.60
A41 Sepsis	98.4	100.0	100.0	0.03
I60 Subarachnoid haemorrhage	97.5	95.9	96.0	0.78
J80 Adult respiratory distress syndrome	97.4	94.2	92.7	0.19
J96 Respiratory failure, not elsewhere classified	97.3	98.5	96.9	0.61
N17 Acute renal failure	96.5	94.2	96.0	0.58
J18 Pneumonia	95.8	93.7	95.0	0.73
K85 Acute pancreatitis	95.6	90.6	93.4	0.29
I46 Cardiac arrest	95.2	97.9	97.1	0.47
I71 Aortic aneurism and dissection	95.0	97.2	95.5	0.68
S72 Fracture of femur	94.7	85.4	93.7	0.008
I24 Other acute ischemic heart disease	94.4	93.1	93.1	0.93
I61 Intracerebral haemorrhage	93.4	89.0	90.5	0.45
I62 Other non traumatic intracranial haemorrhage	93.2	91.7	90.5	0.68
S06 Intracranial injury	92.9	94.9	97.9	0.02
I50 Heart failure	91.8	94.5	94.8	0.47
G93 Other disorders of brain	91.1	87.3	87.5	0.56
J44 Other chronic obstructive pulmonary disease	90.9	87.5	89.9	0.61
K55 Vascular disorders of intestine	90.4	92.0	90.4	0.89
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts	90.2	84.1	86.6	0.38
I63 Cerebral infarction	87.6	89.6	88.8	0.87

Table 5. Continued

Diagnosis Groups	≤ 5 years	5 < x ≤ 10 years	> 10 years	p value*
K26 Duodenal ulcer	87.0	77.4	78.8	0.10
L03 Cellulitis	86.7	75.9	79.5	0.09
S32 Fracture of lumbar spine and pelvis	86.7	87.7	90.4	0.41
J69 Pneumonitis due to solids and liquids	86.0	82.8	87.2	0.41
K56 Paralytic ileus and intestinal obstruction without hernia	83.5	83.1	85.7	0.69
F05 Delirium, not induced by alcohol and other psychoactive substances	82.3	81.9	90.9	0.003
I64 Stroke, not specified as haemorrhage or infarction	81.7	82.6	86.7	0.28
K92 Other diseases of digestive system	80.7	72.8	79.8	0.20
K57 Diverticular disease of intestine	78.3	70.5	72.9	0.36
K72 Hepatic failure	76.3	75.9	75.7	1.00
E11 Diabetes Mellitus type 2	68.6	61.9	70.6	0.16

*Level of significance : $p < 0.0014$ (Fisher's exact test)

Table 6. Stratified Analysis of the Survey Results by Location of Practice in Canada

Diagnosis Groups	East	West	Maritimes	North*	p value**
A41 Sepsis	100.0	99.7	99.0	100.0	0.29
I21 Acute Myocardial Infarction	99.7	100.0	100.0	100.0	0.57
R57 Shock, not elsewhere classified	99.6	100.0	100.0	100.0	0.56
E86 Volume depletion	98.9	97.3	100.0	100.0	0.26
E87 Other disorders of fluid, electrolyte and acid-base balance	97.5	99.7	99.0	100.0	0.14
I46 Cardiac arrest	96.9	97.6	93.0	100.0	0.20
I26 Pulmonary embolism	96.8	99.3	100.0	100.0	0.07
I71 Aortic aneurism and dissection	96.8	94.5	96.9	87.5	0.23
K65 Peritonitis	96.6	98.2	98.9	100.0	0.51
I60 Subarachnoid haemorrhage	96.4	95.9	95.8	100.0	0.92
J96 Respiratory failure, not elsewhere classified	96.2	98.2	96.7	100.0	0.45
S06 Intracranial injury	95.4	97.5	94.4	100.0	0.41
N17 Acute renal failure	94.6	96.1	97.8	100.0	0.64
I50 Heart failure	94.3	94.2	93.8	87.5	0.68
J80 Adult respiratory distress syndrome	93.9	92.8	95.7	100.0	0.79
J18 Pneumonia	92.8	96.2	95.8	100.0	0.31
I24 Other acute ischemic heart disease	92.3	92.8	96.0	87.5	0.43
K85 Acute pancreatitis	91.9	93.9	94.6	100.0	0.76
J44 Other chronic obstructive pulmonary disease	91.7	88.5	86.2	87.5	0.31
I62 Other non traumatic intracranial haemorrhage	89.5	93.8	88.2	75.0	0.05
S72 Fracture of femur	89.3	94.2	93.3	100.0	0.19
F05 Delirium, not induced by alcohol and other psychoactive substances	89.1	85.6	85.7	100.0	0.47
I61 Intracerebral haemorrhage	89.0	92.4	89.4	87.5	0.42
K55 Vascular disorders of intestine	88.6	92.5	89.1	83.3	0.28
S32 Fracture of lumbar spine and pelvis	85.8	92.4	88.6	100.0	0.08
G93 Other disorders of brain	85.6	90.7	86.7	87.5	0.25
I63 Cerebral infarction	85.3	92.3	89.3	75.0	0.03

Table 6. Continued

Diagnosis Groups	East	West	Maritimes	North*	p value**
J69 Pneumonitis due to solids and liquids	85.0	86.5	83.0	100.0	0.63
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts	82.5	88.9	92.1	71.4	0.03
K56 Paralytic ileus and intestinal obstruction without hernia	80.7	87.1	87.9	100.0	0.12
I64 Stroke, not specified as haemorrhage or infarction	80.6	89.1	84.4	75.0	0.02
K26 Duodenal ulcer	77.7	80.9	79.6	85.7	0.83
L03 Cellulitis	77.5	80.5	84.4	100.0	0.32
K72 Hepatic failure	74.0	76.6	74.7	85.7	0.85
K92 Other diseases of digestive system	74.0	82.0	76.9	100.0	0.07
K57 Diverticular disease of intestine	72.5	73.1	76.3	85.7	0.85
E11 Diabetes Mellitus type 2	65.2	70.6	71.4	62.5	0.46

East = Ontario and Quebec; West = Manitoba, Saskatchewan, Alberta and British Columbia; Maritimes = New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland; North = Yukon, Northwest Territories and Nunavut.

*8 respondents

**Level of significance : $p < 0.0014$ (Fisher's exact test)

Table 7. Additional Diagnoses Suggested as Possible Emergency Sensitive Conditions

Infectious diseases

1. Necrotizing fasciitis
2. Infections associated with the spine

Obstetrical emergencies

1. Pelvic uterine hemorrhage
2. Pregnancy associated bleeding
3. Birth and neonatal resuscitation
4. Incomplete abortion
5. Abruptio placentae

Toxicological emergencies

1. Tricyclic
2. Methanol
3. MDMA
4. ASA (acute or chronic)
5. Acetaminophen (acute or chronic)
6. Calcium blockers
7. Beta-blockers

Psychiatric emergencies

1. Acute psychosis
2. Mania
3. Suicidal ideation

Environmental emergencies

1. Thermal emergencies
2. Major burns
3. CO poisoning

Trauma

1. Blunt or penetrating multisystem trauma
2. Major amputation

Respiratory conditions

1. Airway obstruction
2. Status asthmaticus

Ophtalmological emergencies

1. Acute angle closure glaucoma

Neurological emergencies

1. Status epilepticus

Vascular emergencies

1. Pulseless limb, arterial or major venous occlusions

Urologic emergencies

1. Kidney stones

Metabolic emergencies

1. Type 1 diabetes

Allergic reactions

1. Severe allergic reaction/anaphylaxis

Geriatric emergencies

1. Frail elderly

Chapter 4:

Development of a Hospital Standardized Mortality Ratio relevant to Emergency Department Care

Not submitted

Simon Berthelot, MD[1,2], Eddy S. Lang, MD[3], Hude Quan, MD PhD[2], Henry T. Stelfox, MD PhD[2,4]

Affiliations : [1]Département de médecine d'urgence du CHU de Québec, Québec, Québec, Canada; [2]Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada; [3]Department of Emergency Medicine, University of Calgary, Calgary, Alberta, Canada; [4]Department of Critical Care, University of Calgary, Calgary, Alberta, Canada.

Corresponding author (same author for reprints):

Dr. Simon Berthelot

Department of Emergency Medicine

CHU de Québec – CHUL, 2705 Boul. Laurier, Québec, Qc, Canada, G1V 4G2

siberth@me.com (can be published)

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ABSTRACT

Introduction:

Experts have recommended including mortality rates as quality indicators in an emergency department (ED) performance framework. This study aimed to develop a hospital standardized mortality ratio (HSMR) for patients hospitalized through the ED with conditions where ED care may potentially reduce mortality (*aka,* emergency-sensitive conditions).

Methods:

Data were extracted from Canadian hospital discharge databases from April 1st 2009 to March 31st 2012. The ED-HSMR is the ratio of the number of deaths among patients with emergency-sensitive conditions in a hospital during a year to the expected number of deaths for the same patients during the reference year 2009-10. The expected deaths were estimated using predictive models fitted for different hospital peer-groups (teaching, community-large, -medium and -small hospitals) from the reference year. The ED-HSMR was calculated for a hospital only if the expected number of deaths was above 20. Thirty-seven emergency-sensitive conditions identified from a previous study were included in the calculation of the ED-HSMR.

Results:

The dataset was composed with 629 Canadian hospitals and 2,069,405 patients, of which 8.0% died during their hospitalization. Predictive models for all peer-groups had good discrimination with areas under the curves above 0.80. A total of 294 hospitals were eligible for the calculation of the ED-HSMR and 98% of exclusions were from the

community-small hospitals because of low predicted deaths. When comparing year 2010-11 to year 2011-12, the classification of hospitals by ED-HSMR quartile was stable with the majority of hospitals remaining within the same quartile (n=80, 43.5%) or moving up or down a single quartile (n=74, 40.2%). Comparisons by hospital of the ED-HSMR with other HSMR variants revealed that the ED-HSMR, while following similar distributions, adds information for some hospitals with divergent results.

Conclusion:

The ED-HSMR appears to be a reliable measure and may potentially guide assessment and improvement of ED performance.

INTRODUCTION

For decades, overcrowding and access block in the emergency department (ED) have been major threats to quality and safety of care[1-4]. As a result, performance assessment reviews and guidelines have focused on access-to-care indicators and waiting times[5]. Although a prominent issue yielding many related metrics, accessibility is only one dimension by which to measure ED performance[6]. Moreover, the over-representation of time-based measures seemed to have significant unintended consequences in some jurisdictions[7,8]. Consequently, a more comprehensive evaluation of ED performance is needed.

Overall or condition-specific mortality rates have been suggested as quality-of-care indicators that should be part of a comprehensive ED performance assessment framework[6,9-11]. This outcome indicator has been successfully used to assess or improve quality of care in different settings or conditions, such as sepsis[12], acute myocardial infarction[13], rural hospital care[14] or during budget rationalization[15]. However, to our knowledge, there is no risk-adjustment model specifically developed to monitor death after an ED care episode.

We have previously proposed to adapt the Canadian Hospital Standardized Mortality Ratio (HSMR) methodology to the ED setting[16]. We hypothesized that including in the calculation of the ratio only the conditions where ED management may potentially improve outcomes (*aka,* emergency-sensitive conditions) would make the HSMR a more relevant

quality-of-care measure to ED care providers and managers. A multidisciplinary panel previously identified different lists of emergency-sensitive diagnosis groups (DG) from the 72 International Classification of Diseases-10-Canada DGs included in the Canadian HSMR. Therefore, we aimed to develop a HSMR capturing the outcomes of patients admitted with emergency-sensitive conditions as their most responsible diagnosis.

Study objectives

The specific objectives of this study were: 1) To develop an ED-HSMR risk-adjustment model; 2) To calculate an ED-HSMR specific to emergency-sensitive conditions.

METHODS

HOSPITAL SELECTION

All Canadian acute care institutions with an emergency department and hospitalization capacities were included. We excluded cancer centres, children's hospitals and heart institutes as they treat specific populations with non-average case-mix. For risk-adjustment purpose, hospitals were classified into one of four peer-groups (teaching, community-large, community-medium and community-small) based on academic designation, patient complexity and volume[17] (Appendix E).

CASE SELECTION

Patients meeting the following criteria were included in the analyses: 1) Discharge or death from a hospital satisfying the hospital selection criteria between April 1st 2009 and

March 31st 2012; 2) Admission through the ED to an acute care facility; 3) Discharge from hospital with an emergency-sensitive DG as the most responsible diagnosis; 4) Age at admission between 29 days and 120 years; 5) Hospital length of stay equal to or less than 365 days; 6) Canadian resident. The following cases were excluded: 1) Death at ED arrival; 2) Discharge against medical advice; 3) Brain death as most responsible diagnosis (G93.81); and 4) Patients with palliative care as most responsible diagnosis (Z51.5), or with palliative care as any diagnosis type in the same care episode for the province of Québec only.

DATA SOURCE

De-identified data were provided by CIHI and extracted from national hospital discharge databases. These databases hold clinical and administrative statistics captured from all hospitalizations in Canadian acute care facilities. They include data from ten provinces and three territories, divided in 51 health regions throughout Canada. Data were provided from April 1st 2009 and March 31st 2012 for nine provinces and three territories, and between April 1st 2009 and March 31st 2011 for the province of Québec;

STATISTICAL ANALYSIS

ED-HSMR calculation

ED-HSMRs were calculated for the fiscal years (April to March) 2010-2011 and 2011-2012, using the following equation:

$$\frac{\text{Actual number of deaths among patients with emergency-sensitive DGs in one year (2010-11 or 2011-12)}}{\text{Expected number of deaths among same patients based on mortality probabilities in the reference year (2009-10)}} \times 100$$

The ratio was calculated at hospital discharge following CIHI methodology for the Canadian HSMR. A HSMR value above 100 was interpreted to mean that more deaths than expected occurred in an acute care facility. Conversely, a HSMR value below 100 was interpreted to mean fewer deaths than expected occurred in an acute care facility. Each HSMR value was reported with a 95% confidence interval estimated with the Byar's approximation.

The 37 DGs previously selected by the panel as conditions for which ED management may potentially reduce mortality were used to calculate the ED-HSMR. All other potential emergency-sensitive DGs identified by the panel were used for further testing and validation of the ratio.

Predictive model selection

To estimate the expected number of deaths in 2010-11 or 2011-12, we fitted logistic regression models from the reference year (2009-10) for each hospital-peer group. The following variables were considered for inclusion in the risk-adjustment model: diagnosis groups, age (measured), gender (dichotomous), transfer from another acute care facility or emergency department (dichotomous), in-hospital length of stay (6 groups: 1, 2, 3-9, 10-15, 16-21 and 22-365 days) and comorbidities (3 groups based on Charlson index score: Group 0 = score 0 (outside Québec) or scores 0 and 1 (Québec); Group 1 = scores 1 and 2 (outside Québec) or scores 2, 3 and 4 (Québec); Group 2 = scores 3 and more (outside Québec) or scores 5 and more (Québec); see Appendix F). When there were missing data, most frequent values were imputed for categorical variables and medians, for measured variables. Each candidate variable was introduced one at a time in the logistic regression

model. Variable selection was achieved by comparing areas (AUC) under receiver operating characteristic (ROC) curves of models with and without the last variable included. A variable was retained in the final model if the comparison of AUCs yielded a significant difference. As a result to the large dataset used for this study, a $p < 0.0001$ was specified as the criterion of significance. Variable codification and logistic regression outputs of retained models are reproduced in the appendices (Appendices G and H).

Model assessment

The final model for each peer-group was assessed for discriminatory power and goodness of fit, using the area under the ROC curve and the Hosmer-Lemeshow test with 10 groups based on deciles of risk.

Calculation of the expected number of deaths

Probability of death for each included patient was calculated using the appropriate hospital-peer group specific model. After conversion from the log odds of death ($p_{death} = e^{log\ odds\ of\ death} / [1 + (e^{log\ odds\ of\ death})]$), all patient probabilities were summed to get the expected number of deaths in a specific hospital, in 2010-11 or 2011-12. An ED-HSMR for a specific acute care facility was only calculated if there were more than 20 expected deaths in this institution. Previous reports have underlined the unreliability and volatility of a HSMR measure with a denominator under 20[18].

Reliability of the ED-HSMR

To be a reliable performance metric, the ED-HSMR should be consistent from one year to another without showing extreme disruptions in the trends previously observed. To assess for consistency, we classified institution distribution by quartiles for years 2010-11 and 2011-12. After cross-tabulating quartiles of both years, we calculated the proportion of institutions that changed two or three quartiles over a year. Consistency-of-agreement intraclass correlation coefficient between successive years was also estimated.

Comparison between HSMR variants

Comparisons between the HSMR with 72 DGs and the ED-HSMR with 37 DGs, and between ED-HSMR for 2010-11 and ED-HSMR for 2011-12 were conducted to assess for differences, using graphical representations and two-sided paired t tests with $\alpha = 0.05$.

ED-HSMR at different time points

In addition to measuring the ED-HSMR at hospital discharge, calculations were processed at 2, 7 and 30 days following patient hospitalization. Estimating the ED-HSMR at these additional time points after ED admission was designed to test the hypothesis that measuring mortality proximally to the ED visit is likely to better reflect the influence of ED care on patient outcomes. Paired t tests with $\alpha = 0.05$ were computed to test for significant differences at the peer-group level. Using fixed time points led to collinearity when modeling with length of stay as a predictor. As a result, length-of-stay was excluded from the predictive model for ED-HSMR at 2, 7 and 30 days.

Analyses were performed using Stata version MP 11.2 (StataCorp, TX, USA). The study received ethics approval from the Conjoint Health Research Ethics Board at the University of Calgary (E-24580).

RESULTS

Characteristics of cases and hospitals

Table 1 reports the characteristics of all cases of the dataset compared to those included in the ED-HSMR calculated with 37 emergency-sensitive DGs. The dataset was composed with 2,069,405 patients admitted through the ED and discharged between April 1st 2009 and March 31st 2012 with one of 119 DGs. This included patients with either one of the 72 DGs included in the Canadian HSMR as most responsible diagnosis (in which are nested the 37 mortality-related DGs identified with the panel) or one of the 47 additional DGs not included in the Canadian HSMR, but suggested by the panelists as potential emergency-sensitive conditions. Of these cases, 82% were older than 50 years old (Fig. 1A and 1B), 65.8% had a Charlson index score of 0 and 8.0% (95% CI: 8.0-8.1%) died during their hospitalization. Stratified mortality rate by peer-group was 8.7% (95% CI: 8.6-8.8%) for teaching hospitals, 8.3% (95% CI: 8.2-8.3%) for community-large, 7.6% (95% CI: 7.5-7.6%) for community-medium and 6.5% (95%CI: 6.4-6.6%) for community-small hospitals. More than 87% of deaths occurred within 30 days of admission to hospital (Fig. 2A and 2B). Among 629 hospitals, 25.4% were from Ontario, 14.9% from Québec, 14.8% from Alberta and 11.3% from British Columbia, representing two thirds of all hospitals and 82% of all cases (Table 2). Although community-large hospitals provided the highest number of cases

among all four peer-groups, community-small hospitals were the most frequent acute care facilities, accounting for 58.2% of all Canadian hospitals.

Table 3 shows distribution of the study population by DG, reports DG-specific mortality rates and underlines the 37 DGs included in the ED-HSMR. The DGs with the highest incidence during the study period were other chronic obstructive pulmonary disease (J44, n=172,451, mortality rate 6.9%), pneumonia (J18, n=137,704, mortality rate 8.5%), heart failure (I50, n=130,597, mortality rate 10.3%) and acute myocardial infarction (I21, n=121,463, mortality rate 7.4%), while those with the highest mortality rates were cardiac arrest (I46, n=3582, mortality rate 65.1%), shock not elsewhere classified (R57, n=5130, mortality rate 50.0%), malignant neoplasm without specification of site (C80, n=1644, mortality rate 40.5%) and other disorders of the brain (G93, n=4179, mortality rate 39.4%).

Selection of the predictive model

AUCs of the predictive model for each peer-group increased from a minimum of 0.70 when including only Diagnosis Groups in the logistic regression to a maximum of 0.83 with all candidate variables (Fig. 3). Discriminatory power of the model was not improved when including all 72 Diagnosis Groups of the Canadian HSMR compared to the 37 ED-related DGs. The one-at-a-time selection process revealed that gender and transfer variables did not significantly increase AUCs ($p > 0.0001$) when sequentially added to the logistic regression (Table 4). Both variables were excluded from the final predictive model.

Model assessment

The retained predictive model for the calculation of the ED-HSMR was the following:

log odds of death = β_0 + ($\beta_1 DG_1$ + $\beta_2 DG_2$ + … + $\beta_{36} DG_{36}$) + ($\beta_{39} C_1$ + $\beta_{40} C_2$) + ($\beta_{41} LOS_1$ + … + $\beta_{45} LOS_5$) + ($\beta_{46} A$)

with Diagnosis Groups (DG_x), Charlson-score groups (C_x), length-of -stay groups (LOS_x) and age (A) as independent variables (Appendix H). The discriminatory power of the final model was good with AUCs between 0.80 and 0.81 for all peer-groups (Table 5 and Fig. 4). In the counterpart, the Hosmer-Lemeshow test did not demonstrate a good fit between the observed and expected mortality for any peer-group models (Table 5 and Appendix I). The calibration plots of the expected to the observed number of deaths are summarized in Figure 5.

ED-HSMR calculation

For the fiscal year 2010-11, an ED-HSMR was calculated for 95% of the teaching hospitals (42/44), 100% of the community-large (93/93), 97% of the community-medium (122/126) and only 10% of the community-small hospitals (37/366). Overall, 53% of all Canadian acute care facilities were not eligible for the ED-HSMR calculation because their expected number of deaths for 2010-11 was under 20. As the expected number of deaths and the size of hospital decrease, the confidence intervals significantly widen and the ED-HSMR estimates become less precise (Fig. 6A to 6D).

Reliability of the ED-HSMR

Table 6 reports the cross-tabular analysis between institution quartiles of 2010-11 and institution quartiles of 2011-12. The classification of hospitals by ED-HSMR quartile was stable with the majority of hospitals remaining within the same quartile (n=80, 43.5%) or moving up or down a single quartile (n=74, 40.2%). No hospitals moved from the top quartile to the bottom quartile. One hospital moved from the bottom quartile to the top quartile. The intraclass correlation coefficient revealed moderate consistency of agreement and was estimated at 0.64 (95% CI: 0.55-0.71).

Comparisons between the HSMR variants

The comparison between 2010-11 and 2011-12 showed that 112 of 184 institutions with data available in both years improved their ED-HSMR point estimates (Fig. 7A to 7D). At the peer-group level, this trend was significant for teaching and community-large hospital peer-groups, but not for community-medium and community-small hospitals (Table 7).

Figures 8A to 8D illustrate the comparison for each institution of the ED-HSMR with 37 DGs to the HSMR with 72 DGs. Although both distributions show very similar pattern, some hospitals have very different point estimate results. Comparison at the peer-group level showed no difference between the mean ED-HSMR and the mean HSMR with 72 DGs (Tables 7 and 8).

Finally, peer-group level comparisons between ED-HSMR measured at different time points after admission did not demonstrate any significant differences (Table 9). Moreover, as the time point for calculation gets closer to the ED care episode, the confidence intervals increased substantially.

DISCUSSION

We developed the first hospital standardized mortality ratio meant to monitor in-hospital mortality of patients admitted through the ED with emergency-sensitive conditions. The risk model used to calculate the expected number of deaths adjusts for diagnosis groups, age, in-hospital length of stay and comorbidities. The ED-HSMR calculated on hospital discharge with 37 emergency-sensitive DGs appears to be a reliable measure and may potentially provide added value to other existing HSMR variants, especially for teaching, community-large and community-medium hospitals.

The HSMR methodology was first developed in the mid-1990s by Jarman et al (1999)[19] to explain mortality variations observed between hospitals in the United Kingdom. Since then, many jurisdictions have adopted the HSMR as an important metric to track in-hospital mortality. Although the HSMR has been criticized, its proponents have claimed it is a useful screening performance metric that can be used to identify institutions or time periods when further evaluation of performance is warranted using additional data sources[20,21].

Relevance and reliability of aggregated mortality measures as quality-of-care indicators have also been questioned. When comparing different methods of measuring in-hospital adjusted mortality rates, Shahian et al (2010) identified significant differences in results for same hospitals, suggesting that any link between a specific hospital mortality metric and quality of care should be cautiously drawn[22]. Among other causes potentially explaining these discrepancies such as reliability of data sources and utilization of different statistical methods, the authors suggested that "one potential alternative to the use of hospital-wide mortality rates as a metric would be to estimate hospital quality on the basis of a more limited subgroup of diagnoses for which the link between mortality and quality is most plausible, sample sizes and end points are adequate, and credible risk models are available or can be developed". The ED-HSMR developed with this study represents one such opportunity. First, the ED-HSMR has been calculated by including a limited subgroup of 37 emergency-sensitive DGs selected using a RAND/UCLA Appropriateness Method and a national multidisciplinary panel. Experts believed high-quality ED care could potentially reduce mortality from these conditions. Second, by selecting these emergency-sensitive conditions among 72 DGs accounting for 80% of in-hospital mortality in Canada, the panel was implicitly led to choose the most prevailing conditions with adequate sample size for inclusion in the ratio. Third and finally, the risk models fitted to calculate the expected number of deaths for each hospital appeared to be credible as it demonstrated good predictive performance as measured by the AUC of the different ROC curves.

As for the all-case HSMR, the ED variant is not meant to compare hospitals between them, since it does not adjust for all potential confounders such as local discharge strategies

or within-DG mortality variations. The ED-HSMR should instead be used by each institution as a way to monitor in-hospital mortality trends, trigger more in-depth evaluations and if needed, implement appropriate quality improvement changes. Since our ratio showed good consistency over two years for the highest and lowest rated institutions, jurisdictional authorities could possibly use the ED-HSMR to identify significant outliers.

Comparisons by hospital of the ED-HSMR with other HSMR variants revealed that the ED-HSMR, while following similar distributions, adds information for some hospitals with divergent results. The HSMR specific to emergency-sensitive conditions does not isolate the ED contribution on patients' outcomes. This measure of "ED-related" in-hospital mortality is in fact a hospital-wide metric and will have to be weighted with the relative influence of the other components of the hospital system in which EDs are integrated. Consequently, it may serve as a tool to improve integration of care and collaboration between hospital care providers.

We explored if ED-HSMR variants calculated at fixed time points after hospital admission would be a better reflection of ED care. As the time between the measurement and the ED stay decreased, the HSMR value became less precise with wide confidence intervals. Moreover, statistical comparisons at the peer-group level did not identify any significant differences between the ratios at hospital discharge and at 2, 7 and 30 days. Further research is needed before concluding on the best time point to calculate the ED-HSMR.

LIMITATIONS

This study has a number of limitations. As the HSMR calculation relies exclusively on administrative data sources, accurate chart coding appears critical. However, previous studies have demonstrated that diagnostic and comorbidity inaccuracies have a small to modest effect on the stability of a HSMR measure[23,24] and that coding is generally adequate[25].

The predictive models used to calculate the expected number of deaths has good discriminatory power but poor calibration according to the Hosmer-Lemeshow test. This goodness-of-fit test is very sensitive to sample size and can detect small and sometimes unimportant differences when applied on large study population [26,27]. Consequently, the calibration plots are better tools to assess how good is the fit.

For privacy concerns, we did not have access to the all-case CIHI HSMR values for each institution, which include urgent as well as elective admissions. The HSMR with 72 DGs calculated in this study included only patients admitted through the ED. Consequently, our results do not allow for any firm conclusions on potential differences between the CIHI HSMR and our ED variant. Rather they suggest that, for patients admitted to hospital from the ED, the ED variant with 37 DGs produces similar results to the model with 72 DGs.

Although representing 58.2% of all Canadian hospitals, only 10% of community-small institutions had an ED-HSMR assigned because of an insufficient number of expected

deaths. The ED-HSMR appears to not be a viable tool for the majority of small hospitals, and in-hospital mortality should be analyzed cautiously for these institutions because of a low mortality incidence in this peer-group. Alternative measures of ED care outcomes are needed for small hospitals.

CONCLUSION

The ED-HSMR calculated on hospital discharge with 37 emergency-sensitive DGs appears to be a reliable measure and may potentially provide added value to other existing HSMR variants, especially for teaching, community-large and community-medium hospitals. Further research is needed to determine the best time point after admission to calculate the ratio and to assess if the ED-HSMR is an appropriate proxy measure of in-hospital quality-of-care. Alternative outcome measures need to be developed for small hospitals with few deaths.

REFERENCES

1. Pines JM, Localio AR, Hollander JE, et al. The impact of emergency department crowding measures on time to antibiotics for patients with community-acquired pneumonia. *Ann Emerg Med.* Nov 2007;50(5):510-516.

2. Barrett TW, Schriger DL. Annals of Emergency Medicine Journal Club. Emergency department crowding is associated with poor care for patients with severe pain. *Ann Emerg Med.* Jan 2008;51(1):6-7.

3. Bernstein SL, Aronsky D, Duseja R, et al. The effect of emergency department crowding on clinically oriented outcomes. *Acad Emerg Med.* Jan 2009;16(1):1-10.

4. Kennebeck SS, Timm NL, Kurowski EM, Byczkowski TL, Reeves SD. The association of emergency department crowding and time to antibiotics in febrile neonates. *Acad Emerg Med.* Dec 2011;18(12):1380-1385.

5. Cameron PA, Schull MJ, Cooke MW. A framework for measuring quality in the emergency department. *Emerg Med J.* Sep 2011;28(9):735-740.

6. Schull MJ, Guttmann A, Leaver CA, et al. Prioritizing performance measurement for emergency department care: consensus on evidence-based quality of care indicators. *CJEM.* Sep 2011;13(5):300-309, E328-343.

7. Mason S. Keynote address: United Kingdom experiences of evaluating performance and quality in emergency medicine. *Acad Emerg Med.* Dec 2011;18(12):1234-1238.

8. Jones P, Schimanski K. The four hour target to reduce Emergency Department 'waiting time': a systematic review of clinical outcomes. *Emergency medicine Australasia : EMA.* Oct 2010;22(5):391-398.

9. Jones P, Harper A, Wells S, et al. Selection and validation of quality indicators for the Shorter Stays in Emergency Departments National Research Project. *Emergency medicine Australasia : EMA.* Jun 2012;24(3):303-312.

10. Beattie E, Mackway-Jones K. A Delphi study to identify performance indicators for emergency medicine. *Emerg Med J.* Jan 2004;21(1):47-50.

11. Sibbritt D, Isbister GK, Walker R. Emergency department performance indicators that encompass the patient journey. *Qual Manag Health Care.* Jan-Mar 2006;15(1):27-38.

12. Nguyen HB, Corbett SW, Steele R, et al. Implementation of a bundle of quality indicators for the early management of severe sepsis and septic shock is associated with decreased mortality. *Crit Care Med.* Apr 2007;35(4):1105-1112.

13. Simms AD, Baxter PD, Cattle BA, et al. An assessment of composite measures of hospital performance and associated mortality for patients with acute myocardial infarction. Analysis of individual hospital performance and outcome for the National Institute for Cardiovascular Outcomes Research (NICOR). *European heart journal. Acute cardiovascular care.* Mar 2013;2(1):9-18.

14. Joynt KE, Harris Y, Orav EJ, Jha AK. Quality of care and patient outcomes in critical access rural hospitals. *JAMA.* Jul 6 2011;306(1):45-52.

15. Shen YC, Wu VY. Reductions in Medicare payments and patient outcomes: an analysis of 5 leading Medicare conditions. *Med Care.* Nov 2013;51(11):970-977.

16. Berthelot S, Lang ES, Quan H, Stelfox HT, Panel on Emergency-Sensitive C. Identifying Emergency-Sensitive Conditions for the Calculation of an Emergency Care Inhospital Standardized Mortality Ratio. *Ann Emerg Med.* April 2014; 63(4):418-24.

17. Canadian Institute for Health Information. Technical Notes: Hospital Standardized Mortality Ratio (HSMR). Ottawa 2012.

18. Brien SE, Ghali WA. CIHI's hospital standardized mortality ratio: friend or foe? *Healthc Pap.* 2008;8(4):57-61; discussion 69-75.

19. Jarman B, Gault S, Alves B, et al. Explaining differences in English hospital death rates using routinely collected data. *BMJ.* Jun 5 1999;318(7197):1515-1520.

20. Popowich J, Zaborowski J, Bellows M. Hospital standardized mortality ratios: a tale of two sites. *Healthcare quarterly.* 2011;14(2):42-48.

21. Jarman B. In defence of the hospital standardized mortality ratio. *HealthcarePapers.* 2008;8(4):37-42; discussion 69-75.

22. Shahian DM, Wolf RE, Iezzoni LI, Kirle L, Normand SL. Variability in the measurement of hospital-wide mortality rates. *The New England journal of medicine.* Dec 23 2010;363(26):2530-2539.

23. Ben-Tovim DI, Pointer SC, Woodman R, Hakendorf PH, Harrison JE. Routine use of administrative data for safety and quality purposes--hospital mortality. *The Medical journal of Australia.* Oct 18 2010;193(8 Suppl):S100-103.

24. Bottle A, Jarman B, Aylin P. Hospital standardized mortality ratios: sensitivity analyses on the impact of coding. *Health services research.* Dec 2011;46(6pt1):1741-1761.

25. Wen E, Sandoval C, Zelmer J, Webster G. Understanding and using the hospital standardized mortality ratio in Canada: challenges and opportunities. *HealthcarePapers.* 2008;8(4):26-36; discussion 69-75.

26. Ben-Tovim DI, Woodman R, Harrison JE, Pointer SC, Hakendorf PH, Henley G. Measuring and reporting mortalityin hospital patients. Vol Cat. no. HSE 69: Australian Institute of Health and Welfare; 2009.

27. Aylin P, Bottle A, Majeed A. Use of administrative data or clinical databases as predictors of risk of death in hospital: comparison of models. *Bmj.* May 19 2007;334(7602):1044.

TABLES

Table 1. Characteristics of patients*

Characteristics of patients		
	All cases/119 Diagnosis Groups[a] (n= 2 069 405)	**ED-HSMR cases/37 Diagnosis Groups[b] (n= 1 335 379)**
Median Age (IQR)	71 (56-82)	73 (59-83)
Male	1 046 230 (50.6)	673 102 (50.4)
Median Charlson score (IQR)	0 (0-1)	0 (0-1)
Median In-hospital length of stay [days (IQR)]	5 (2-10)	5 (3-11)
Transfer from another acute care facility to ED	55 268 (2.7)	35 290 (2.6)
In-hospital deaths	166 490 (8.0)	118649 (8.9)
Hospital peer-groups		
Teaching	520 874 (25.2)	326 585 (24.5)
Community - Large	912 299 (44.1)	583 776 (43.7)
Community - Medium	421 729 (20.4)	280 549 (21.0)
Community - Small	214 503 (10.4)	144 469 (10.8)
Province[d]		
Ontario	827 949 (40.0)	542 335 (40.6)
Québec	342 460 (16.5)	210 914 (15.8)
British Columbia	306 116 (14.8)	195 956 (14.7)
Alberta	221 277 (10.7)	140 809 (10.5)
Saskatchewan	92 676 (4.5)	59 019 (4.4)
Manitoba	83 076 (4.0)	55 921 (4.2)
New Brunswick	67 278 (3.3)	44 236 (3.3)
Nova Scotia	65 189 (3.2)	44 001 (3.3)
Newfoundland and Labrador	44985 (2.2)	30 277 (2.7)
Prince Edward Island	11 446 (0.6)	7661 (0.6)
Territories	6953 (0.3)	4250 (0.3)

* All data are presented as number and percentage [n (%)] unless otherwise indicated

[a] Composed of patients admitted with one of the 72 Diagnosis Groups included in the Canadian HSMR and patients admitted with one of 47 additional potential emergency-sensitive Diagnosis Groups identified with a multidisciplinary panel (Berthelot et al 2014)

[b] Composed of patients admitted with one of 37 emergency-sensitive Diagnosis Groups identified with a multidisciplinary panel (Berthelot et al 2014)

[d] Data from fiscal years 2009-10, 2010-11 and 2011-12, except Québec (2009-10 and 2010-11)

Table 2. Number of hospitals (N=629) per peer-group and province

Province	Teaching	Community -Large	Community -Medium	Community -Small	*Total*
Newfoundland and Labrador	1	0	5	23	29
Prince Edward Island	0	1	1	3	5
Nova Scotia	1	1	8	22	32
New Brunswick	1	4	5	10	20
Québec	16	24	28	26	94
Ontario	13	35	38	74	160
Manitoba	2	5	7	45	59
Saskatchewan	5	0	6	49	60
Alberta	3	8	6	76	93
British Columbia	2	15	20	34	71
Territories	0	0	2	4	6
Total	44	93	126	366	**629**

Table 3. Study population (N=2 069 405) distribution and mortality rates by Diagnosis Group

Diagnosis Groups		n	%	Number of deaths	Mortality rate	95% CI	
J44	Other chronic obstructive pulmonary disease	172451	8.3	11828	6.9	6.7	7.0
J18	Pneumonia	137704	6.7	11674	8.5	8.3	8.6
I50	Heart failure	130597	6.3	13393	10.3	10.1	10.4
I21	Acute Myocardial Infarction (AMI)	121463	5.9	8983	7.4	7.2	7.5
K35	Appendicitis	82475	4.0	84	0.1	0.1	0.1
S72	Fracture of femur	81591	3.9	4325	5.3	5.1	5.5
N39	Other disorders of urinary system	69737	3.4	2403	3.4	3.3	3.6
K56	Paralytic ileus and intestinal obstruction without hernia	69397	3.4	2558	3.7	3.5	3.8
I48	Atrial fibrillation and flutter	59967	2.9	1081	1.8	1.7	1.9
I63	Cerebral infarction	50987	2.5	6472	12.7	12.4	13.0
K85	Acute pancreatitis	46149	2.2	714	1.5	1.4	1.7
I20	Angina pectoris	45557	2.2	228	0.5	0.4	0.6
E11	Diabetes Mellitus type 2	43269	2.1	1672	3.9	3.7	4.0
T81	Complications of procedures, not elsewhere classified	42411	2.0	606	1.4	1.3	1.5
L03	Cellulitis	41177	2.0	645	1.6	1.4	1.7
A41	Sepsis	40769	2.0	10198	25.0	24.6	25.4
K57	Diverticular disease of intestine	38133	1.8	633	1.7	1.5	1.8
K92	Other diseases of digestive system	34946	1.7	1639	4.7	4.5	4.9
N17	Acute renal failure	31631	1.5	3612	11.4	11.1	11.8
S06	Intracranial injury	29756	1.4	3294	11.1	10.7	11.4
E87	Other disorders of fluid, electrolyte and acid-base balance	25760	1.2	690	2.7	2.5	2.9
C34	Malignant neoplasm of bronchus and lung	25129	1.2	8102	32.2	31.7	32.8
S32	Fracture of lumbar spine and pelvis	24063	1.2	681	2.8	2.6	3.0
I64	Stroke, not specified as haemorrhage or infarction	23687	1.1	3328	14.0	13.6	14.5
I26	Pulmonary embolism	23237	1.1	1335	5.7	5.4	6.0
R53	Malaise and fatigue	20297	1.0	1011	5.0	4.7	5.3
J69	Pneumonitis due to solids and liquids	20131	1.0	5747	28.5	27.9	29.2

..... = Included in the ED-HSMR calculated with 37 Diagnosis Groups

Table 3. Continued - Study population (N=2 069 405) distribution and mortality rates by Diagnosis Group

Diagnosis Groups		n	%	Number of deaths	Mortality rate	95% CI	
F05	Delirium, not induced by alcohol and other psychoactive substances	20038	1.0	1215	6.1	5.7	6.4
N20	Calculus of kidney and ureter	19597	0.9	21	0.1	0.1	0.2
I25	Chronic ischemic heart disease	18461	0.9	997	5.4	5.1	5.7
I24	Other acute ischemic heart disease	17864	0.9	606	3.4	3.1	3.7
A04	Other bacterial intestinal infection	16800	0.8	1486	8.8	8.4	9.3
K81	Cholecystitis	15347	0.7	163	1.1	0.9	1.2
F03	Unspecified dementia	15077	0.7	1064	7.1	6.6	7.5
S22	Fracture of rib(s), sternum and thoracic spine	14920	0.7	324	2.2	1.9	2.4
C78	Secondary malignant neoplasm of respiratory and digestive organs	14036	0.7	3318	23.6	22.9	24.3
C79	Secondary malignant neoplasm of other sites	13945	0.7	2169	15.6	15.0	16.2
C18	Malignant neoplasm of colon	13552	0.7	2000	14.8	14.2	15.4
E86	Volume depletion	13475	0.7	634	4.7	4.3	5.1
K70	Alcoholic liver disease	12702	0.6	2208	17.4	16.7	18.0
I47	Paroxysmal tachycardia	12684	0.6	230	1.8	1.6	2.0
J96	Respiratory failure, not elsewhere classified	12351	0.6	4365	35.3	34.5	36.2
J90	Pleural effusion, not elsewhere classified	11812	0.6	837	7.1	6.6	7.5
G30	Alzheimer's disease	11654	0.6	1022	8.8	8.3	9.3
K55	Vascular disorders of intestine	11554	0.6	1791	15.5	14.8	16.2
I44	Atrioventricular and left bundle-branch block	10990	0.5	301	2.7	2.4	3.0
K26	Duodenal ulcer	10964	0.5	565	5.2	4.7	5.6
I49	Other cardiac arrhythmias	10915	0.5	436	4.0	3.6	4.4
I61	Intracerebral haemorrhage	10783	0.5	3440	31.9	31.0	32.8
T82	Complications of cardiac and vascular prosthetic devices, implants and grafts	9182	0.4	362	3.9	3.5	4.3
R64	Cachexia	9162	0.4	939	10.2	9.6	10.9
O00	Ectopic pregnancy	9064	0.4	0	0.0	0.0	0.0
T39	Poisoning by nonopioid analgesics, antipyretics and antirheumatics	8632	0.4	83	1.0	0.8	1.2
T42	Poisoning by antiepileptic, sedative-hypnotic and antiparkinsonism drugs	8539	0.4	62	0.7	0.5	0.9

..... = Included in the ED-HSMR calculated with 37 Diagnosis Groups

Table 3. Continued - Study population (N=2 069 405) distribution and mortality rates by Diagnosis Group

Diagnosis Groups		n	%	Number of deaths	Mortality rate	95% CI	
T43	Poisoning by psychotropic drugs, not elsewhere classified	7723	0.4	52	0.7	0.5	0.9
S27	Injury of other and unspecified intrathoracic organs (pneumothorax and hemothorax)	7415	0.4	139	1.9	1.6	2.2
K72	Hepatic failure	7040	0.3	1231	17.5	16.6	18.4
J84	Other interstitial pulmonary diseases	7019	0.3	1546	22.0	21.1	23.0
C25	Malignant neoplasm of pancreas	5982	0.3	1485	24.8	23.7	25.9
I62	Other non traumatic intracranial haemorrhage	5467	0.3	1141	20.9	19.8	21.9
K65	Peritonitis	5433	0.3	450	8.3	7.5	9.0
S36	Injury of intra-abdominal organs	5344	0.3	165	3.1	2.6	3.6
C71	Malignant neoplasm of the brain	5338	0.3	595	11.1	10.3	12.0
K63	Other diseases of intestine	5227	0.3	651	12.5	11.6	13.3
T40	Poisoning by narcotics and psychodysleptics [hallucinogens]	5151	0.2	102	2.0	1.6	2.4
R57	Shock, not elsewhere classified	5130	0.2	2566	50.0	48.7	51.4
I71	Aortic aneurism and dissection	5033	0.2	1277	25.4	24.2	26.6
K74	Fibrosis and cirrhosis of liver	4900	0.2	713	14.6	13.6	15.5
I60	Subarachnoid haemorrhage	4797	0.2	1043	21.7	20.6	22.9
N18	Chronic renal failure	4773	0.2	841	17.6	16.5	18.7
S12	Fracture of neck	4741	0.2	211	4.5	3.9	5.0
N23	Unspecified renal colic	4526	0.2	4	0.1	0.0	0.2
I70	Atherosclerosis	4211	0.2	485	11.5	10.6	12.5
G93	Other disorders of brain	4179	0.2	1648	39.4	38.0	40.9
I35	Nonrheumatic aortic valve disorders	4154	0.2	387	9.3	8.4	10.2
C16	Malignant neoplasm of stomach	4045	0.2	838	20.7	19.5	22.0
C67	Malignant neoplasm of bladder	4000	0.2	699	17.5	16.3	18.7
C61	Malignant neoplasm of prostate	3845	0.2	875	22.8	21.4	24.1
C90	Multiple myeloma and malignant plasma cell neoplasms	3797	0.2	668	17.6	16.4	18.8
T78	Adverse effects, not elsewhere classified (anaphylactic shock)	3756	0.2	17	0.5	0.2	0.7
I46	Cardiac arrest	3582	0.2	2331	65.1	63.5	66.6

..... = Included in the ED-HSMR calculated with 37 Diagnosis Groups

Table 3. Continued - Study population (N=2 069 405) distribution and mortality rates by Diagnosis Group

Diagnosis Groups		n	%	Number of deaths	Mortality rate	95% CI	
I74	Arterial embolism and thrombosis	3499	0.2	260	7.4	6.6	8.3
C50	Malignant neoplasm of breast	3488	0.2	1059	30.4	28.8	31.9
C85	Other and unspecified types of non-Hodgkin's lymphoma	3395	0.2	677	19.9	18.6	21.3
Z54	Convalescence	3357	0.2	47	1.4	1.0	1.8
C22	Malignant neoplasm of liver and intrahepatic bile ducts	3301	0.2	920	27.9	27.9	27.9
C83	Diffuse non-Hodgkin's lymphoma	3041	0.1	597	19.6	18.2	21.0
C92	Myeloid leukemia	2901	0.1	754	26.0	24.4	27.6
I30	Acute pericarditis	2702	0.1	30	1.1	0.7	1.5
C15	Malignant neoplasm of oesophagus	2270	0.1	553	24.4	22.6	26.1
S31	Open wound of abdomen, lower back and pelvis	1651	0.1	11	0.7	0.3	1.1
C80	Malignant neoplasm without specification of site	1644	0.1	666	40.5	38.1	42.9
J80	Adult respiratory distress syndrome	1609	0.1	563	35.0	32.7	37.3
S37	Injury of urinary and pelvic organs (bladder rupture)	1529	0.1	18	1.2	0.6	1.7
T51	Toxic effect of alcohol	1517	0.1	21	1.4	0.8	2.0
T46	Poisoning by agents primarily affecting the cardiovascular system	1179	0.1	40	3.4	2.4	4.4
M72	Fibroblastic disorders (necrotizing fasciitis)	1173	0.1	141	12.0	10.2	13.9
T79	Certain early complications of trauma, not elsewhere classified	1128	0.1	57	5.1	3.8	6.3
G00	Bacterial meningitis, not elsewhere classified	1019	0.0	93	9.1	7.4	10.9
S14	Injury of nerves and spinal cord at neck level	1008	0.0	78	7.7	6.1	9.4
G04	Encephalitis, myelitis and encephalomyelitis	717	0.0	52	7.3	5.4	9.2
T44	Poisoning by drugs primarily affecting the autonomic nervous system	658	0.0	10	1.5	0.6	2.5
S11	Open wound of neck	569	0.0	3	0.5	0.0	1.1
I40	Acute myocarditis	521	0.0	10	1.9	0.7	3.1
S21	Open wound of thorax	521	0.0	6	1.2	0.2	2.1
T68	Hypothermia	407	0.0	36	8.8	6.1	11.6
T58	Toxic effect of carbon monoxide	376	0.0	14	3.7	1.8	5.6
T67	Effects of heat and light	298	0.0	6	2.0	0.4	3.6

..... = Included in the ED-HSMR calculated with 37 Diagnosis Groups

Table 3. Continued - Study population (N=2 069 405) distribution and mortality rates by Diagnosis Group

Diagnosis Groups		n	%	Number of deaths	Mortality rate	95% CI	
T29	Burns and corrosions of multiple body regions	226	0.0	9	4.0	1.4	6.5
T74	Maltreatment syndromes	209	0.0	4	1.9	0.1	3.8
S15	Injury of blood vessels at neck level	187	0.0	13	7.0	3.3	10.6
T27	Burn and corrosion of respiratory tract	91	0.0	6	6.6	1.5	11.7
T31	Burns classified according to extent of body surface involved	35	0.0	2	5.7	0.0	13.4
G01	Meningitis in bacterial diseases classified elsewhere	0	0.0	N/A	N/A	N/A	N/A
G02	Meningitis in other infectious and parasitic diseases classified elsewhere	0	0.0	N/A	N/A	N/A	N/A
G05	Encephalitis, myelitis and encephalomyelitis in diseases classified elsewhere	0	0.0	N/A	N/A	N/A	N/A
I32	Pericarditis in diseases classified elsewhere	0	0.0	N/A	N/A	N/A	N/A
I41	Myocarditis in diseases classified elsewhere	0	0.0	N/A	N/A	N/A	N/A
M01	Direct infections of joint in infectious and parasitic diseases classified elsewhere	0	0.0	N/A	N/A	N/A	N/A
J45	Asthma	Missing	.	.	.	.	.

..... = Included in the ED-HSMR calculated with 37 Diagnosis Groups

Table 4. Comparisons of the areas under the curve of the predictive models* derived from sequential variable inclusion (p-values[§])

37 Diagnosis Groups (DG) vs	Adding Gender (G)	Adding Transfer[a] (T)	Adding Charlson Groups[b] (C)	Adding LOS groups (LOS)[c]	Adding Age Groups[d] (A)
Teaching	0.0008	0.5944	<0.0001	<0.0001	<0.0001
Community-Large	0.0806	0.5197	<0.0001	<0.0001	<0.0001
Community-Medium	0.6304	0.0190	<0.0001	<0.0001	<0.0001
Community-Small	0.1288	0.4683	<0.0001	<0.0001	<0.0001

*log odds of death = $\beta_0 + (\beta_1 DG_1 + \beta_2 DG_2 + \ldots + \beta_{36} DG_{36}) + (\beta_{37} G) + (\beta_{38} T) + (\beta_{39} C_1 + \beta_{40} C_2) + (\beta_{41} LOS_1 + \ldots + \beta_{45} LOS_5) + (\beta_{46} A_1 + \ldots + \beta_{50} A_5)$

§$\propto$=0.0001

[a] Transfer from another acute care facility or another emergency department

[b] Three groups according to the Charlson index score (see methods and Appendix F)

[c] Six groups according to in-hospital length of stay (see methods)

[d] Six groups based on age: A_1 0-20; A_2 21-40; A_3 41-60; A_4 61-80; A_5 81-100; A_6 >100. Age was categorized in groups only for the discrimination assessment to reduce the computational strain on the data analysis software.

Table 5. Performance assessment of the final predictive model* used for the calculation of the ED_HSMR with 37 Diagnosis Groups by peer-group

Hospital peer-groups	AUC[a]	95% CI		Hosmer-Lemeshow test[b] (p-value)
Teaching	0.8000	0.79688	0.80302	<0.0001
Community-Large	0.8043	0.80198	0.80653	<0.0001
Community-Medium	0.8030	0.79960	0.80633	<0.0001
Community-Small	0.8123	0.80735	0.81719	0.02

*log odds of death = $\beta_0 + (\beta_1 DG_1 + \beta_2 DG_2 + \ldots + \beta_{36} DG_{36}) + (\beta_{39} C_1 + \beta_{40} C_2) + (\beta_{41} LOS_1 + \ldots + \beta_{45} LOS_5) + (\beta_{46} A)$

[a]Area under the curve

[b]$\propto$=0.05; see Appendix I Hosmer-Lemeshow test output

Table 6. Cross-tabulation of the classification of institutions by quartiles based on the ED-HSMR in 2010-11 and 2011-12*

		2011-12				
	Quartiles	1	2	3	4	**Total**
2010-11	1	25	11	10	0	46
	2	14	13	11	7	45
	3	5	15	15	11	46
	4	1	7	12	27	47
	Total	45	46	48	45	184

*Intraclass correlation coefficient (consistency): 0.64 (95%CI: 0.55-0.71)

.... = Change by 2 or 3 quartiles over two years (30/184)

Table 7. Comparisons of the ED-HSMR 2010-11 to the ED-HSMR 2011-12 and of the ED-HSMR to the HSMR with 72 Diagnosis Groups*

Hospital peer-groups	ED-HSMR 2010-11	ED-HSMR 2011-12	p-value§	ED-HSMR 37 DGs	HSMR 72 DGs	p-value§
Teaching	96.1 (2.3)	91.2 (2.2)	0.005	96.0 (2.3)	95.8 (2.2)	0.8
Community-Large	94.2 (2.0)	86.7 (1.8)	<0.0001	95.5 (1.6)	95.8 (1.7)	0.7
Community-Medium	97.5 (2.6)	94.9 (2.2)	0.2	95.9 (2.2)	97.0 (2.1)	0.1
Community-Small	108.1 (7.4)	114.2 (8.4)	0.4	109.9 (5.2)	106.0 (4.7)	0.06

*HSMR values are presented as means and standard errors [mean(SE)]

§$\propto$=0.05

Table 8. Comparison between the ED-HSMR with 37 diagnosis groups and the HSMR with 72 diagnosis groups at hospital discharge for 2010-11

8A. Teaching hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGS	95% CI	
29333	69.4	56.2	84.9	72.8	62.3	84.5
29546	69.7	58.2	82.9	78.9	69.1	89.7
29527	78.7	63.0	97.1	79.6	66.9	93.9
91771	80.9	74.0	88.2	84.2	78.1	90.6
53370	81.5	71.5	92.5	84.9	75.8	94.7
60045	82.6	73.1	92.9	104.9	96.7	113.7
83710	83.0	74.6	92.1	79.1	72.1	86.6
23539	83.7	71.7	97.2	89.7	80.7	99.4
72711	83.7	72.8	95.9	78.6	69.4	88.6
56110	83.9	75.1	93.5	81.0	73.2	89.4
53534	84.8	71.8	99.5	84.5	73.3	97.0
50959	88.3	80.8	96.3	89.4	82.8	96.3
84710	88.4	80.3	97.0	84.9	78.0	92.3
28546	88.4	76.7	101.4	79.8	70.7	89.7
24539	89.1	71.7	109.4	84.0	73.0	96.3
56999	90.3	82.1	99.0	87.6	81.0	94.6
54514	90.7	79.9	102.5	92.1	82.6	102.4
39730	90.9	78.8	104.4	90.9	80.3	102.5
47685	91.4	81.9	101.7	95.9	87.9	104.4
51839	93.1	80.1	107.7	94.0	83.6	105.3
66750	93.9	82.2	106.8	96.3	86.0	107.5
22527	94.2	75.7	116.0	96.4	81.9	112.6
86750	94.4	86.7	102.7	90.8	84.2	97.9
54589	96.3	81.8	112.7	92.5	79.9	106.5
53509	96.7	84.6	109.9	106.0	94.8	118.1
50928	97.2	90.2	104.6	103.0	96.6	109.7
52509	99.4	89.2	110.3	101.6	92.0	112.0
65770	99.7	87.3	113.5	95.2	84.7	106.7
92771	101.3	89.3	114.4	97.1	87.2	107.7
58110	102.0	91.6	113.3	103.2	94.5	112.5
19473	102.4	91.8	113.8	106.5	97.6	115.9
20547	102.5	85.6	121.7	98.5	85.1	113.4
70791	104.3	90.1	120.1	93.7	82.7	105.8
79731	104.9	93.4	117.4	97.3	87.7	107.7
22539	105.0	89.5	122.4	99.9	87.7	113.3
95944	105.8	94.2	118.4	112.3	104.2	120.9
1770	111.4	100.5	123.2	105.3	96.0	115.1
50571	112.3	101.1	124.3	115.6	105.9	126.0
71711	119.5	104.0	136.5	103.4	92.0	115.9
25700	120.3	107.9	133.7	119.9	109.2	131.4
28527	128.4	107.7	151.9	128.8	113.7	145.5
21398	148.5	113.8	190.4	144.4	118.0	174.9

8B. Community-Large hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGs	95% CI	
27388	63.0	51.3	76.6	59.0	49.4	69.9
55166	68.7	58.5	80.1	65.7	56.8	75.6
57905	70.9	60.5	82.5	78.1	68.0	89.3
80731	71.6	57.4	88.3	83.3	69.8	98.7
51106	72.5	63.9	81.9	74.9	67.1	83.5
92751	75.8	65.6	87.1	73.0	64.3	82.6
53928	77.3	68.0	87.4	70.4	62.7	78.8
26308	78.2	67.0	90.8	75.6	66.1	86.1
54121	78.3	67.5	90.3	78.0	68.0	88.9
21379	78.6	68.1	90.2	85.6	76.4	95.5
26981	78.9	68.1	91.0	79.4	70.5	89.2
56902	80.0	70.6	90.2	82.4	73.7	91.9
91791	80.5	69.1	93.2	79.7	69.8	90.6
52121	80.7	70.4	92.2	84.6	75.2	94.9
55579	81.4	68.0	96.8	84.7	72.5	98.3
56310	81.7	72.3	92.0	77.0	68.8	85.9
91773	81.8	68.4	97.0	76.0	64.7	88.6
23378	82.2	69.2	96.9	97.2	85.1	110.5
91776	82.3	68.8	97.5	82.0	70.0	95.4
88711	83.2	72.7	94.8	85.4	76.1	95.6
50541	83.2	72.1	95.6	80.2	70.7	90.5
99776	84.3	73.3	96.5	86.4	76.6	97.1
50593	84.4	76.4	93.2	79.7	72.9	87.0
58547	84.5	73.3	97.1	87.3	76.9	98.6
25308	84.8	73.4	97.6	93.5	83.2	104.6
59939	85.2	75.3	96.0	84.8	75.9	94.6
38710	85.8	70.0	104.2	89.5	75.6	105.3
52573	85.9	75.5	97.2	83.2	74.1	93.1
56939	86.4	74.9	99.1	84.3	74.7	94.8
69770	86.6	73.2	101.7	90.8	78.6	104.4
92773	87.5	77.6	98.5	81.9	73.5	91.0
53514	87.8	78.9	97.5	83.9	76.3	92.2
54997	88.2	75.5	102.4	80.7	70.3	92.2
93777	88.3	71.8	107.4	78.0	64.4	93.6
80730	89.0	79.8	99.0	87.0	79.3	95.2
51506	89.8	78.6	102.3	89.0	79.1	99.8
57174	89.9	77.8	103.2	91.2	80.5	102.8
28368	90.4	75.4	107.5	98.7	86.1	112.6
39790	90.9	70.6	115.2	87.6	69.6	108.9
29359	91.0	78.2	105.3	88.1	77.9	99.3
31770	91.1	77.4	106.5	94.9	82.5	108.5
23359	91.2	77.1	107.1	85.5	74.5	97.7
30730	91.6	77.2	107.9	92.8	80.3	106.7
57959	92.3	84.9	100.3	92.8	86.2	99.8

8B. Continued - Community-Large hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGs	95% CI	
24379	92.4	81.5	104.4	94.0	84.8	103.8
55154	92.4	78.1	108.6	89.6	76.8	104.0
25368	92.5	82.7	103.2	101.9	94.3	109.9
91774	92.7	80.2	106.5	90.6	79.8	102.4
52999	94.4	83.7	106.0	93.9	84.4	104.3
29598	95.0	80.5	111.4	93.1	82.0	105.2
59560	95.2	84.0	107.4	94.8	85.2	105.3
90791	95.9	85.2	107.6	99.7	89.9	110.2
26378	96.9	84.4	110.6	109.0	98.4	120.4
91731	96.9	84.1	111.0	88.8	78.1	100.6
53513	97.1	85.0	110.5	93.6	82.7	105.6
28307	97.4	80.9	116.2	89.0	76.2	103.4
58390	98.0	87.1	110.0	95.7	86.6	105.6
56519	99.6	85.8	115.1	94.2	82.5	107.0
11770	99.6	82.7	119.0	101.7	86.7	118.6
58909	99.9	84.7	117.1	99.8	86.1	115.1
95751	100.2	86.7	115.2	99.0	87.3	111.8
81710	100.5	85.9	116.7	95.0	82.8	108.4
55538	101.4	89.6	114.4	103.7	93.0	115.3
72165	101.7	86.7	118.7	98.2	86.2	111.4
61770	104.9	84.3	128.9	106.3	88.8	126.2
92772	104.9	95.6	114.9	100.8	93.0	109.2
51546	104.9	89.9	121.6	105.4	92.3	119.8
99771	104.9	93.6	117.3	99.1	89.6	109.3
27338	104.9	91.7	119.5	107.1	95.9	119.3
96751	105.0	94.8	116.0	107.8	98.7	117.4
25359	105.8	90.6	122.8	110.6	98.0	124.5
54132	105.9	94.4	118.5	96.8	87.1	107.3
82710	106.0	92.5	120.9	106.2	94.3	119.1
82780	106.1	91.2	122.7	109.4	96.4	123.6
53908	107.4	95.8	119.9	105.6	95.1	116.9
25350	108.1	97.3	119.7	113.5	104.3	123.2
57977	109.3	97.2	122.6	108.3	97.5	119.9
63770	109.3	93.2	127.5	116.6	101.8	132.8
91775	109.9	96.9	124.0	113.3	101.7	126.0
26384	110.9	98.8	124.1	107.5	98.0	117.6
61750	111.3	96.0	128.3	115.9	102.2	130.9
51954	111.8	95.2	130.4	118.0	103.4	134.0
67770	112.9	95.4	132.7	127.2	111.2	144.8
89760	114.2	95.6	135.5	112.4	96.1	130.7
21361	116.7	98.2	137.8	119.0	103.4	136.3
47360	117.9	103.8	133.4	116.5	105.5	128.4
81760	119.9	104.6	136.9	119.2	105.8	133.9
28308	120.7	105.4	137.6	120.7	108.8	133.5

8B. Continued - Community-Large hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGs	95% CI	
53919	122.5	108.8	137.5	121.3	108.9	134.7
59120	124.0	111.6	137.5	137.1	126.0	148.9
29578	124.7	109.9	141.0	119.3	107.5	132.1
27700	127.0	112.2	143.3	117.7	104.9	131.6
20361	156.4	131.4	184.8	158.1	138.6	179.7

8C. Community-Medium hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGs	95% CI	
22972	47.0	27.9	74.3	51.3	34.9	72.9
70700	52.0	30.8	82.1	61.3	40.7	88.6
96774	54.5	31.1	88.5	58.0	36.3	87.8
96791	54.7	42.6	69.1	61.0	49.8	74.0
80760	55.0	35.2	81.8	51.3	34.3	73.7
10277	57.4	29.6	100.2	57.3	33.4	91.8
25598	63.0	46.6	83.3	61.0	47.2	77.4
93751	63.4	43.3	89.5	70.3	51.9	93.3
26368	64.3	45.5	88.2	64.6	48.9	83.6
94791	64.7	50.5	81.8	63.2	50.6	77.9
84751	65.3	43.4	94.4	75.7	55.0	101.6
32730	65.5	50.2	84.0	68.3	54.1	85.1
54906	67.8	53.0	85.4	65.9	52.8	81.3
20387	68.4	49.5	92.2	68.6	53.3	87.0
54518	68.7	54.8	85.1	66.3	54.1	80.4
79711	70.6	49.1	98.1	68.3	49.2	92.3
39770	70.7	52.7	93.0	66.4	51.2	84.6
28371	70.8	47.8	101.1	64.7	47.6	86.1
27367	71.4	51.0	97.3	80.0	61.8	102.0
28599	71.8	48.8	101.9	76.3	56.7	100.6
51124	71.9	59.6	86.1	76.4	65.0	89.2
64751	72.9	49.5	103.4	76.3	55.4	102.4
35790	73.1	53.7	97.2	79.7	62.0	100.9
91726	73.8	47.3	109.8	82.2	56.6	115.4
26388	74.0	56.3	95.5	80.3	64.7	98.6
22388	74.5	53.5	101.1	75.4	57.8	96.7
83751	74.6	49.5	107.8	84.2	58.7	117.1
60751	74.6	49.6	107.8	74.1	51.6	103.1
77771	75.5	51.3	107.2	104.8	79.6	135.5
23710	75.5	55.3	100.8	71.5	53.0	94.2
24388	75.8	60.7	93.7	87.4	73.9	102.5
29394	77.5	60.8	97.5	77.6	62.6	95.2
50948	79.2	61.3	100.5	89.1	72.5	108.4
76780	79.3	61.8	100.2	76.0	60.7	94.0
52130	80.4	58.6	107.6	90.0	69.9	114.1
58170	80.6	64.1	100.1	79.9	64.7	97.5
55508	81.2	56.5	112.9	102.4	77.9	132.1
35770	82.0	64.1	103.2	74.2	59.4	91.7
58320	83.2	56.5	118.1	96.7	71.7	127.5
95777	83.2	53.9	122.9	92.1	64.1	128.1
62731	83.6	60.3	113.1	88.6	66.9	115.1
21547	83.9	59.4	115.2	97.8	75.3	124.9
94774	84.4	63.0	110.7	93.9	74.2	117.2
27366	85.2	67.2	106.4	82.2	67.4	99.2

8C. Continued - Community-Medium hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGs	95% CI	
10077	86.3	54.1	130.7	77.1	50.4	113.0
58595	86.6	64.9	113.3	85.4	65.7	109.0
28359	87.3	68.0	110.3	90.0	74.2	108.2
76761	87.3	65.6	113.9	88.2	69.0	111.0
27740	88.7	70.3	110.4	87.8	71.6	106.6
52997	88.8	61.1	124.7	84.6	62.1	112.5
57372	89.4	57.3	133.1	96.3	67.0	133.9
59520	90.3	74.6	108.4	87.4	73.5	103.3
96727	90.7	69.7	116.0	89.9	71.7	111.3
52136	91.3	67.6	120.7	81.7	61.9	105.9
54527	91.6	71.4	115.8	88.2	70.3	109.1
54954	91.7	72.0	115.2	99.4	81.1	120.5
13770	91.8	67.5	122.1	89.8	68.2	116.0
59156	93.2	71.0	120.3	114.5	93.4	139.0
92775	93.7	75.4	115.0	96.0	79.4	114.9
93773	94.2	79.0	111.5	84.8	72.4	98.7
24324	95.3	75.6	118.6	101.8	85.6	120.1
94776	95.5	78.1	115.6	94.7	79.3	112.2
21750	95.6	75.4	119.4	98.1	79.5	119.6
53588	95.8	79.0	115.1	98.0	82.9	115.0
86720	96.3	73.7	123.7	91.1	72.0	113.7
91751	96.5	66.4	135.5	107.8	79.5	143.0
97752	96.5	73.8	124.0	93.1	74.0	115.5
54919	96.6	76.3	120.8	102.5	84.0	123.9
24750	96.8	77.3	119.7	98.2	81.4	117.6
93772	97.2	80.4	116.5	98.1	83.6	114.5
57567	97.2	74.4	124.9	93.7	73.8	117.3
53532	97.3	82.7	113.7	95.7	82.8	109.9
57540	97.9	80.6	117.8	100.8	84.8	118.9
51539	98.3	84.9	113.3	91.9	80.3	104.7
20338	98.5	74.4	127.9	95.4	75.7	118.8
20359	99.2	82.3	118.5	99.3	86.0	114.1
39710	100.5	75.5	131.1	97.5	74.9	124.7
56156	101.8	73.9	136.6	123.0	96.2	154.9
26720	102.7	84.1	124.3	97.3	80.8	116.1
29318	104.0	87.4	122.8	101.4	87.9	116.5
25370	104.2	88.7	121.8	107.3	94.5	121.2
98775	104.8	80.4	134.4	111.6	88.9	138.4
91728	105.6	78.4	139.2	122.6	98.0	151.4
4740	105.8	75.2	144.6	115.3	87.3	149.4
53152	106.0	92.4	121.1	99.5	87.5	112.6
53528	106.7	90.2	125.5	108.2	93.4	124.7
25740	106.7	88.6	127.5	115.9	99.5	134.3
50351	107.5	77.1	145.8	103.9	77.3	136.6

8C. Continued - Community-Medium hospitals

Institution	ED-HSMR	95% CI		HSMR 72 DGs	95% CI	
22358	108.1	90.4	128.3	111.7	96.8	128.2
54150	109.0	92.6	127.4	104.2	90.2	119.7
70731	109.4	87.8	134.6	110.9	91.4	133.4
20388	109.7	80.0	146.7	99.7	77.1	126.9
91777	109.8	73.0	158.8	118.7	85.9	159.9
57132	110.6	93.5	130.0	106.3	91.1	123.3
56557	111.3	86.9	140.3	102.3	81.8	126.4
28588	113.9	82.1	154.0	120.4	93.3	152.9
81730	114.7	85.7	150.4	113.9	89.1	143.5
53598	114.9	92.2	141.6	124.8	104.4	148.1
54578	116.4	95.8	140.2	109.7	92.0	129.8
91778	116.7	89.8	149.0	111.9	88.6	139.4
51585	117.3	96.4	141.4	122.6	103.6	144.1
20519	118.1	93.6	147.0	105.9	87.2	127.5
28325	120.8	92.6	154.8	107.8	86.2	133.1
53558	121.0	84.3	168.3	114.2	84.5	151.0
53562	121.8	101.9	144.4	113.4	96.8	132.1
62741	124.7	93.9	162.3	132.7	105.5	164.7
54989	125.3	88.2	172.8	119.5	86.5	161.0
22308	125.9	99.5	157.1	125.4	103.9	150.1
92759	126.0	83.0	183.4	120.0	83.6	166.9
59577	127.1	98.1	162.0	144.8	117.0	177.2
59937	129.2	98.3	166.6	131.5	103.2	165.1
63761	132.7	95.6	179.4	115.3	85.9	151.6
20328	134.1	113.5	157.3	118.8	104.3	134.8
94777	134.8	95.9	184.3	121.4	88.2	163.0
51768	134.9	100.1	177.8	127.8	100.5	160.2
28750	137.7	114.2	164.5	140.3	118.8	164.6
4770	137.7	111.8	167.8	136.8	114.6	162.0
9710	138.6	106.2	177.7	138.6	110.8	171.1
55555	145.9	117.6	178.9	154.6	128.0	185.2
8790	149.7	121.0	183.2	131.5	107.8	158.7
740	155.6	123.9	192.9	161.2	132.0	195.0
20790	193.7	155.5	238.4	180.9	148.7	218.0

8D. Community-Small hospitals

Institution	Discharge	95% CI		30 days	95% CI	
50517	66.9	37.4	110.3	74.9	46.3	114.5
20378	71.8	44.4	109.7	81.1	58.4	109.6
55144	72.0	42.7	113.9	69.1	43.3	104.7
50568	73.3	41.0	120.8	82.8	51.9	125.4
55170	75.6	49.8	110.0	80.0	56.0	110.8
23303	79.7	48.7	123.1	83.7	56.1	120.3
24351	79.8	54.2	113.2	85.8	64.4	111.9
54531	84.1	52.0	128.5	82.2	55.9	116.7
56599	85.0	58.1	120.0	88.8	63.1	121.4
80721	86.1	53.3	131.6	118.3	84.1	161.8
56572	86.8	54.4	131.4	93.2	62.9	133.1
24579	86.9	61.8	118.8	84.6	64.3	109.4
72780	87.1	52.4	136.0	68.5	44.3	101.2
99773	89.1	54.4	137.6	79.5	51.9	116.5
29306	94.3	64.1	133.9	75.1	53.6	102.2
74720	96.6	59.8	147.7	94.5	61.1	139.5
28367	100.6	66.3	146.4	111.4	83.0	146.5
51352	100.9	64.0	151.5	89.2	59.7	128.1
50321	101.9	63.8	154.2	91.9	62.0	131.2
59587	103.5	66.3	154.0	99.6	68.6	139.9
29301	113.1	77.4	159.7	105.4	80.4	135.6
1730	114.5	72.6	171.9	114.3	78.2	161.4
33790	116.1	77.1	167.8	100.5	70.0	139.8
92776	117.3	80.2	165.5	91.1	64.5	125.1
52989	117.3	79.7	166.5	120.4	86.4	163.3
57585	119.7	86.3	161.8	128.6	97.4	166.6
53572	123.6	82.1	178.6	110.6	75.2	157.0
57979	124.2	81.1	181.9	105.0	70.8	149.9
55582	124.9	92.7	164.6	125.8	95.8	162.3
59542	134.8	93.3	188.4	128.8	92.4	174.8
27301	141.2	100.4	193.0	126.4	94.4	165.8
53371	149.4	101.5	212.1	127.1	91.6	171.8
57558	158.4	122.0	202.2	154.1	123.0	190.5
82720	164.6	115.3	227.9	135.5	98.0	182.5
56586	168.3	117.9	233.0	164.6	120.0	220.2
59511	174.9	123.1	241.1	174.6	127.8	232.9
28710	182.8	128.7	252.0	174.6	128.8	231.6

Table 9. ED-HSMR at hospital discharge, 30, 7 and 2 days after admission for 2010-11

9A. Teaching hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
29333	69.4	56.2	84.9	66.8	53.0	83.1	60.8	44.3	81.3	43.7	25.5	70.0
29546	69.7	58.2	82.9	69.5	57.4	83.5	67.5	52.1	86.1	66.4	45.1	94.2
29527	78.7	63.0	97.1	74.4	58.6	93.1	54.7	38.3	75.7	54.1	32.5	84.5
91771	80.9	74.0	88.2	79.4	72.1	87.3	75.1	66.3	84.8	78.3	66.1	92.2
53370	81.5	71.5	92.5	80.4	69.5	92.4	74.5	61.3	89.8	64.5	47.4	85.8
60045	82.6	73.1	92.9	79.4	69.2	90.6	64.7	52.9	78.4	59.6	43.7	79.6
83710	83.0	74.6	92.1	80.1	71.3	89.6	85.9	74.2	99.0	86.6	70.0	106.0
23539	83.7	71.7	97.2	80.5	68.0	94.5	66.6	52.8	82.9	63.8	45.8	86.6
72711	83.7	72.8	95.9	83.1	72.0	95.5	86.5	72.6	102.4	81.2	62.9	103.1
56110	83.9	75.1	93.5	86.9	77.3	97.5	88.5	76.5	101.9	79.2	64.0	96.9
53534	84.8	71.8	99.5	82.9	69.2	98.4	81.6	64.3	102.2	81.5	57.4	112.4
50959	88.3	80.8	96.3	90.1	82.0	98.9	91.1	80.7	102.4	86.9	73.0	102.8
84710	88.4	80.3	97.0	91.0	82.1	100.6	96.0	84.6	108.6	94.9	79.4	112.4
28546	88.4	76.7	101.4	92.5	80.0	106.4	93.7	78.4	111.1	101.5	80.4	126.6
24539	89.1	71.7	109.4	85.6	67.5	107.0	94.5	70.1	124.6	82.2	51.5	124.4
56999	90.3	82.1	99.0	100.1	90.7	110.1	112.9	100.5	126.4	109.3	92.8	128.0
54514	90.7	79.9	102.5	88.2	77.1	100.4	77.5	65.0	91.7	75.7	59.7	94.6
39730	90.9	78.8	104.4	86.2	73.8	100.1	90.3	74.0	109.0	82.7	61.2	109.3
47685	91.4	81.9	101.7	93.6	83.1	105.1	83.0	71.1	96.3	79.1	63.8	97.0
51839	93.1	80.1	107.7	92.2	78.5	107.7	81.2	65.3	99.6	91.1	68.8	118.3
66750	93.9	82.2	106.8	90.9	78.8	104.4	81.5	67.4	97.8	87.7	68.3	111.0
22527	94.2	75.7	116.0	96.3	76.3	119.8	110.9	83.5	144.4	137.3	94.5	192.9
86750	94.4	86.7	102.7	88.5	80.7	96.9	83.6	74.2	93.9	77.6	65.3	91.5
54589	96.3	81.8	112.7	110.0	92.8	129.4	116.7	94.3	142.8	123.0	91.3	162.2
53509	96.7	84.6	109.9	101.6	88.5	116.1	111.9	94.2	132.0	101.0	77.4	129.5
50928	97.2	90.2	104.6	105.3	97.4	113.7	106.9	96.9	117.6	106.6	92.9	121.7
52509	99.4	89.2	110.3	109.4	97.7	122.1	117.3	102.3	133.9	127.4	106.4	151.4
65770	99.7	87.3	113.5	96.8	83.6	111.5	108.4	90.8	128.4	99.0	76.3	126.5
92771	101.3	89.3	114.4	98.7	86.1	112.6	93.6	78.2	111.3	83.6	63.5	108.1
58110	102.0	91.6	113.3	109.2	97.3	122.1	113.8	98.2	131.2	109.1	87.5	134.4
19473	102.4	91.8	113.8	105.2	94.0	117.4	97.8	84.5	112.5	106.3	87.7	127.6
20547	102.5	85.6	121.7	94.6	77.7	114.1	80.0	60.6	103.6	57.5	36.1	87.1
70791	104.3	90.1	120.1	112.0	95.8	130.1	115.3	94.3	139.5	98.0	70.9	132.0
79731	104.9	93.4	117.4	112.4	99.5	126.5	116.4	100.0	134.7	127.3	104.0	154.2
22539	105.0	89.5	122.4	103.8	87.5	122.3	101.1	80.5	125.3	75.6	51.4	107.4
95944	105.8	94.2	118.4	110.3	97.5	124.3	120.4	103.8	138.9	135.8	111.9	163.3
1770	111.4	100.5	123.2	109.0	97.6	121.4	111.8	97.3	127.9	113.6	93.3	136.9
50571	112.3	101.1	124.3	115.5	103.3	128.7	117.3	101.9	134.2	106.6	86.8	129.7
71711	119.5	104.0	136.5	124.8	108.1	143.3	117.0	96.6	140.4	141.5	110.3	178.7
25700	120.3	107.9	133.7	119.8	106.7	134.1	117.4	101.2	135.4	107.4	86.5	131.9
28527	128.4	107.7	151.9	112.8	92.7	135.9	98.2	75.1	126.1	97.6	66.7	137.7
21398	148.5	113.8	190.4	134.0	99.7	176.1	105.9	68.5	156.3	101.4	52.3	177.1

9B. Community-Large hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
27388	63.0	51.3	76.6	67.3	54.7	81.9	65.5	50.0	84.3	70.2	47.7	99.7
55166	68.7	58.5	80.1	74.1	63.0	86.6	82.9	68.3	99.6	85.6	65.0	110.7
57905	70.9	60.5	82.5	72.0	60.9	84.5	79.1	64.7	95.8	80.1	60.2	104.5
80731	71.6	57.4	88.3	68.6	53.7	86.2	68.3	49.6	91.7	76.6	48.6	115.0
51106	72.5	63.9	81.9	71.1	62.3	80.8	77.2	65.9	90.0	81.0	65.0	99.8
92751	75.8	65.6	87.1	83.1	71.5	95.9	80.6	66.5	96.7	88.3	67.8	113.0
53928	77.3	68.0	87.4	79.7	70.0	90.4	83.1	70.7	97.1	89.6	71.5	110.9
26308	78.2	67.0	90.8	84.2	71.7	98.3	78.2	63.3	95.6	89.4	67.2	116.7
54121	78.3	67.5	90.3	79.3	67.8	92.2	85.7	70.7	103.1	81.6	60.7	107.3
21379	78.6	68.1	90.2	79.2	68.0	91.7	64.2	51.9	78.7	52.1	36.9	71.5
26981	78.9	68.1	91.0	75.8	64.9	88.0	80.1	66.0	96.2	67.6	49.8	89.6
56902	80.0	70.6	90.2	84.5	74.2	95.9	87.1	74.1	101.8	100.2	80.8	122.9
91791	80.5	69.1	93.2	86.1	72.9	101.1	78.7	63.0	97.1	87.0	63.9	115.7
52121	80.7	70.4	92.2	81.6	70.4	94.0	81.8	67.6	98.1	92.4	70.7	118.7
55579	81.4	68.0	96.8	86.1	71.2	103.3	90.2	70.8	113.2	80.1	54.4	113.6
56310	81.7	72.3	92.0	83.9	73.8	94.9	78.1	66.1	91.7	84.1	66.8	104.5
91773	81.8	68.4	97.0	91.3	75.7	109.2	79.0	61.2	100.3	74.4	50.5	105.6
23378	82.2	69.2	96.9	87.4	73.1	103.6	88.6	70.8	109.5	72.9	50.5	101.8
91776	82.3	68.8	97.5	89.0	73.6	106.7	78.0	60.3	99.2	68.1	45.6	97.8
88711	83.2	72.7	94.8	75.3	65.0	86.8	61.7	50.1	75.3	59.7	43.8	79.3
50541	83.2	72.1	95.6	89.3	76.8	103.2	94.3	78.4	112.5	101.8	78.7	129.5
99776	84.3	73.3	96.5	85.4	73.5	98.6	82.8	68.4	99.3	87.2	66.9	111.8
50593	84.4	76.4	93.2	85.9	77.0	95.4	79.4	68.7	91.4	89.0	72.7	108.0
58547	84.5	73.3	97.1	79.3	67.9	92.0	73.2	59.6	89.1	71.1	52.2	94.6
25308	84.8	73.4	97.6	79.9	68.4	92.9	64.6	51.9	79.5	73.2	54.5	96.2
59939	85.2	75.3	96.0	87.8	77.3	99.4	90.9	77.6	105.7	93.6	74.9	115.4
38710	85.8	70.0	104.2	77.2	61.5	95.5	74.9	55.9	98.2	76.5	50.4	111.4
52573	85.9	75.5	97.2	89.7	78.4	102.2	89.6	75.3	105.9	107.3	84.7	134.1
56939	86.4	74.9	99.1	86.3	74.3	99.6	80.4	65.7	97.3	84.4	63.0	110.6
69770	86.6	73.2	101.7	87.6	73.3	104.0	84.0	66.4	104.9	101.6	74.4	135.5
92773	87.5	77.6	98.5	95.8	84.6	108.2	90.9	77.4	105.9	89.0	70.9	110.4
53514	87.8	78.9	97.5	93.2	83.2	103.9	98.4	85.6	112.7	102.8	84.3	124.2
54997	88.2	75.5	102.4	89.7	76.2	104.9	77.4	61.6	95.9	74.0	52.6	101.1
93777	88.3	71.8	107.4	82.5	65.1	103.1	95.1	72.2	123.0	106.6	73.8	149.0
80730	89.0	79.8	99.0	79.3	70.3	89.2	71.5	60.6	83.9	69.3	53.8	87.9
51506	89.8	78.6	102.3	96.0	83.4	110.0	103.5	86.9	122.3	83.4	62.2	109.3
57174	89.9	77.8	103.2	88.9	76.1	103.3	90.3	74.3	108.7	87.8	66.0	114.6
28368	90.4	75.4	107.5	94.1	77.9	112.6	88.0	68.7	111.0	77.7	52.4	110.9
39790	90.9	70.6	115.2	93.1	71.5	119.1	90.7	64.5	123.9	98.6	61.0	150.7
29359	91.0	78.2	105.3	91.6	78.1	106.7	97.3	80.0	117.2	103.5	78.8	133.5
31770	91.1	77.4	106.5	91.2	76.5	107.8	84.9	67.4	105.5	88.0	63.4	118.9
23359	91.2	77.1	107.1	93.4	78.2	110.6	94.6	75.5	116.9	86.5	60.9	119.2
30730	91.6	77.2	107.9	87.8	73.1	104.5	88.4	70.4	109.6	77.8	55.0	106.8
57959	92.3	84.9	100.3	94.4	86.5	102.7	97.7	87.8	108.5	92.3	79.1	107.0

9B. Continued - Community-Large hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
24379	92.4	81.5	104.4	104.1	91.3	118.1	113.9	97.1	132.7	132.9	107.3	162.8
55154	92.4	78.1	108.6	98.5	83.0	116.0	95.8	77.0	117.8	91.5	66.2	123.3
25368	92.5	82.7	103.2	98.1	87.1	110.1	96.3	82.6	111.6	104.6	84.6	128.1
91774	92.7	80.2	106.5	96.2	82.7	111.1	113.3	95.2	133.7	107.6	83.7	136.2
52999	94.4	83.7	106.0	100.2	88.3	113.3	108.1	92.5	125.6	123.2	99.9	150.3
29598	95.0	80.5	111.4	93.4	78.6	110.2	100.8	81.8	123.0	93.6	68.5	124.9
59560	95.2	84.0	107.4	93.9	82.3	106.7	103.6	88.1	121.2	97.6	76.1	123.3
90791	95.9	85.2	107.6	103.9	91.5	117.4	102.2	86.9	119.3	123.3	99.5	151.1
26378	96.9	84.4	110.6	101.4	87.5	117.0	96.0	79.1	115.5	99.1	75.0	128.3
91731	96.9	84.1	111.0	100.1	86.2	115.7	88.0	71.8	106.7	93.4	70.0	122.2
53513	97.1	85.0	110.5	93.0	80.0	107.5	87.1	71.3	105.4	115.3	89.5	146.2
28307	97.4	80.9	116.2	99.4	81.8	119.6	94.6	73.5	119.9	106.9	75.6	146.7
58390	98.0	87.1	110.0	103.2	91.3	116.1	108.2	93.1	125.1	127.2	104.3	153.6
56519	99.6	85.8	115.1	107.8	92.6	124.9	114.2	94.7	136.6	130.0	100.6	165.5
11770	99.6	82.7	119.0	92.3	75.3	111.9	90.6	69.9	115.5	74.7	49.2	108.6
58909	99.9	84.7	117.1	109.6	92.9	128.4	140.8	117.0	168.0	132.5	99.8	172.5
95751	100.2	86.7	115.2	101.0	86.2	117.7	93.7	75.8	114.5	84.5	60.6	114.6
81710	100.5	85.9	116.7	91.6	76.9	108.4	91.1	72.6	112.9	105.4	77.2	140.6
55538	101.4	89.6	114.4	104.8	92.1	118.8	111.7	95.2	130.3	111.4	88.0	139.0
72165	101.7	86.7	118.7	99.3	83.7	116.9	90.0	71.4	112.0	107.0	77.8	143.7
61770	104.9	84.3	128.9	99.0	78.0	123.9	101.8	75.3	134.5	123.2	82.5	176.9
92772	104.9	95.6	114.9	109.8	99.6	120.8	103.1	90.6	116.7	107.9	90.0	128.3
51546	104.9	89.9	121.6	103.8	88.2	121.3	103.3	84.1	125.5	97.3	71.7	129.0
99771	104.9	93.6	117.3	109.7	97.3	123.1	115.3	99.7	132.6	123.1	101.2	148.4
27338	104.9	91.7	119.5	105.0	90.8	120.8	101.8	84.3	121.9	113.5	87.4	145.0
96751	105.0	94.8	116.0	102.3	91.5	113.9	100.5	87.1	115.3	106.8	87.4	129.3
25359	105.8	90.6	122.8	102.1	86.5	119.9	103.7	83.9	126.7	104.4	76.4	139.2
54132	105.9	94.4	118.5	109.0	96.8	122.3	100.1	85.6	116.4	92.3	72.8	115.3
82710	106.0	92.5	120.9	99.0	85.4	114.2	96.7	79.7	116.3	75.3	54.5	101.5
82780	106.1	91.2	122.7	97.4	82.4	114.2	95.8	77.6	117.0	82.7	59.6	111.8
53908	107.4	95.8	119.9	108.2	95.5	122.1	111.5	95.4	129.5	121.6	98.2	149.0
25350	108.1	97.3	119.7	108.6	97.2	121.1	104.3	90.6	119.5	94.4	76.6	115.2
57977	109.3	97.2	122.6	110.1	97.3	124.0	99.4	84.3	116.4	80.5	61.7	103.1
63770	109.3	93.2	127.5	101.7	85.3	120.3	83.2	64.8	105.1	80.5	55.4	113.1
91775	109.9	96.9	124.0	111.5	97.6	126.9	96.3	80.3	114.6	91.6	69.9	117.9
26384	110.9	98.8	124.1	105.5	93.3	118.9	103.6	88.7	120.3	101.7	81.4	125.4
61750	111.3	96.0	128.3	102.7	87.4	120.0	98.8	79.7	121.0	101.5	73.7	136.2
51954	111.8	95.2	130.4	121.2	102.7	142.1	124.6	101.4	151.5	132.0	98.9	172.6
67770	112.9	95.4	132.7	109.4	91.3	130.0	106.3	84.0	132.7	100.1	69.7	139.3
89760	114.2	95.6	135.5	108.8	89.5	131.0	104.9	81.2	133.5	122.1	86.0	168.3
21361	116.7	98.2	137.8	105.3	86.9	126.4	96.9	75.4	122.6	80.7	54.5	115.2
47360	117.9	103.8	133.4	114.0	99.5	130.0	84.2	68.7	102.1	81.6	60.0	108.5
81760	119.9	104.6	136.9	124.9	108.4	143.3	138.8	116.9	163.6	156.3	123.3	195.3
28308	120.7	105.4	137.6	125.4	108.8	143.8	112.5	93.2	134.7	126.3	98.0	160.1

9B. Continued - Community-Large hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
53919	122.5	108.8	137.5	132.0	116.8	148.8	146.7	127.0	168.5	160.4	132.7	192.2
59120	124.0	111.6	137.5	113.3	100.9	126.8	122.2	106.3	139.8	126.9	104.6	152.4
29578	124.7	109.9	141.0	113.7	98.9	130.1	92.4	76.0	111.3	73.5	53.6	98.3
27700	127.0	112.2	143.3	120.8	105.4	137.7	104.5	86.7	125.0	116.2	89.5	148.4
20361	156.4	131.4	184.8	140.8	116.0	169.3	147.3	116.7	183.6	135.9	96.6	185.8

9C. Community-Medium hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
22972	47.0	27.9	74.3	50.9	30.2	80.5	55.1	29.3	94.2	66.8	28.8	131.7
70700	52.0	30.8	82.1	52.1	29.7	84.5	49.9	23.9	91.9	42.7	11.5	109.4
96774	54.5	31.1	88.5	60.5	33.8	99.8	61.3	29.3	112.7	51.5	13.8	131.7
96791	54.7	42.6	69.1	58.8	45.1	75.4	52.3	36.6	72.4	47.9	27.4	77.9
80760	55.0	35.2	81.8	38.0	20.8	63.8	29.5	11.8	60.8	18.4	2.1	66.5
10277	57.4	29.6	100.2	64.7	33.4	113.1	78.4	37.5	144.2	90.3	33.0	196.6
25598	63.0	46.6	83.3	58.2	41.9	78.7	61.8	41.3	88.7	44.7	21.4	82.2
93751	63.4	43.3	89.5	69.8	46.7	100.2	64.2	38.1	101.5	91.2	48.5	156.0
26368	64.3	45.5	88.2	59.2	40.2	84.1	61.1	37.8	93.3	71.5	36.9	124.9
94791	64.7	50.5	81.8	77.1	59.5	98.3	60.8	41.8	85.3	79.9	49.5	122.2
84751	65.3	43.4	94.4	69.4	44.9	102.5	48.2	24.0	86.2	58.0	21.2	126.3
32730	65.5	50.2	84.0	62.0	45.8	81.9	53.6	35.3	78.0	61.1	33.4	102.5
54906	67.8	53.0	85.4	71.6	56.0	90.1	83.0	62.4	108.3	87.2	57.4	126.8
20387	68.4	49.5	92.2	65.8	46.3	90.7	71.7	46.8	105.0	56.5	27.0	103.9
54518	68.7	54.8	85.1	73.8	58.9	91.4	85.5	65.8	109.2	82.7	55.8	118.0
79711	70.6	49.1	98.1	74.0	51.2	103.4	85.7	56.5	124.7	67.4	33.6	120.5
39770	70.7	52.7	93.0	69.0	50.3	92.4	67.6	44.9	97.7	68.7	36.5	117.4
28371	70.8	47.8	101.1	74.9	50.5	106.9	75.9	46.3	117.2	71.0	32.4	134.9
27367	71.4	51.0	97.3	67.8	47.5	93.9	75.8	49.9	110.3	90.4	51.6	146.8
28599	71.8	48.8	101.9	74.5	49.9	107.0	69.6	41.2	110.0	87.8	43.8	157.0
51124	71.9	59.6	86.1	73.8	60.6	89.1	73.3	56.9	92.9	61.2	40.0	89.7
64751	72.9	49.5	103.4	70.3	46.7	101.5	79.6	49.3	121.7	47.1	17.2	102.6
35790	73.1	53.7	97.2	69.2	49.4	94.2	78.0	52.2	112.1	70.1	36.2	122.5
91726	73.8	47.3	109.8	72.3	44.1	111.6	72.8	38.7	124.5	81.3	32.6	167.5
26388	74.0	56.3	95.5	76.3	58.1	98.5	83.6	60.0	113.4	79.8	47.3	126.1
22388	74.5	53.5	101.1	78.6	55.9	107.5	80.7	52.7	118.2	52.7	22.7	103.8
83751	74.6	49.5	107.8	73.1	46.3	109.7	44.9	20.5	85.2	87.9	37.8	173.2
60751	74.6	49.6	107.8	78.7	51.4	115.4	72.1	41.2	117.1	70.6	30.4	139.1
77771	75.5	51.3	107.2	76.4	50.7	110.4	76.3	45.9	119.2	76.6	36.7	140.8
23710	75.5	55.3	100.8	67.7	47.9	93.0	59.9	37.5	90.7	68.0	35.1	118.9
24388	75.8	60.7	93.7	77.5	61.6	96.2	88.2	67.2	113.8	101.0	68.6	143.4
29394	77.5	60.8	97.5	76.0	58.9	96.5	78.1	56.8	104.9	66.9	39.0	107.2
50948	79.2	61.3	100.5	78.6	60.2	100.7	79.1	56.5	107.7	63.9	35.7	105.4
76780	79.3	61.8	100.2	80.2	61.9	102.2	79.1	57.0	106.9	83.0	51.3	126.8
52130	80.4	58.6	107.6	81.2	59.0	109.1	66.9	42.9	99.6	67.3	34.7	117.6
58170	80.6	64.1	100.1	88.8	70.2	110.8	86.3	63.8	114.1	112.6	76.0	160.8
55508	81.2	56.5	112.9	83.3	57.3	117.0	51.7	27.5	88.3	26.4	5.3	77.0
35770	82.0	64.1	103.2	75.3	57.7	96.5	64.3	44.5	89.9	96.5	61.8	143.6
58320	83.2	56.5	118.1	79.2	52.2	115.3	104.7	67.1	155.8	86.0	41.2	158.1
95777	83.2	53.9	122.9	89.7	57.5	133.5	104.4	62.8	163.1	116.9	58.3	209.2
62731	83.6	60.3	113.1	81.2	55.9	114.1	92.8	59.5	138.1	99.7	51.5	174.2
21547	83.9	59.4	115.2	69.6	47.0	99.4	60.5	35.2	96.9	59.6	25.7	117.5
94774	84.4	63.0	110.7	97.9	73.1	128.3	107.0	75.7	146.9	106.9	64.3	167.0
27366	85.2	67.2	106.4	86.7	67.7	109.3	97.4	72.8	127.8	125.4	85.8	177.1

9C. Continued - Community-Medium hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
10077	86.3	54.1	130.7	96.9	60.7	146.7	96.0	53.7	158.4	109.8	50.1	208.4
58595	86.6	64.9	113.3	102.0	76.4	133.4	107.7	75.8	148.4	107.5	63.7	169.9
28359	87.3	68.0	110.3	99.2	77.1	125.8	110.5	81.5	146.6	114.9	72.8	172.4
76761	87.3	65.6	113.9	81.8	59.4	109.8	80.4	53.8	115.5	100.5	59.5	158.9
27740	88.7	70.3	110.4	77.3	59.6	98.8	63.4	43.9	88.6	38.4	18.4	70.6
52997	88.8	61.1	124.7	87.4	59.0	124.8	111.0	71.1	165.1	81.4	35.1	160.4
57372	89.4	57.3	133.1	96.0	60.9	144.1	107.1	62.3	171.5	128.8	61.7	236.9
59520	90.3	74.6	108.4	88.7	72.7	107.2	98.4	77.6	122.9	98.4	68.9	136.2
96727	90.7	69.7	116.0	93.4	70.8	121.1	103.9	74.6	141.0	124.5	78.9	186.9
52136	91.3	67.6	120.7	97.9	72.5	129.5	140.9	103.2	188.0	136.9	84.7	209.3
54527	91.6	71.4	115.8	94.1	73.2	119.1	98.6	72.5	131.2	96.4	60.4	145.9
54954	91.7	72.0	115.2	87.4	67.9	110.8	89.5	65.5	119.4	89.3	56.0	135.2
13770	91.8	67.5	122.1	90.8	66.0	121.9	72.5	45.9	108.7	58.2	26.5	110.4
59156	93.2	71.0	120.3	95.2	71.5	124.2	99.2	69.8	136.7	98.2	58.2	155.3
92775	93.7	75.4	115.0	97.1	77.1	120.7	80.9	59.0	108.2	86.7	55.5	129.0
93773	94.2	79.0	111.5	94.4	78.4	112.7	88.7	69.6	111.3	98.9	70.3	135.2
24324	95.3	75.6	118.6	92.0	71.8	116.0	87.3	63.4	117.2	99.3	63.6	147.7
94776	95.5	78.1	115.6	96.4	77.7	118.3	79.8	59.0	105.5	82.1	52.6	122.1
21750	95.6	75.4	119.4	92.1	71.4	117.0	94.8	69.6	126.0	100.6	65.1	148.5
53588	95.8	79.0	115.1	89.9	73.5	109.0	90.1	69.6	114.6	89.8	60.5	128.1
86720	96.3	73.7	123.7	93.2	69.8	121.9	98.5	68.9	136.3	109.2	65.7	170.5
91751	96.5	66.4	135.5	100.0	67.4	142.7	98.8	59.5	154.3	122.8	61.2	219.8
97752	96.5	73.8	124.0	110.6	83.5	143.6	109.3	76.1	152.0	87.6	46.6	149.7
54919	96.6	76.3	120.8	92.4	72.0	116.7	101.6	75.6	133.5	76.6	46.1	119.6
24750	96.8	77.3	119.7	94.3	73.8	118.8	100.1	74.3	132.0	107.1	69.9	156.9
93772	97.2	80.4	116.5	102.3	83.8	123.8	90.4	69.1	116.1	71.8	45.5	107.7
57567	97.2	74.4	124.9	101.8	77.5	131.3	106.8	75.9	146.0	102.7	59.8	164.4
53532	97.3	82.7	113.7	99.9	84.9	116.9	103.6	84.7	125.4	98.5	72.6	130.7
57540	97.9	80.6	117.8	98.2	80.0	119.2	109.0	85.5	137.1	130.4	93.6	176.9
51539	98.3	84.9	113.3	95.8	82.1	111.0	93.2	76.7	112.1	88.3	65.6	116.5
20338	98.5	74.4	127.9	105.9	79.6	138.2	112.2	79.0	154.7	124.3	74.8	194.2
20359	99.2	82.3	118.5	93.3	76.3	113.0	84.7	64.8	108.8	85.5	57.2	122.7
39710	100.5	75.5	131.1	98.3	72.0	131.2	78.1	50.0	116.2	86.7	46.1	148.3
56156	101.8	73.9	136.6	105.8	75.6	144.0	83.1	51.4	127.1	102.6	54.6	175.4
26720	102.7	84.1	124.3	96.5	77.8	118.4	86.7	65.1	113.1	86.6	56.6	127.0
29318	104.0	87.4	122.8	98.7	82.0	117.9	98.5	78.2	122.4	76.0	51.6	107.8
25370	104.2	88.7	121.8	106.4	90.2	124.6	93.3	74.7	115.1	89.9	64.2	122.4
98775	104.8	80.4	134.4	102.6	77.3	133.5	98.8	68.4	138.1	109.6	64.9	173.2
91728	105.6	78.4	139.2	111.0	80.6	149.0	108.9	72.3	157.4	103.6	55.1	177.2
4740	105.8	75.2	144.6	106.4	74.5	147.3	99.1	62.8	148.7	116.5	63.6	195.4
53152	106.0	92.4	121.1	111.7	97.1	127.8	116.6	98.2	137.4	116.2	90.1	147.6
53528	106.7	90.2	125.5	109.5	91.9	129.4	119.1	96.5	145.5	128.0	94.4	169.7
25740	106.7	88.6	127.5	99.5	81.2	120.7	93.7	71.8	120.1	118.3	82.8	163.8
50351	107.5	77.1	145.8	115.2	81.9	157.5	132.8	89.0	190.8	137.4	75.0	230.5

9C. Continued - Community-Medium hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
22358	108.1	90.4	128.3	109.8	90.8	131.5	110.5	87.0	138.3	106.6	74.2	148.2
54150	109.0	92.6	127.4	104.8	88.3	123.5	101.2	81.4	124.4	92.2	65.5	126.0
70731	109.4	87.8	134.6	97.9	76.5	123.5	82.5	58.7	112.8	74.5	43.4	119.4
20388	109.7	80.0	146.7	105.6	75.8	143.3	129.7	89.3	182.2	160.5	98.0	247.9
91777	109.8	73.0	158.8	110.9	71.0	165.0	125.8	74.5	198.8	183.9	97.8	314.5
57132	110.6	93.5	130.0	116.5	98.3	137.1	115.5	93.2	141.5	104.1	74.1	142.4
56557	111.3	86.9	140.3	117.3	91.3	148.4	117.3	85.2	157.5	119.9	74.2	183.3
28588	113.9	82.1	154.0	115.9	82.0	159.1	122.6	80.1	179.7	110.6	55.1	197.9
81730	114.7	85.7	150.4	106.2	77.2	142.6	113.0	76.8	160.4	103.7	56.7	174.0
53598	114.9	92.2	141.6	116.0	92.0	144.4	106.0	78.2	140.6	113.8	73.6	168.0
54578	116.4	95.8	140.2	120.0	98.1	145.5	127.9	100.2	160.8	134.2	95.0	184.2
91778	116.7	89.8	149.0	124.9	95.8	160.2	118.7	84.4	162.3	150.2	97.2	221.7
51585	117.3	96.4	141.4	118.2	96.4	143.5	112.2	86.2	143.5	86.5	54.8	129.8
20519	118.1	93.6	147.0	113.8	89.2	143.1	97.5	69.9	132.2	87.4	51.8	138.1
28325	120.8	92.6	154.8	126.2	95.3	163.9	136.9	97.4	187.2	137.5	82.7	214.7
53558	121.0	84.3	168.3	128.3	88.3	180.2	95.0	53.1	156.6	104.8	42.0	215.9
53562	121.8	101.9	144.4	129.8	108.4	154.3	131.0	104.3	162.3	155.7	114.0	207.6
62741	124.7	93.9	162.3	112.0	81.4	150.4	114.9	77.5	164.1	124.6	71.2	202.3
54989	125.3	88.2	172.8	128.5	88.4	180.4	147.7	94.6	219.8	108.0	46.5	212.8
22308	125.9	99.5	157.1	125.9	98.5	158.6	130.9	96.8	173.0	158.8	106.4	228.1
92759	126.0	83.0	183.4	121.6	77.0	182.4	102.1	54.3	174.6	106.6	42.7	219.6
59577	127.1	98.1	162.0	132.0	101.0	169.5	123.1	87.1	169.0	160.7	104.0	237.3
59937	129.2	98.3	166.6	113.2	83.1	150.5	110.5	74.0	158.7	148.3	87.8	234.3
63761	132.7	95.6	179.4	132.5	93.7	181.8	116.5	73.0	176.4	110.3	52.8	202.9
20328	134.1	113.5	157.3	126.8	105.9	150.7	112.3	88.3	140.8	123.8	88.5	168.6
94777	134.8	95.9	184.3	141.9	98.8	197.4	132.1	83.7	198.3	105.6	50.6	194.3
51768	134.9	100.1	177.8	147.6	108.4	196.2	157.9	108.7	221.7	215.8	135.2	326.8
28750	137.7	114.2	164.5	138.2	113.1	167.2	130.8	101.2	166.4	129.3	87.8	183.5
4770	137.7	111.8	167.8	123.0	97.8	152.6	102.9	75.1	137.7	93.4	57.0	144.2
9710	138.6	106.2	177.7	128.4	96.5	167.5	82.3	52.2	123.5	74.0	35.4	136.1
55555	145.9	117.6	178.9	156.1	125.5	191.9	186.1	144.5	235.9	223.0	157.0	307.4
8790	149.7	121.0	183.2	138.6	110.2	172.0	124.0	91.4	164.4	135.1	87.4	199.5
740	155.6	123.9	192.9	148.3	116.8	185.6	134.8	98.7	179.9	105.8	62.7	167.3
20790	193.7	155.5	238.4	193.5	153.4	240.8	167.9	123.4	223.3	172.2	110.3	256.3

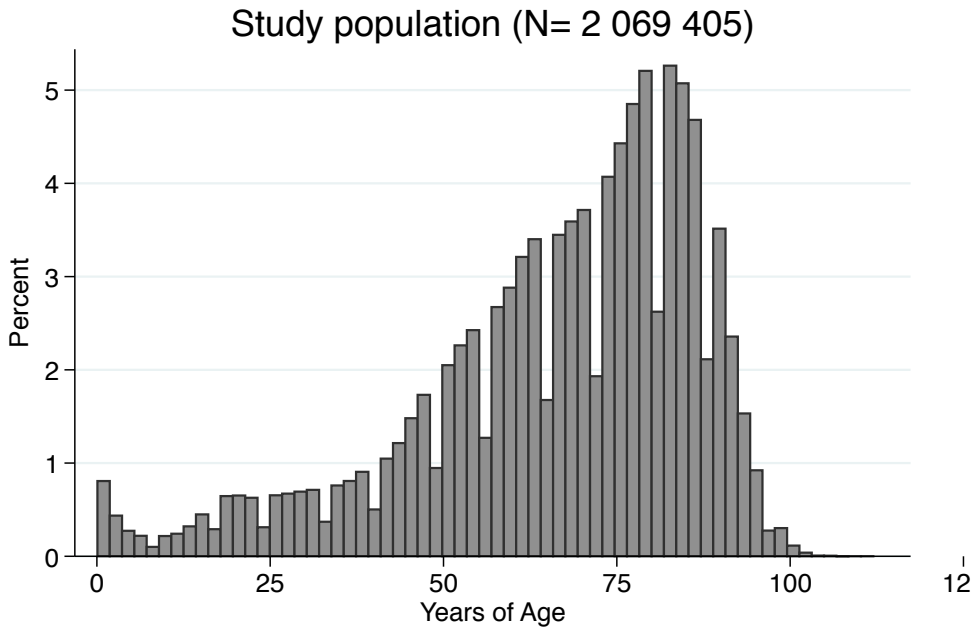
9D. Community-Small hospitals

Institution	Discharge	95% CI		30 days	95% CI		7 days	95% CI		2 days	95% CI	
50517	66.9	37.4	110.3	65.7	35.9	110.3	55.9	24.1	110.1	87.8	32.1	191.1
20378	71.8	44.4	109.7	62.5	36.4	100.0	81.5	45.6	134.5	70.1	25.6	152.7
55144	72.0	42.7	113.9	70.2	40.1	114.1	57.0	26.0	108.3	78.9	28.8	171.7
50568	73.3	41.0	120.8	76.2	42.6	125.7	76.3	36.5	140.4	85.5	27.5	199.5
55170	75.6	49.8	110.0	75.7	48.5	112.7	87.2	52.5	136.2	48.2	15.5	112.6
23303	79.7	48.7	123.1	84.3	51.5	130.3	81.7	43.5	139.7	82.7	30.2	180.0
24351	79.8	54.2	113.2	82.5	56.1	117.2	79.9	49.5	122.2	94.4	48.7	164.8
54531	84.1	52.0	128.5	82.4	50.3	127.3	98.4	56.2	159.8	101.1	43.5	199.3
56599	85.0	58.1	120.0	85.8	58.7	121.1	93.8	60.1	139.6	90.4	45.0	161.7
80721	86.1	53.3	131.6	81.7	48.4	129.2	66.3	31.7	122.0	43.6	8.8	127.5
56572	86.8	54.4	131.4	83.6	51.0	129.1	84.5	46.1	141.8	96.3	41.5	189.8
24579	86.9	61.8	118.8	88.3	62.5	121.2	74.8	46.9	113.2	58.2	25.1	114.7
72780	87.1	52.4	136.0	90.3	53.5	142.7	60.9	26.2	120.1	50.8	10.2	148.4
99773	89.1	54.4	137.6	97.8	59.7	151.0	100.6	55.0	168.8	122.5	52.7	241.3
29306	94.3	64.1	133.9	93.7	63.2	133.7	82.1	48.6	129.8	85.1	38.8	161.6
74720	96.6	59.8	147.7	108.9	67.4	166.5	101.2	53.8	173.0	67.7	18.2	173.3
28367	100.6	66.3	146.4	108.0	71.2	157.1	96.0	55.9	153.7	90.0	38.8	177.4
51352	100.9	64.0	151.5	95.9	59.3	146.6	97.0	54.2	159.9	93.8	37.6	193.3
50321	101.9	63.8	154.2	109.6	68.6	165.9	114.8	65.6	186.5	113.9	49.1	224.5
59587	103.5	66.3	154.0	99.1	61.3	151.4	76.4	38.1	136.7	119.6	51.5	235.7
29301	113.1	77.4	159.7	102.9	68.4	148.7	109.0	67.5	166.7	116.2	57.9	207.8
1730	114.5	72.6	171.9	110.9	68.6	169.6	68.2	31.1	129.5	108.7	43.6	224.0
33790	116.1	77.1	167.8	118.7	78.2	172.7	110.9	64.6	177.6	126.2	57.6	239.6
92776	117.3	80.2	165.5	129.6	88.6	183.0	141.8	89.9	212.8	132.4	63.4	243.6
52989	117.3	79.7	166.5	126.0	85.0	179.9	142.2	90.1	213.4	183.2	100.1	307.5
57585	119.7	86.3	161.8	119.8	85.2	163.8	129.0	85.7	186.4	140.7	76.8	236.1
53572	123.6	82.1	178.6	131.2	87.1	189.6	152.9	95.8	231.4	181.0	93.4	316.2
57979	124.2	81.1	181.9	123.8	80.8	181.3	103.3	57.8	170.4	41.3	8.3	120.8
55582	124.9	92.7	164.6	124.6	91.9	165.2	105.7	70.2	152.7	104.2	55.4	178.1
59542	134.8	93.3	188.4	133.6	90.7	189.6	122.5	74.8	189.1	95.5	41.1	188.1
27301	141.2	100.4	193.0	145.3	103.3	198.6	146.4	96.5	213.1	195.1	113.6	312.5
53371	149.4	101.5	212.1	130.7	84.6	193.0	135.7	80.4	214.5	134.4	61.3	255.2
57558	158.4	122.0	202.2	156.9	119.4	202.4	173.4	126.5	232.0	201.4	130.3	297.3
82720	164.6	115.3	227.9	162.0	110.1	230.0	156.6	96.9	239.5	118.0	50.8	232.5
56586	168.3	117.9	233.0	172.7	119.6	241.3	169.6	107.5	254.5	119.2	51.3	234.8
59511	174.9	123.1	241.1	179.8	124.5	251.3	232.1	156.5	331.3	195.0	100.7	340.7
28710	182.8	128.7	252.0	195.8	135.5	273.6	223.1	145.7	327.0	277.3	155.1	457.3

FIGURES

Figure 1. Age distribution

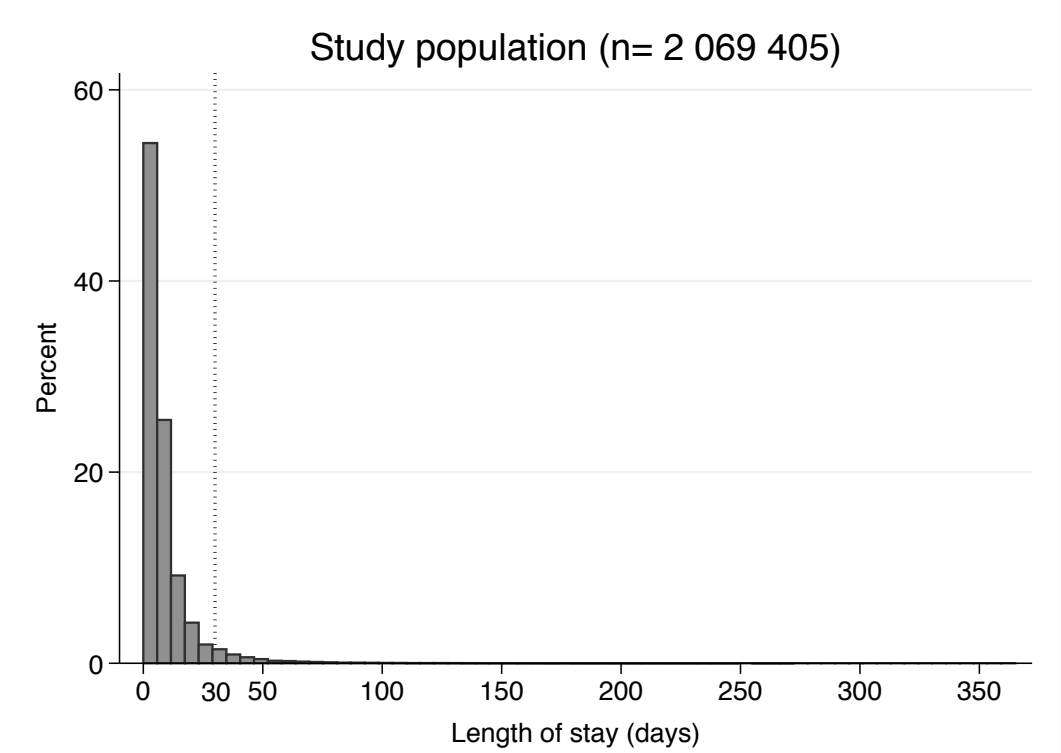
A.



B.

Figure 2. In-hospital length of stay distribution

A.



B.

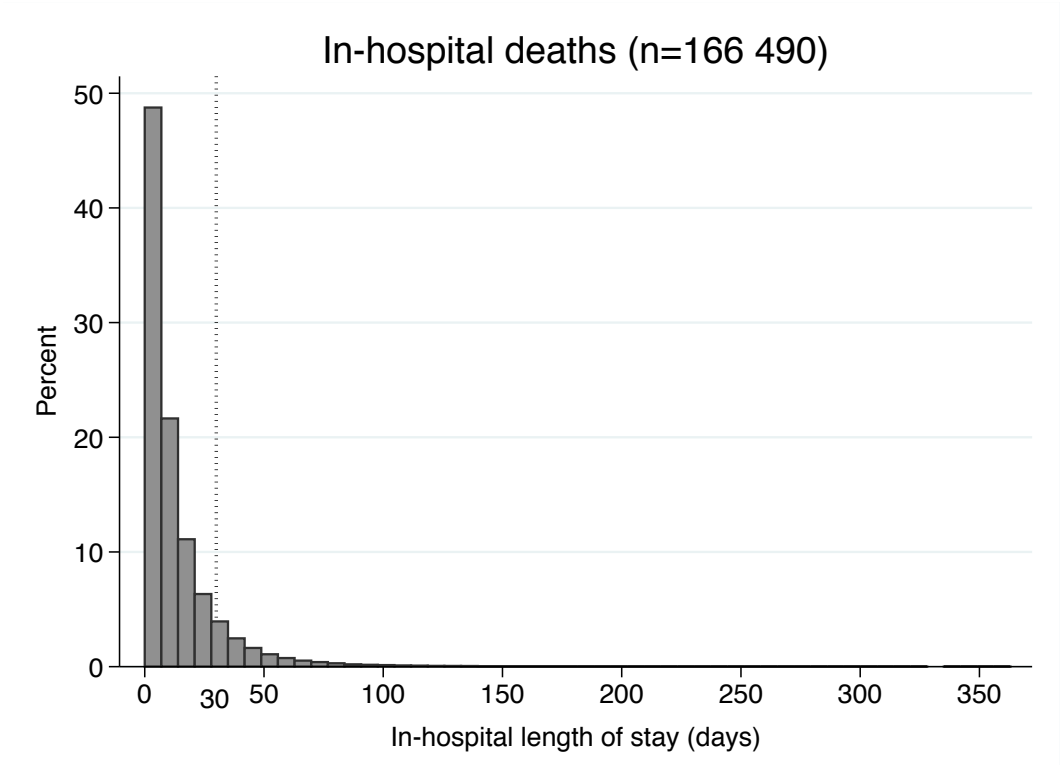
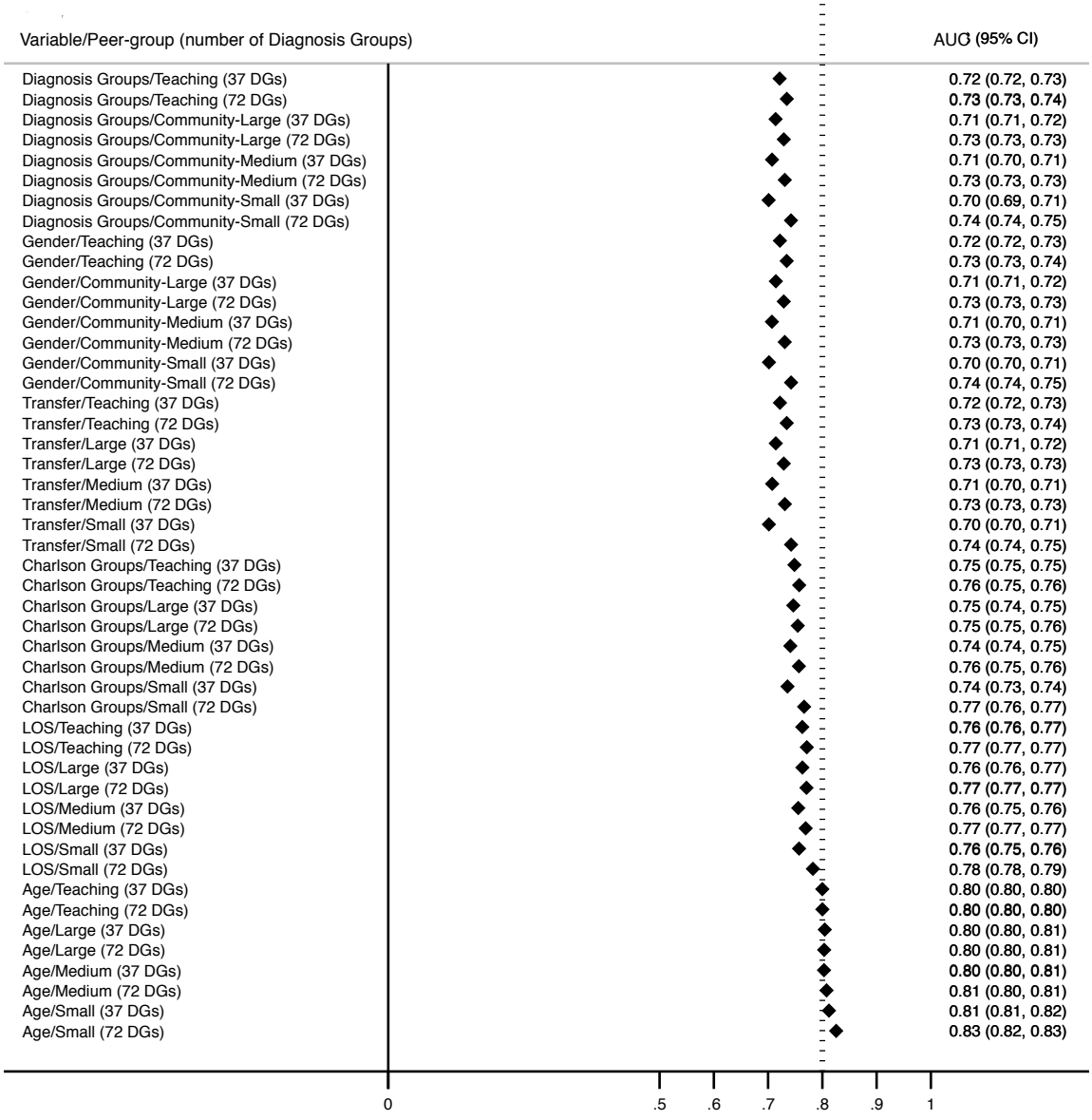


Figure 3. Performance of the predictive models* from the variable selection process

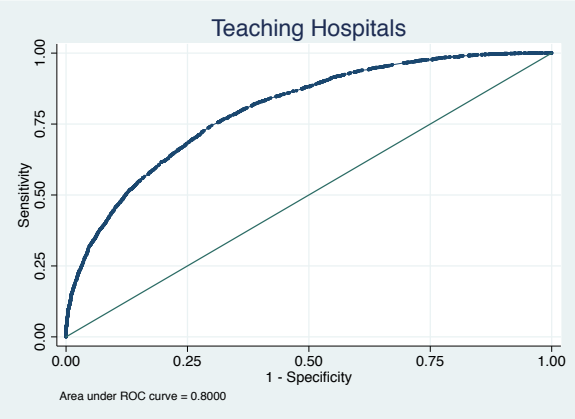
Area under the Receiver Operating Characteristic Curve (AUC)



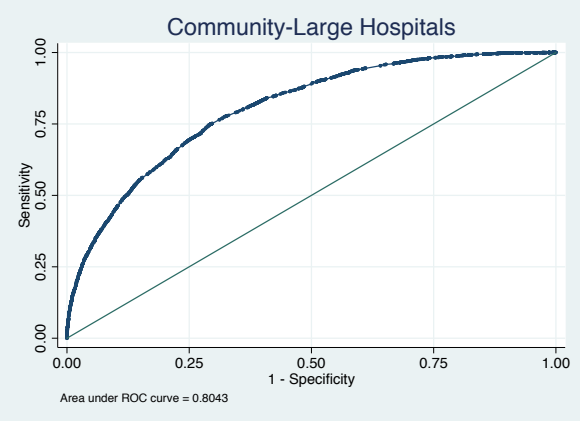
*log odds of death = $\beta_0 + (\beta_1 DG_1 + \beta_2 DG_2 + \ldots + \beta_{36} DG_{36}) + (\beta_{37} G) + (\beta_{38} T) + (\beta_{39} C_1 + \beta_{40} C_2) + (\beta_{41} LOS_1 + \ldots + \beta_{45} LOS_5) + (\beta_{46} A_1 + \ldots + \beta_{50} A_5)$

Figure 4. ROC curves and AUCs for the final predictive model with 37 diagnosis groups

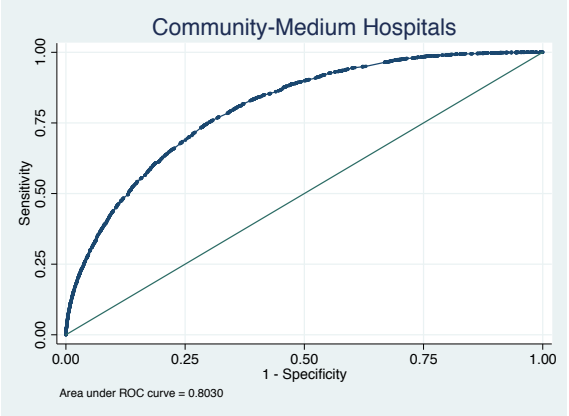
A.



B.



C.



D.

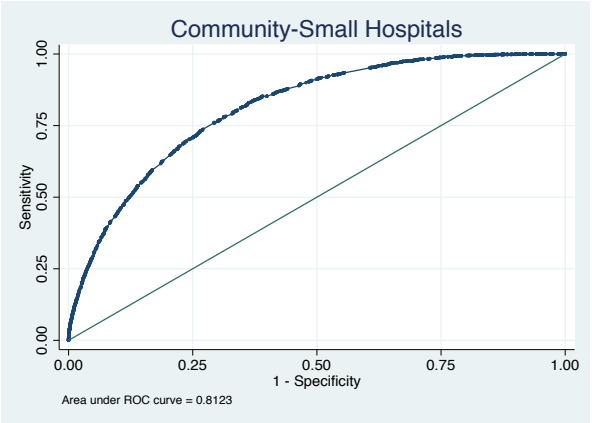
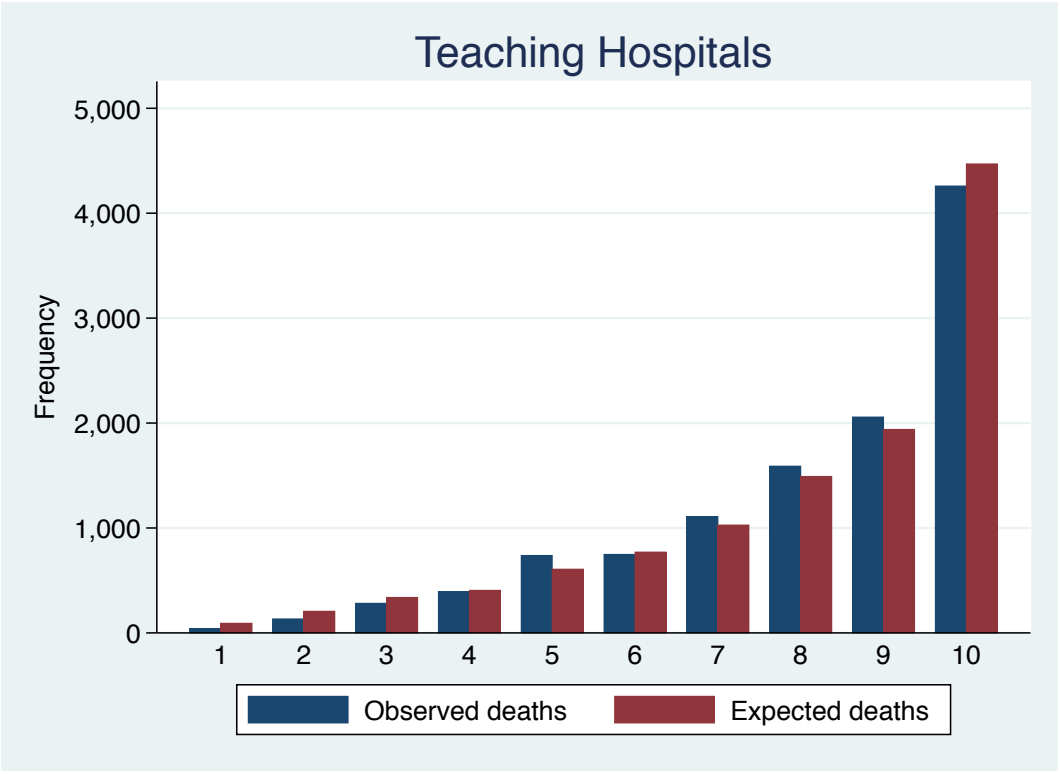
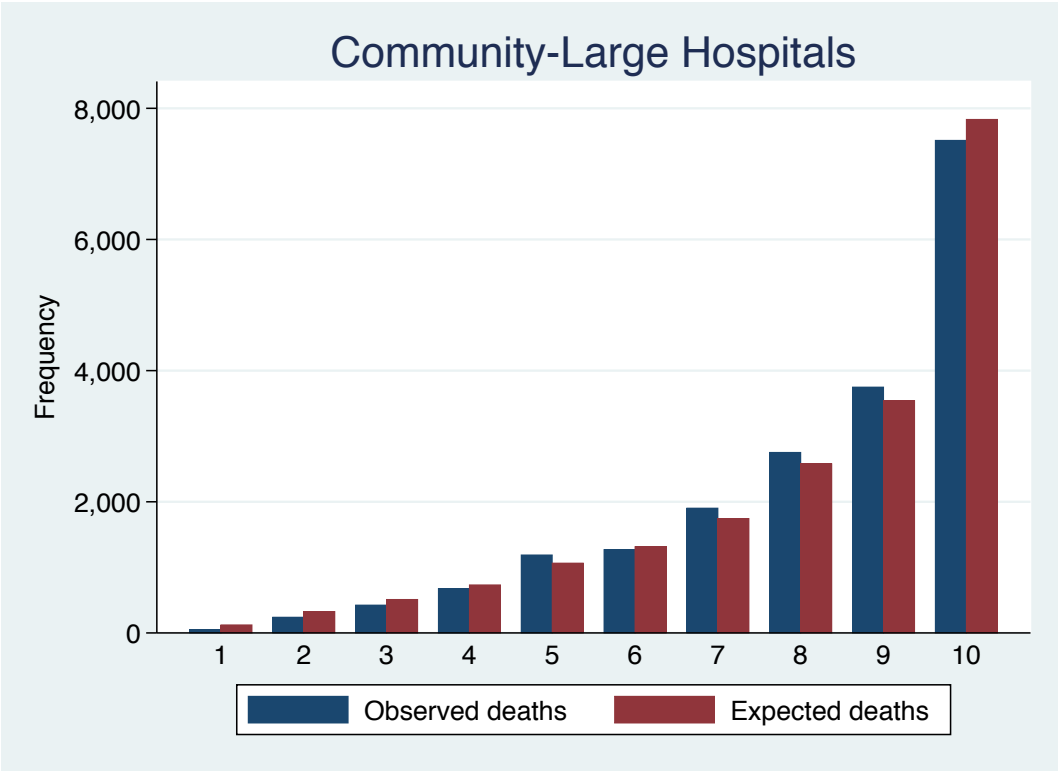


Figure 5. Calibration plots of the observed vs the expected number of deaths in 2009-10 by deciles of risk

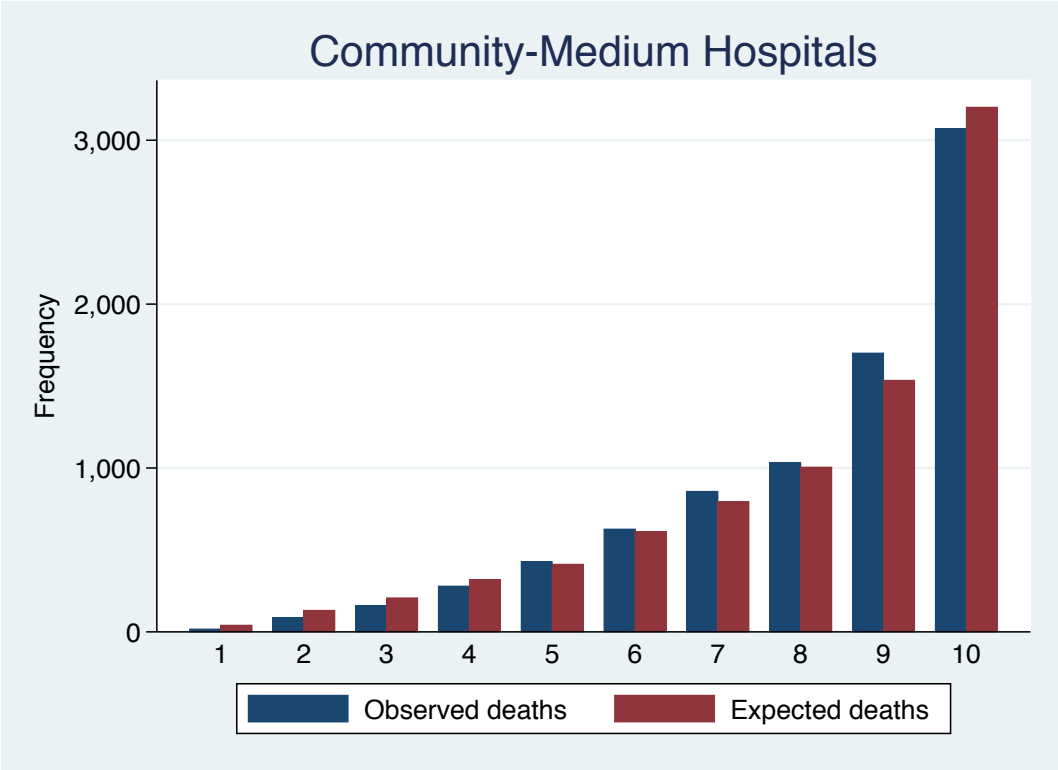
A.



B.



C.


Community-Medium Hospitals
Frequency
0
1,000
2,000
3,000
1
2
3
4
5
6
7
8
9
10
Observed deaths
Expected deaths

D.

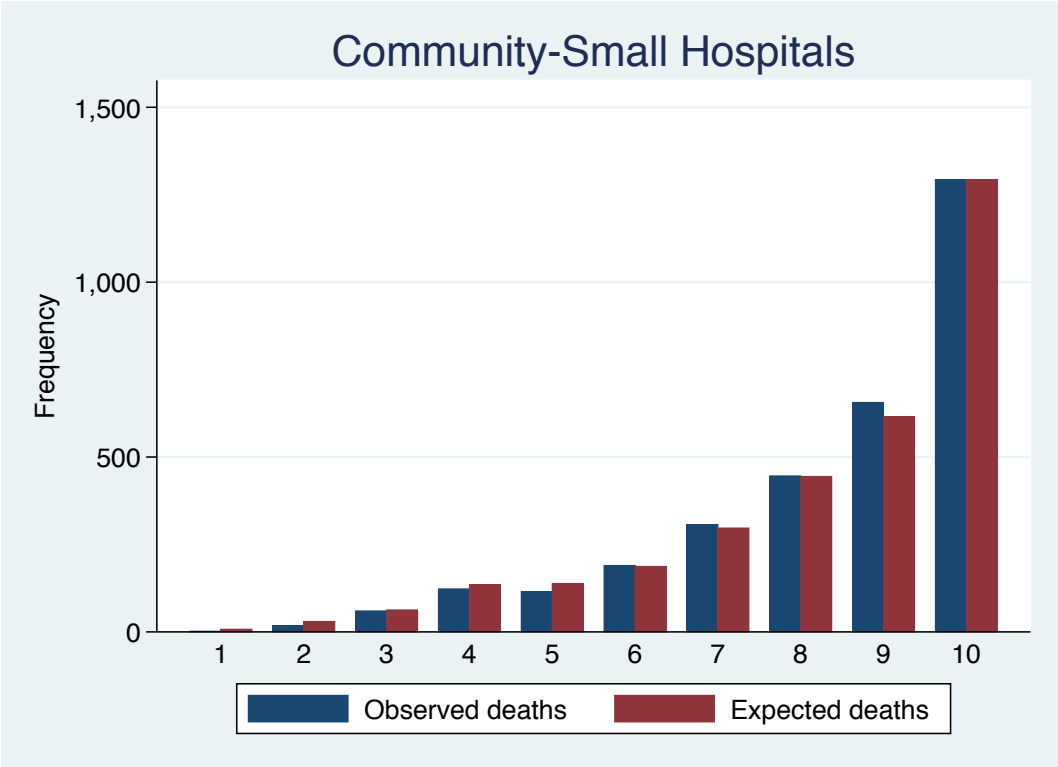
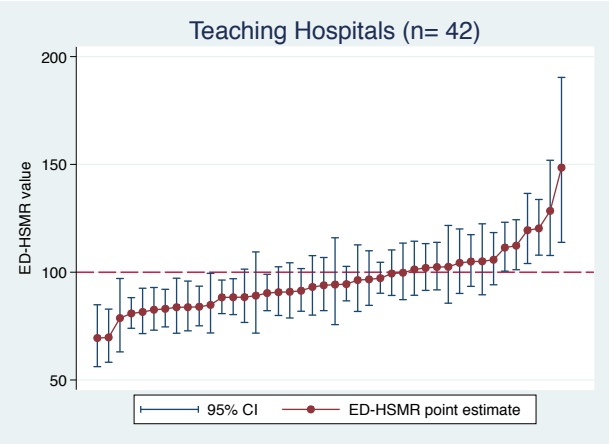
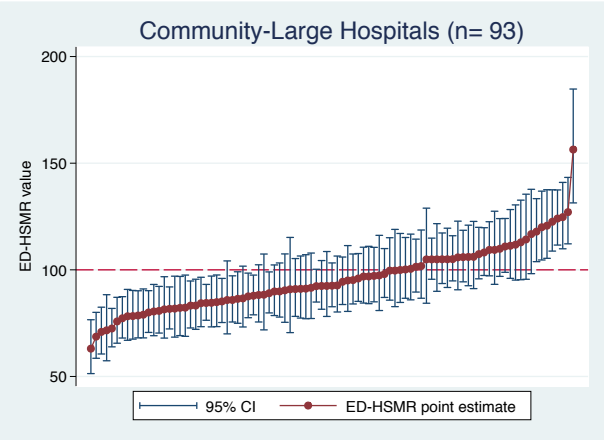

Community-Small Hospitals
Frequency
0
500
1,000
1,500
1
2
3
4
5
6
7
8
9
10
Observed deaths
Expected deaths

Figure 6. Caterpillar plots of the ED-HSMR by institution in 2010-11

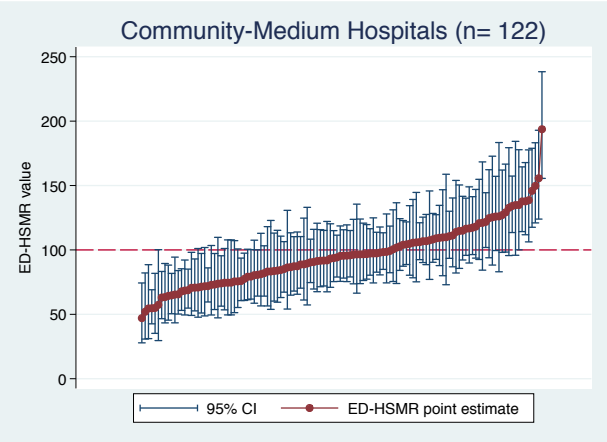
A.



B.



C.



D.

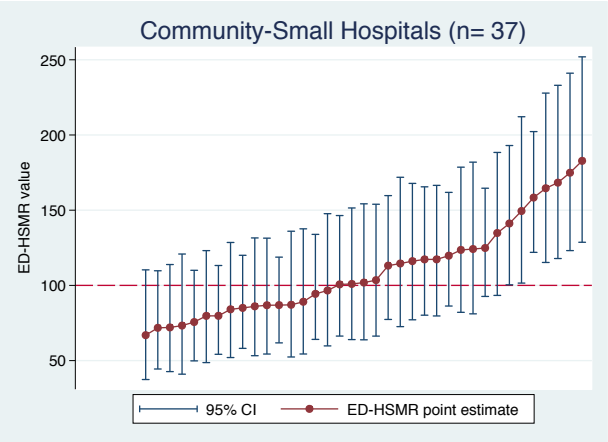
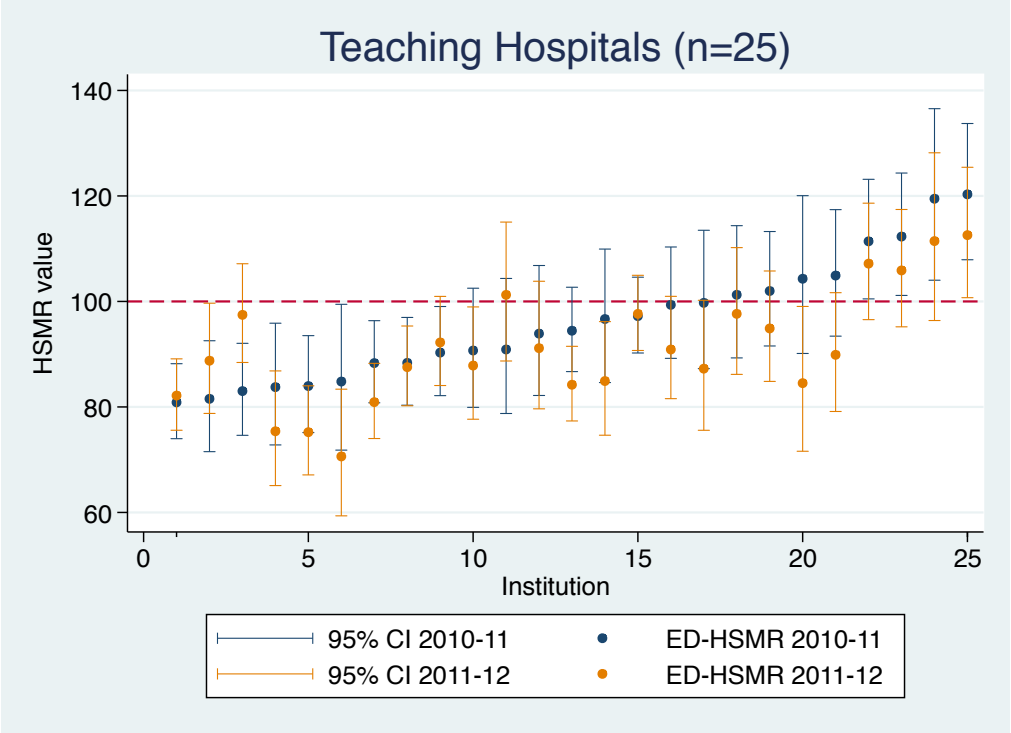
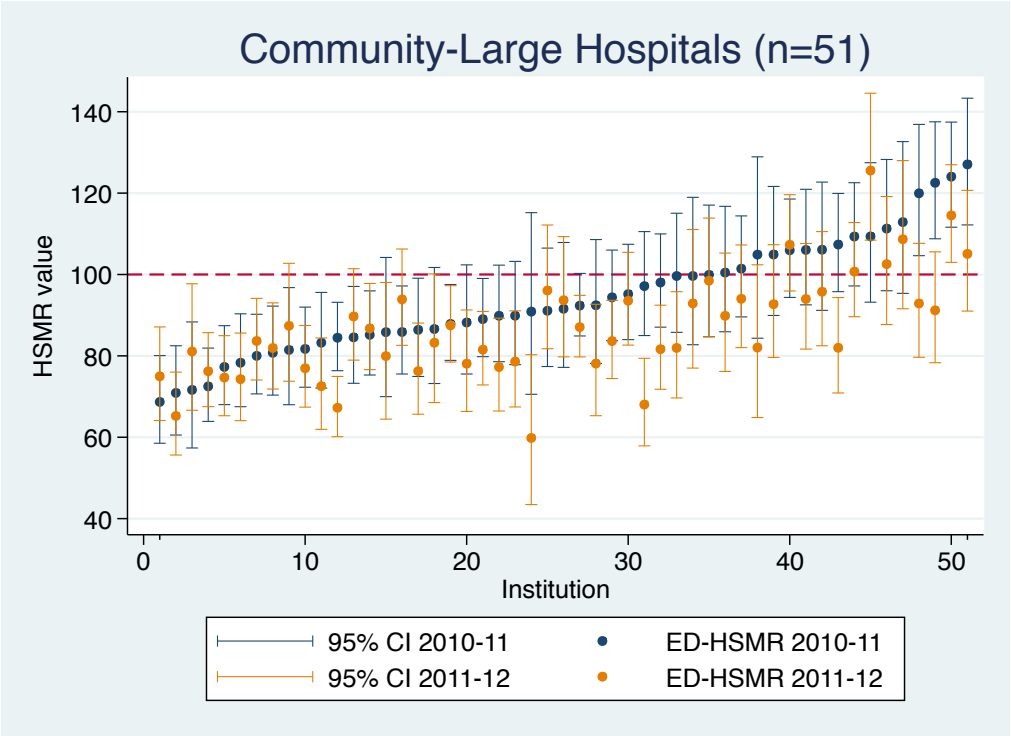


Figure 7. Caterpillar plots of the ED-HSMR by institution in 2010-11 and 2011-12

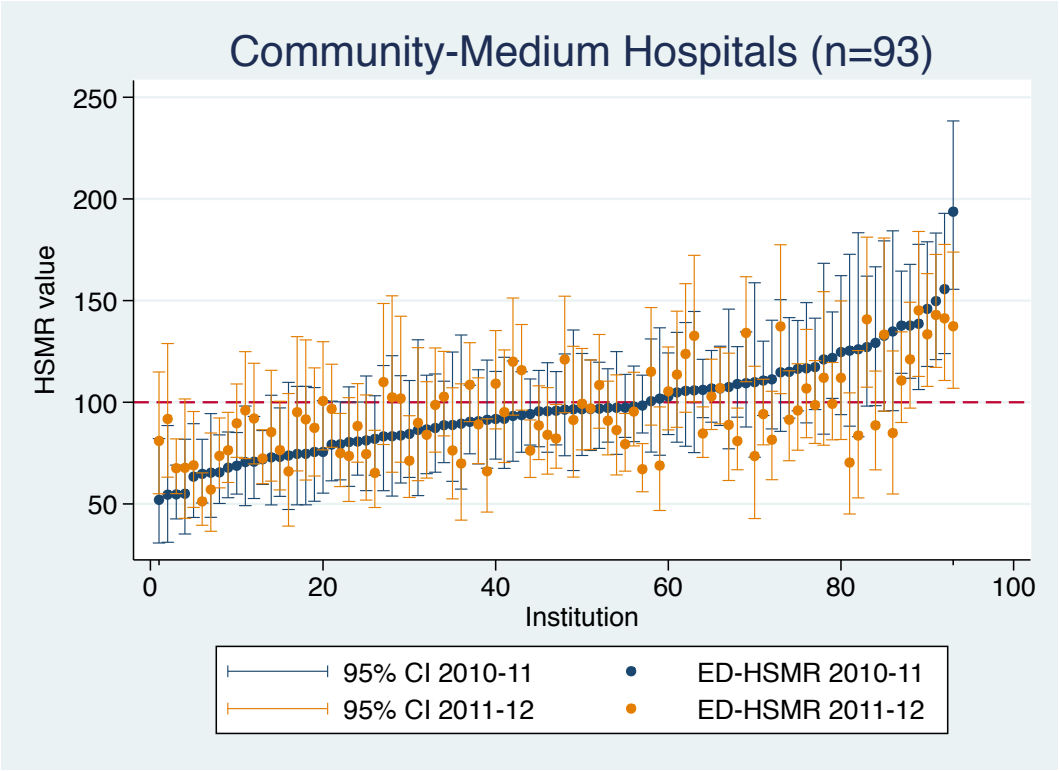
A.



B.



C.


Community-Medium Hospitals (n=93)
HSMR value
250
200
150
100
50
0
20
40
60
80
100
Institution
95% CI 2010-11
95% CI 2011-12
ED-HSMR 2010-11
ED-HSMR 2011-12

D.

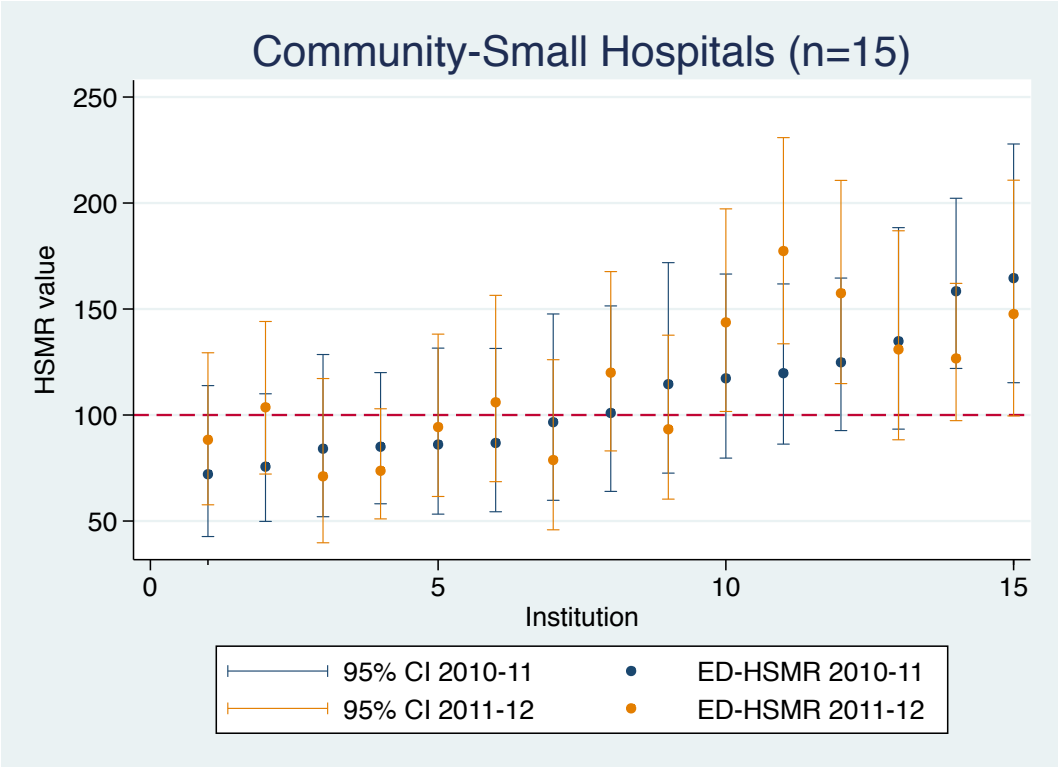
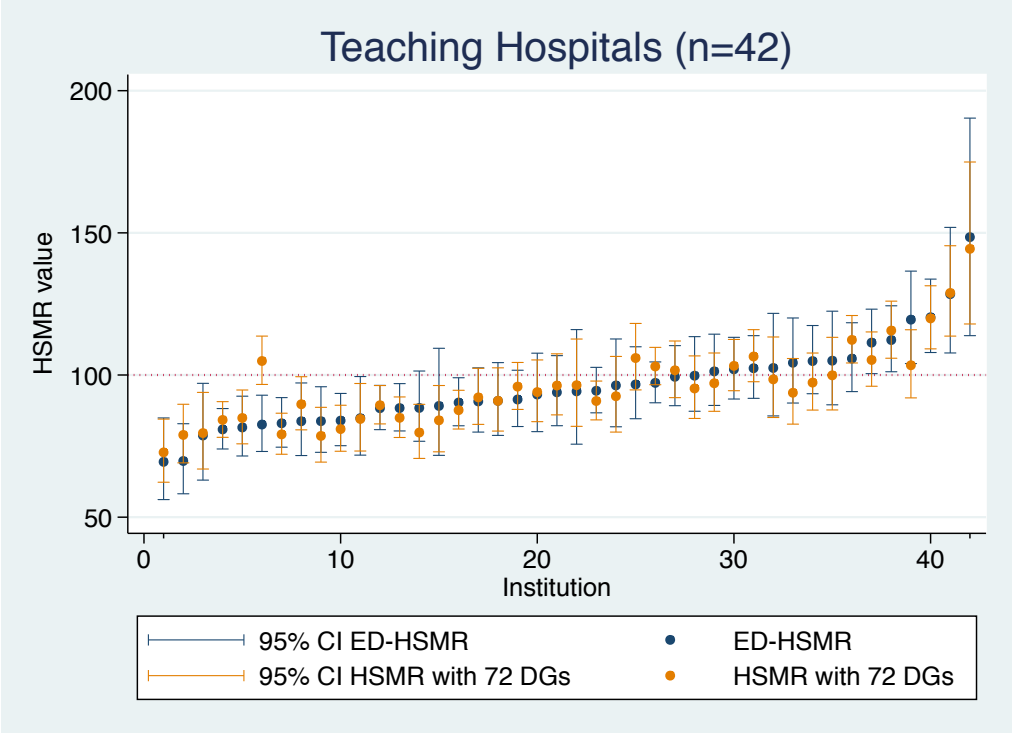
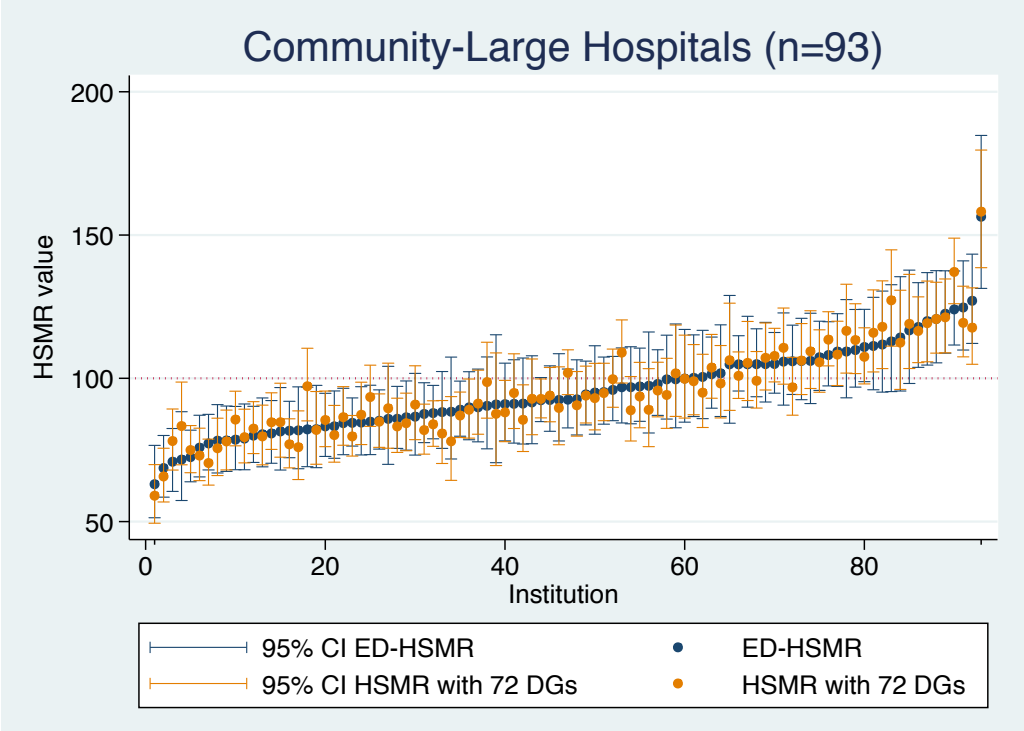

Community-Small Hospitals (n=15)
HSMR value
250
200
150
100
50
0
5
10
15
Institution
95% CI 2010-11
95% CI 2011-12
ED-HSMR 2010-11
ED-HSMR 2011-12

Figure 8. Comparisons between the ED-HSMR with 37 diagnosis groups and the HSMR with 72 diagnosis groups by institution in 2010-11

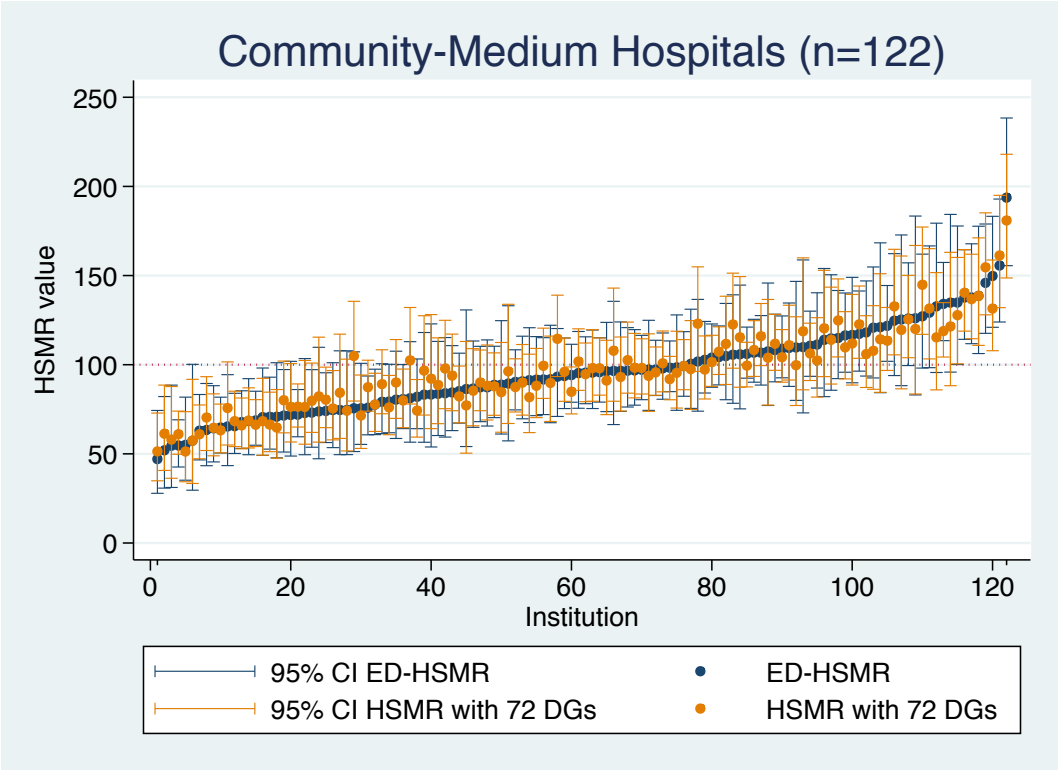
A.



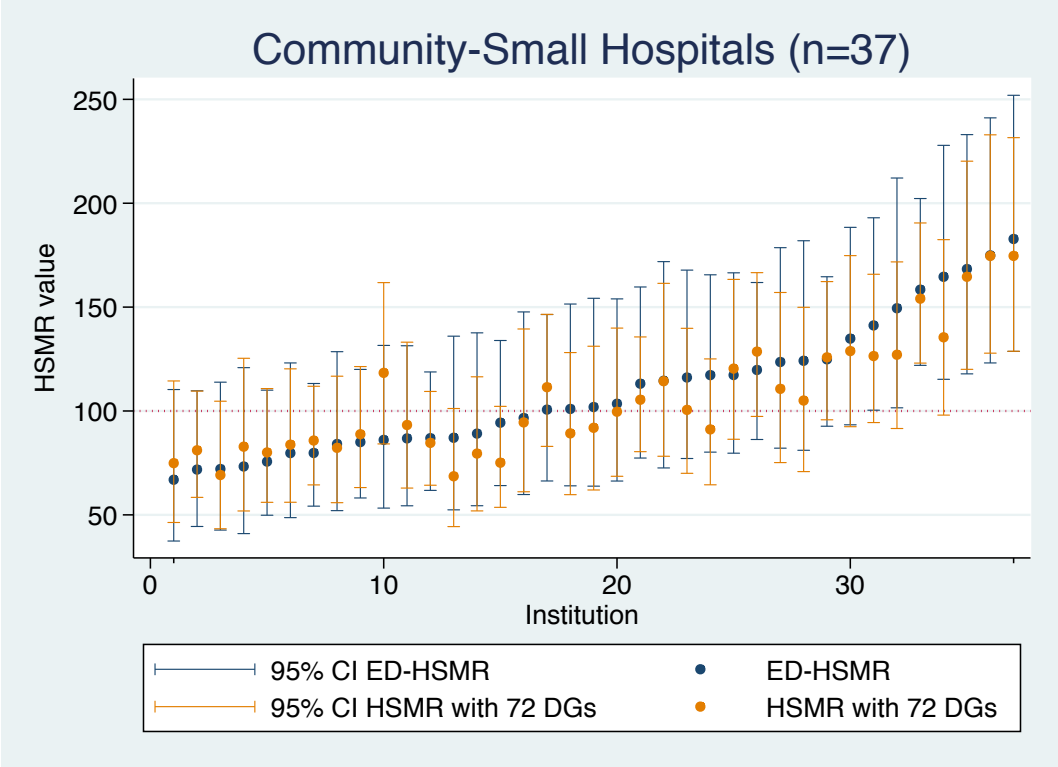
B.



C.


Community-Medium Hospitals (n=122)
HSMR value
250
200
150
100
50
0
0
20
40
60
80
100
120
Institution
95% CI ED-HSMR
95% CI HSMR with 72 DGs
ED-HSMR
HSMR with 72 DGs

D.


Community-Small Hospitals (n=37)
HSMR value
250
200
150
100
50
0
10
20
30
Institution
95% CI ED-HSMR
95% CI HSMR with 72 DGs
ED-HSMR
HSMR with 72 DGs

Chapter 5: Conclusion

5.1 Original contribution and research directions

This thesis had two overarching goals:

1) To identify emergency-sensitive conditions;
2) To develop a risk-adjustment model for the calculation of a HSMR adapted to the ED setting.

Although linked in this project, these two goals constitute by themselves two unique contributions to the field of emergency medicine.

5.1.1 Emergency-sensitive conditions

Optimizing performance in emergency medicine is elusive. The range of conditions an ED care provider may encounter during a shift is vast and almost unlimited. The concept of emergency-sensitive conditions proposes a new paradigm by sampling a few conditions as proxies for all others to assess ED performance. To my knowledge, the manuscript reproduced in chapter 2 of this thesis was the first to propose different lists of emergency-sensitive conditions. I used them to develop the ED-HSMR, but their potential utility exceeds the scope of this thesis project. Among other possibilities, emergency-sensitive conditions could be used to:

1) Identify research gaps and define a research agenda in ED performance assessment;
2) Structure a performance assessment framework;
3) Guide the development of care protocols;

4) Set quality improvements priorities.

In all cases, evaluation of emergency-sensitive conditions may ultimately contribute to improve patient care.

My work offers opportunities for further development of the emergency-sensitive condition concept. The lists of conditions identified by this thesis were first meant to be used for inpatient mortality assessment. They represent one performance improvement approach and could also inform new research initiatives with the goal of expanding their content and generalizability. To cover the full spectrum of patients encountered in the ED, other emergency-sensitive conditions should be identified to target minor treatment area, ambulatory or discharged patients. Other relevant outcomes (e.g., ED readmission) should also be assessed, used and validated as quality indicators for these conditions. Once a reliable, valid and available set of conditions and indicators is defined, the full deployment of the concept of emergency-sensitive conditions will enable the implementation of a comprehensive ED performance assessment framework.

5.1.2 The ED-HSMR

Similarly, the ED-HSMR is, to my knowledge, the first risk-adjustment model developed to monitor mortality of patients with conditions where ED care may influence outcomes. This hospital-wide metric may serve as a tool to improve integration of care and collaboration between hospital care providers.

The results of the third manuscript show that the ED-HSMR may be a promising and useful indicator to track in-hospital mortality of patients with emergency-sensitive conditions. However, further research is needed to ascertain its validity, reliability and responsiveness. Consequently, the next steps pertaining to a more complete validation of the ED-HSMR should include:

1) To test its robustness with case-mix bootstrapping. Since the predictive models adjust for the most responsible diagnosis and comorbidities (Charlson score), the ED-HSMR of a hospital in a specific year should not vary significantly with different case-mix, assuming the ratio value depends on the quality of the delivered care.
2) To test its face validity with ED care providers or decision-makers.
3) To validate its construct validity by correlation studies with other process-of-care and outcomes-of-care indicators. A good performance on the ED-HSMR should correspond with a good performance on other metrics.
4) To compare it with other measures of in-hospital mortality not specifically developed for the ED setting, such as the cumulative sum statistic (CUSUM) or the Regression-Adjusted Mortality (RAM). These comparisons will evaluate the added value of the ED-HSMR.

Measuring performance using mortality is challenging, as it needs appropriate risk-adjustment. The ED-HSMR is one tool that can be used to measure the quality of care provided to patients admitted to hospital from the ED and to help target quality improvement efforts to ensure that patients receive the best care possible.

Bibliography

1. Pines JM, Schneider SM, Bernstein SL. Emergency care and the affordable care act: how can we learn from the past to predict the future? *Acad Emerg Med.* Nov 2011;18(11):1189-1190.
2. Ovens H. ED overcrowding: the Ontario approach. *Acad Emerg Med.* Dec 2011;18(12):1242-1245.
3. Mason S. Keynote address: United Kingdom experiences of evaluating performance and quality in emergency medicine. *Acad Emerg Med.* Dec 2011;18(12):1234-1238.
4. Cameron PA, Schull MJ, Cooke MW. A framework for measuring quality in the emergency department. *Emerg Med J.* Sep 2011;28(9):735-740.
5. Mant J. Process versus outcome indicators in the assessment of quality of health care. *International journal for quality in health care : journal of the International Society for Quality in Health Care / ISQua.* Dec 2001;13(6):475-480.
6. Schull MJ, Hatcher CM, Guttmann A, et al. Development of a Consensus on Evidence-Based Quality of Care Indicators for Canadian Emergency Departments: ICES Investigative Report. *Institute for Clinical Evaluative Sciences.* March 2010.
7. Burstin H. "Crossing the Quality Chasm" in emergency medicine. *Acad Emerg Med.* Nov 2002;9(11):1074-1077.
8. Sanders AB. Quality in emergency medicine: an introduction. *Acad Emerg Med.* Nov 2002;9(11):1064-1066.
9. Thomas EJ, Studdert DM, Burstin HR, et al. Incidence and types of adverse events and negligent care in Utah and Colorado. *Med Care.* Mar 2000;38(3):261-271.

10. Calder LA, Forster A, Nelson M, et al. Adverse events among patients registered in high-acuity areas of the emergency department: a prospective cohort study. *CJEM.* Sep 2010;12(3):421-430.

11. Adams JG, Biros MH. The elusive nature of quality. *Acad Emerg Med.* Nov 2002;9(11):1067-1070.

12. Schull MJ, Guttmann A, Leaver CA, et al. Prioritizing performance measurement for emergency department care: consensus on evidence-based quality of care indicators. *CJEM.* Sep 2011;13(5):300-309, E328-343.

13. McClelland MS, Jones K, Siegel B, Pines JM. A field test of time-based emergency department quality measures. *Ann Emerg Med.* Jan 2012;59(1):1-10 e12.

14. Bernstein SL, Aronsky D, Duseja R, et al. The effect of emergency department crowding on clinically oriented outcomes. *Acad Emerg Med.* Jan 2009;16(1):1-10.

15. Kennebeck SS, Timm NL, Kurowski EM, Byczkowski TL, Reeves SD. The association of emergency department crowding and time to antibiotics in febrile neonates. *Acad Emerg Med.* Dec 2011;18(12):1380-1385.

16. Pines JM, Localio AR, Hollander JE, et al. The impact of emergency department crowding measures on time to antibiotics for patients with community-acquired pneumonia. *Ann Emerg Med.* Nov 2007;50(5):510-516.

17. Barrett TW, Schriger DL. Annals of Emergency Medicine Journal Club. Emergency department crowding is associated with poor care for patients with severe pain. *Ann Emerg Med.* Jan 2008;51(1):6-7.

18. Sills MR, Fairclough DL, Ranade D, Mitchell MS, Kahn MG. Emergency department crowding is associated with decreased quality of analgesia delivery for children with

pain related to acute, isolated, long-bone fractures. *Acad Emerg Med.* Dec 2011;18(12):1330-1338.

19. Singer AJ, Thode HC, Jr., Viccellio P, Pines JM. The association between length of emergency department boarding and mortality. *Acad Emerg Med.* Dec 2011;18(12):1324-1329.

20. Weissman JS, Bailit M, D'Andrea G, Rosenthal MB. The design and application of shared savings programs: lessons from early adopters. *Health affairs.* Sep 2012;31(9):1959-1968.

21. Heyworth J. Emergency medicine-quality indicators: the United Kingdom perspective. *Acad Emerg Med.* Dec 2011;18(12):1239-1241.

22. Hughes G. Australian emergency targets: an update. *Emerg Med J.* Nov 2011;28(11):914.

23. Baker M, Clancy M. Can mortality rates for patients who die within the emergency department, within 30 days of discharge from the emergency department, or within 30 days of admission from the emergency department be easily measured? *Emerg Med J.* Aug 2006;23(8):601-603.

24. Ben-Tovim DI. Hospital mortality ratios. Death is final: getting the balance right. *BMJ.* 2010;340:c2741.

25. Nafsi T, Russell R, Reid CM, Rizvi SM. Audit of deaths less than a week after admission through an emergency department: how accurate was the ED diagnosis and were any deaths preventable? *Emerg Med J.* Oct 2007;24(10):691-695.

26. Jones P, Harper A, Wells S, et al. Selection and validation of quality indicators for the Shorter Stays in Emergency Departments National Research Project. *Emergency medicine Australasia : EMA.* Jun 2012;24(3):303-312.

27. Pitts SR, Pines JM, Handrigan MT, Kellermann AL. National trends in emergency department occupancy, 2001 to 2008: effect of inpatient admissions versus emergency department practice intensity. *Ann Emerg Med.* Dec 2012;60(6):679-686 e673.

28. Sklar DP, Crandall CS, Loeliger E, Edmunds K, Paul I, Helitzer DL. Unanticipated death after discharge home from the emergency department. *Ann Emerg Med.* Jun 2007;49(6):735-745.

29. Champagne F, Contrandriopoulos A-P, Picot-Touché J, Béland F, Nguyen H. Un cadre d'évaluation de la performance des systèmes de services de santé: Le modèle EGIPSS. Montréal: Université de Montréal; 2005.

30. Canadian Institute for Health Information. Report from the Third Health Indicators Consensus Conference 2009. Ottawa2009.

31. Althaus F, Paroz S, Hugli O, et al. Effectiveness of interventions targeting frequent users of emergency departments: a systematic review. *Ann Emerg Med.* Jul 2011;58(1):41-52 e42.

32. Institute of Medicine, Committee on the Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century.* Washington DC: National Academy Press; 2001.

33. Pines JM, McCarthy ML. Executive summary: interventions to improve quality in the crowded emergency department. *Acad Emerg Med.* Dec 2011;18(12):1229-1233.

34. Assuring Quality in Emergency Care. Proceedings of the AEM 2002 Consensus Conference. *Acad Emerg Med.* Nov 2002;9(11):1063-1212.

35. Beattie E, Mackway-Jones K. A Delphi study to identify performance indicators for emergency medicine. *Emerg Med J.* Jan 2004;21(1):47-50.

36. Lindsay P, Schull M, Bronskill S, Anderson G. The development of indicators to measure the quality of clinical care in emergency departments following a modified-delphi approach. *Acad Emerg Med.* Nov 2002;9(11):1131-1139.

37. Guttmann A, Razzaq A, Lindsay P, Zagorski B, Anderson GM. Development of measures of the quality of emergency department care for children using a structured panel process. *Pediatrics.* Jul 2006;118(1):114-123.

38. Glickman SW, Schulman KA, Peterson ED, Hocker MB, Cairns CB. Evidence-based perspectives on pay for performance and quality of patient care and outcomes in emergency medicine. *Ann Emerg Med.* May 2008;51(5):622-631.

39. Sibbritt D, Isbister GK, Walker R. Emergency department performance indicators that encompass the patient journey. *Qual Manag Health Care.* Jan-Mar 2006;15(1):27-38.

40. Canadian Institute for Health Information. RNMH: Une nouvelle méthode de mesure des tendances relatives à la mortalité hospitalière au Canada. Ottawa2007.

41. Trypuc J, Hudson A, MacLeod H. The pivotal role of critical care and surgical efficiencies in supporting Ontario's Wait Time Strategy: Part 3. *Healthcare quarterly.* 2006;9(4):37-45, 32.

42. Carr BG, Conway PH, Meisel ZF, Steiner CA, Clancy C. Defining the emergency care sensitive condition: a health policy research agenda in emergency medicine. *Ann Emerg Med.* Jul 2010;56(1):49-51.

Appendix A. Diagnosis Groups from the 10th version of the International Classification of Diseases included in the Canadian Hospital Standardized Mortality Ratio

Diagnosis Groups	
A04	Other bacterial intestinal infection
A41	Sepsis
C15	Malignant neoplasm of oesophagus
C16	Malignant neoplasm of stomach
C18	Malignant neoplasm of colon
C22	Malignant neoplasm of liver and intrahepatic bile ducts
C25	Malignant neoplasm of pancreas
C34	Malignant neoplasm of bronchus and lung
C50	Malignant neoplasm of breast
C61	Malignant neoplasm of prostate
C67	Malignant neoplasm of bladder
C71	Malignant neoplasm of the brain
C78	Secondary malignant neoplasm of respiratory and digestive organs
C79	Secondary malignant neoplasm of other sites
C80	Malignant neoplasm without specification of site
C83	Diffuse non-Hodgkin's lymphoma
C85	Other and unspecified types of non-Hodgkin's lymphoma
C90	Multiple myeloma and malignant plasma cell neoplasms
C92	Myeloid leukemia
E11	Diabetes Mellitus type 2
E86	Volume depletion
E87	Other disorders of fluid, electrolyte and acid-base balance
F03	Unspecified dementia
F05	Delirium, not induced by alcohol and other psychoactive substances
G30	Alzheimer's disease
G93	Other disorders of brain
I21	Acute Myocardial Infarction (AMI)
I24	Other acute ischemic heart disease
I25	Chronic ischemic heart disease
I26	Pulmonary embolism
I35	Nonrheumatic aortic valve disorders
I46	Cardiac arrest
I48	Atrial fibrillation and flutter
I50	Heart failure
I60	Subarachnoid haemorrhage
I61	Intracerebral haemorrhage
I62	Other non traumatic intracranial haemorrhage
I63	Cerebral infarction
I64	Stroke, not specified as haemorrhage or infarction
I70	Atherosclerosis
I71	Aortic aneurism and dissection

Appendix A. Continued
Diagnosis Groups

J18	Pneumonia
J44	Other chronic obstructive pulmonary disease
J69	Pneumonitis due to solids and liquids
J80	Adult respiratory distress syndrome
J84	Other interstitial pulmonary diseases
J90	Pleural effusion, not elsewhere classified
J96	Respiratory failure, not elsewhere classified
K26	Duodenal ulcer
K55	Vascular disorders of intestine
K56	Paralytic ileus and intestinal obstruction without hernia
K57	Diverticular disease of intestine
K63	Other diseases of intestine
K65	Peritonitis
K70	Alcoholic liver disease
K72	Hepatic failure
K74	Fibrosis and cirrhosis of liver
K85	Acute pancreatitis
K92	Other diseases of digestive system
L03	Cellulitis
N17	Acute renal failure
N18	Chronic renal failure
N39	Other disorders of urinary system
R53	Malaise and fatigue
R57	Shock, not elsewhere classified
R64	Cachexia
S06	Intracranial injury
S32	Fracture of lumbar spine and pelvis
S72	Fracture of femur
T81	Complications of procedures, not elsewhere classified
T82	Complications of cardiac and vascular prosthetic devices, implants and grafts
Z54	Convalescence

Reproduced from : CIHI. Hospital Standardized Mortality Ratio (HSMR): Technical Notes. Public Release. Ottawa, February 2012.

Appendix B. Panel web-rating instrument[2]

Panel on Emergency-Sensitive Conditions (PESC)

Introduction

Dear panelists,

We first want to thank you for your participation in this study. Our project is to develop the first *in-hospital standardized mortality ratio* for emergency-sensitive conditions. We believe the development of this new indicator is necessary for Emergency Physicians and Healthcare Managers to monitor changes in patients' outcomes and to identify opportunities for improvement. With your expertise, you will contribute significantly to this process.

This survey is the first round of a consensus process that ultimately aims to define a list of emergency-sensitive conditions. This list will be built from the 72 Diagnosis Groups (DG) used by the Canadian Institute for Health Information (CIHI) to estimate the *Hospital Standardized Mortality Ratio* (HSMR) for each individual Canadian Hospital. We believe this list will be an important step for improving Quality Assessment in the ED. It will provide guidance in prioritizing conditions that are most relevant and worth monitoring in the ED setting. No studies have previously addressed this matter.

Implicit consent

By completing this questionnaire, you are providing **implicit consent** to participate in this consensus process which is comprised of two (2) rounds of ratings and one (1) teleconference.

Computer used for this task

It will be possible for you to leave and return to this questionnaire as many times as you like in order to complete your task over a period of few days if you prefer. However, **you will have to use the SAME computer throughout the process** (unique survey identifier). If for any reason, it is no longer possible to complete the survey work with the same computer, please email (email Simon Berthelot) or call (403 464-6515) Simon Berthelot. He will let you know which section of the survey you should direct yourself to in order to resume your ratings.

General Information

All personal information will be managed anonymously. They will be used only for the purpose of this study and will never be sold or given to another researcher or organization.

*1. Demographic Information

Name (Last, First):	
Organization:	
Position:	
City/Town:	
Province:	
Email Address:	
Phone Number:	

[2] Since the panel web-rating instrument has 149 pages and that an identical approach is used for all diagnosis groups presented, pages 8 to 146 are not reproduced in this appendix for conciseness purposes.

Panel on Emergency-Sensitive Conditions (PESC)

2. Gender

- F
- M

3. When did you graduate from your last training program?

	Year
Answer	

4. How many years of experience do you hold in your current position?

	Years of experience
Answer	

Rating Instructions

For the proper completion of this survey, you are asked to identify emergency-sensitive and time-sensitive conditions by rating each of the 72 Diagnosis Groups (DG) used by CIHI for the Canadian HSMR.

We will ask you to answer 3 questions for each DG.

1. Most of the time, to what extent does ED management impact on mortality related to this Diagnosis Group (DG)?
2. Most of the time, to what extent does ED management impact on morbidity related to this Diagnosis Group (DG)?
3. Most of the time, to what extent does this Diagnosis Group (DG) require an ED time-sensitive intervention?

You will need to score each question on a 9-point rating scale, where:

- One (1) means that the ED management has no impact on this DG's outcome;
- Five (5) means that ED impact is uncertain and
- Nine (9) means that the ED management has definitely an impact on this DG's outcome.

Medical definitions for each code

For each of the 72 DGs, you will be provided with some relevant medical definitions. The definitions provided for each code are not exhaustive. They are meant to propose a common basic understanding of the main listed diagnoses. Should you need us to provide more definitions on specific terms or diagnoses, please do not hesitate to submit your request to Simon Berthelot (email Simon Berthelot).

Example:

E86 VOLUME DEPLETION

DEFINITIONS:

True volume depletion occurs when fluid is lost from the extracellular fluid at a rate exceeding net intake. These losses may occur from the gastrointestinal tract, skin, or lungs; in the urine; or by acute sequestration in the body in a "third

space" that is not in equilibrium with the extracellular fluid.

Source: Up to Date

ICD-10 Description

Similarly, you will be provided with a description of the specific diagnoses included or excluded in each DG code, according to the International Classification of Diseases version 10 (ICD-10). The ICD-10 description is **ESSENTIAL** to the rating process and should be **CAREFULLY REVIEWED**. Some code descriptions have been truncated for more brevity. You can refer to the original description if you consult the ICD-10 volume we sent you along with the link to this Survey Monkey.

Example:

E86 VOLUME DEPLETION

DEFINITIONS:

True volume depletion occurs when fluid is lost from the extracellular fluid at a rate exceeding net intake. These losses may occur from the gastrointestinal tract, skin, or lungs; in the urine; or by acute sequestration in the body in a "third space" that is not in equilibrium with the extracellular fluid.

Source: Up to Date

ICD-10 DESCRIPTION:

General inclusions:

N/A

General exclusions:

-dehydration of newborn (P74.1);
-hypovolaemic shock NOS (R57.1)
-hypovolaemic shock postoperative (T81.1)
-hypovolaemic shock traumatic (T79.4)

Sub-codes:

E86.0 Dehydration

E86.8 Other volume depletion
Includes:
-Depletion of volume of plasma or extracellular fluid
-Hypovolaemia

The general inclusions and exclusions apply to all sub-codes, while the inclusions under E86.8 apply only to the sub-code E86.8 "Other volume depletion". **The DG you are asked to rate is the general E86 code, considering all sub-codes described under it.**

Finally, you will be able to add any comments you would like to make on any specific DG rating.

Panel on Emergency-Sensitive Conditions (PESC)

If you have any questions or concerns, please feel free to contact Simon Berthelot by email at siberth@me.com (email Simon Berthelot) or by phone at 403 464-6515.

Again, we thank you for your participation.

General Definitions

Emergency-sensitive conditions:
Conditions for which high-quality emergency care makes a unique contribution to patient outcomes (Carr BG et al. Ann Emerg Med 2010;56(1):49-51).

Time-sensitive conditions:
Conditions for which timely care in the ED improves patients' outcomes (Carr BG et al. Ann Emerg Med 2010;56(1):49-51).

Mortality:
Fatal outcome (Stedman Medical Dictionary). For the purpose of this panel, mortality means any death occuring after an ED care episode either in or out of the hospital, whatever the time delay.

Morbidity:
Any departure from physiological or psychological well-being, whether objective or subjective. It is commonly used to describe diseases, injuries, and other nonfatal conditions (Oleckno WA (2008), Epidemiology: Concepts and Methods. Long Grove, Illinois: Waveland Press inc.)

Diagnosis Groups (DG):
Codes of diagnoses used to classify diseases and other health problems according to the International Classification of Diseases version 10 (ICD-10). Those codes enable the storage and retrieval of standardized diagnostic information for clinical, epidemiological and quality purposes (source: http://www.who.int/classifications/icd/en/).

Canadian Institute of Health Information (CIHI):
Independent, not-for-profit Canadian corporation established in 1994 to collect, analyze and publish data and information on health care in a standardized way. Its mandate is to lead the development and maintenance of comprehensive and integrated health information that enables sound policy and effective health system management that improve health and health care in Canada (source: www.cihi.ca).

Hospital Standardized Mortality Ratio (HSMR):
The ratio of the actual number of acute in-hospital deaths to the expected number of in-hospital deaths. The Canadian HSMR calculated by CIHI includes the diagnosis groups accounting for 80% of inpatient mortality. The ultimate objective of this study is to calculate an ED variant capturing only the emergency-sensitive diagnosis groups (CIHI. Hospital Standardized Mortality Ratio (HSMR): Technical Notes. Ottawa, 2012).

RAND/UCLA Appropriateness Method (RAM):
Consensus method usually comprising an expert panel and two rating rounds. In the first round, the ratings are made individually at home, with no interaction among panelists. In the second round, the panelists first meet under the leadership of an experienced moderator and discuss the ratings focusing on areas of disagreement. After the discussion, each panelist independently re-rates each controversial indication, in our study, each controversial diagnosis group (Fitch K, et al. The RAND/UCLA appropriateness method user's manual. RAND ed. Santa Monica, 2001).

NOS: Abbreviation for not otherwise specified.

Panel on Emergency-Sensitive Conditions (PESC)

NEC: Abbreviation for not elsewhere classified.

Emergency-Sensitive and Time-Sensitive Conditions: an important clarificati...

As stated in the previous pages, emergency-sensitive conditions are diagnoses on which performant ED management has an impact.

For instance, Emergency Departments can improve patients' outcomes either by:

- Providing appropriate treatments;
or
- Giving accurate diagnoses;
or
- Managing high-acuity patients in a timely manner;
or
- Appropriately stratifying the risk of patients with possible serious conditions.

This list of possible ED interventions is not necessarily exhaustive. Although the time-critical conditions are probably the most obvious emergency-sensitive conditions, **you will need to address all dimensions of ED management** to appropriately classify a condition as emergency-sensitive or not. Time-sensitivity is then only one dimension of emergency-sensitivity, which represents a broader category.

In the following questionnaire, you will have to answer three (3) questions for each Diagnosis Group (DG):

1. Most of the time, to what extent does ED management impact on mortality related to this Diagnosis Group (DG)?
2. Most of the time, to what extent does ED management impact on morbidity related to this Diagnosis Group (DG)?
3. Most of the time, to what extent does this Diagnosis Group (DG) require an ED time-sensitive intervention?

The third question is a subquestion of the two first ones.

Conceptually, an ED time-sensitive condition should presumably be an emergency-sensitive condition. **Hence if you indicate that a DG is time-sensitive, but not emergency-sensitive (i.e. provide a low score for both mortality and morbidity), please comment in the space provided.**

A04 Other bacterial intestinal infection

DEFINITIONS:

1) **Escherichia** coli are normal inhabitants of the human gastrointestinal tract and are among the bacterial species most frequently isolated from stool cultures. When E. coli strains acquire certain genetic material, they can become pathogenic. E. coli are among the most frequent bacterial causes of diarrhea and are classified by clinical syndrome they produce: Enterotoxigenic E. coli (Watery diarrhea), Enteropathogenic E. coli (Infantile diarrhea), Enterohemorrhagic E. coli (Hemorrhagic colitis and hemolytic uremic syndrome), Enteroinvasive E. coli (dysentery), and Enteroaggregative E. coli (Persistent diarrhea in children and HIV patients).

2) **Campylobacter** infection is an important cause of acute diarrhea worldwide; Campylobacter enteritis is typically caused by Campylobacter jejuni or Campylobacter coli. The organism inhabits the intestinal tracts of a wide range of animal hosts, notably poultry; contamination from these sources can lead to foodborne disease. Campylobacter infection can also be transmitted via water-borne outbreaks and direct contact with animals or animal products.

3) **Y. enterocolitica and Y. pseudotuberculosis** cause yersiniosis, a diarrheal illness. Major clinical manifestations include acute yersiniosis (eg, acute febrile gastroenteritis) and pseudoappendicitis syndrome. A variety of complications (both gastrointestinal and extraintestinal) and post-infectious sequelae have also been described.

4) **Clostridium difficile** infection (CDI) is one of the most common hospital-acquired (nosocomial) infections, and is an increasingly frequent cause of morbidity and mortality among elderly hospitalized patients. C. difficile colonizes the human intestinal tract after the normal gut flora has been altered by antibiotic therapy and is the causative organism of antibiotic-associated pseudomembranous colitis.

SOURCE: Up to Date

ICD-10 DESCRIPTION:

General inclusions:
N/A

General exclusions:
-Foodborne intoxications, elsewhere classified(A05.-)
-Tuberculous enteritis (A18.3)

Sub-codes:
A04.0 Enteropathogenic Escherichia coli infection

A04.1 Enterotoxigenic Escherichia coli infection

A04.2 Enteroinvasive Escherichia coli infection

A04.3 Enterohaemorrhagic Escherichia coli infection

A04.4 Other intestinal Escherichia coli infections
Includes: Escherichia coli enteritis NOS

A04.5 Campylobacter enteritis

A04.6 Enteritis due to Yersinia enterocolitica
Excludes: extraintestinal yersiniosis (A28.2)

A04.7 Enterocolitis due to Clostridium difficile
Includes:
-Foodborne intoxication by Clostridium difficile
-Pseudomembranous colitis

A04.8 Other specified bacterial intestinal infections

A04.9 Bacterial intestinal infection, unspecified
Includes: Bacterial enteritis NOS

Panel on Emergency-Sensitive Conditions (PESC)

5. A04 Other bacterial intestinal infection:

Most of the time, to what extent does ED management impact on mortality/morbidity related to this DG?

	Not at all emergency sensitive				Neutral				Definitely emergency sensitive
	1	2	3	4	5	6	7	8	9
Mortality	○	○	○	○	○	○	○	○	○
Morbidity	○	○	○	○	○	○	○	○	○

Comment

6. A04 Other bacterial intestinal infection:

Most of the time, to what extent does this DG require an ED time-sensitive intervention?

	Not at all time-sensitive				Neutral				Definitely time-sensitive
	1	2	3	4	5	6	7	8	9
Time-sensitive	○	○	○	○	○	○	○	○	○

Comment

A41 Sepsis

DEFINITIONS:

Sepsis is the clinical syndrome that results from a dysregulated inflammatory response to an infection. It exists if two or more of the following abnormalities are present, along with either a culture-proven or visually identified infection:
-Temperature >38,5 C or <35 C
-Heart rate 90 beats/min

Other potential emergency-sensitive conditions

A04 Other bacterial intestinal infection
A41 Sepsis
C15 Malignant neoplasm of oesophagus

Panel on Emergency-Sensitive Conditions (PESC)

C16 Malignant neoplasm of stomach
C18 Malignant neoplasm of colon
C22 Malignant neoplasm of liver and intrahepatic bile ducts
C25 Malignant neoplasm of pancreas
C34 Malignant neoplasm of bronchus and lung
C50 Malignant neoplasm of breast
C61 Malignant neoplasm of prostate
C67 Malignant neoplasm of bladder
C71 Malignant neoplasm of the brain
C78 Secondary malignant neoplasm of respiratory and digestive organs
C79 Secondary malignant neoplasm of other sites
C80 Malignant neoplasm without specification of site
C83 Diffuse non-Hodgkin's lymphoma
C85 Other and unspecified types of non-Hodgkin's lymphoma
C90 Multiple myeloma and malignant plasma cell neoplasms
C92 Myeloid leukemia
E11 Diabetes Mellitus type 2
E86 Volume depletion
E87 Other disorders of fluid, electrolyte and acid-base balance
F03 Unspecified dementia
F05 Delirium, not induced by alcohol and other psychoactive substances
G30 Alzheimer's disease
G93 Other disorders of brain
I21 Acute Myocardial Infarction (AMI)
I24 Other acute ischemic heart disease
I25 Chronic ischemic heart disease
I26 Pulmonary embolism
I35 Nonrheumatic aortic valve disorders
I46 Cardiac arrest
I48 Atrial fibrillation and flutter
I50 Heart failure
I60 Subarachnoid haemorrhage
I61 Intracerebral haemorrhage
I62 Other non traumatic intracranial haemorrhage
I63 Cerebral infarction
I64 Stroke, not specified as haemorrhage or infarction
I70 Atherosclerosis
I71 Aortic aneurism and dissection
J18 Pneumonia
J44 Other chronic obstructive pulmonary disease
J69 Pneumonitis due to solids and liquids
J80 Adult respiratory distress syndrome
J84 Other interstitial pulmonary diseases
J90 Pleural effusion, not elsewhere classified
J96 Respiratory failure, not elsewhere classified
K26 Duodenal ulcer
K55 Vascular disorders of intestine
K56 Paralytic ileus and intestinal obstruction without hernia
K57 Diverticular disease of intestine
K63 Other diseases of intestine
K65 Peritonitis
K70 Alcoholic liver disease
K72 Hepatic failure
K74 Fibrosis and cirrhosis of liver
K85 Acute pancreatitis

Panel on Emergency-Sensitive Conditions (PESC)

K92 Other diseases of digestive system
L03 Cellulitis
N17 Acute renal failure
N18 Chronic renal failure
N39 Other disorders of urinary system
R53 Malaise and fatigue
R57 Shock, not elsewhere classified
R64 Cachexia
S06 Intracranial injury
S32 Fracture of lumbar spine and pelvis
S72 Fracture of femur
T81 Complications of procedures, not elsewhere classified
T82 Complications of cardiac and vascular prosthetic devices, implants and grafts
Z54 Convalescence

149. If it applies, please list all diagnoses or conditions that are not covered in the previous list of Diagnosis Groups and that should be considered as emergency-sensitive conditions.

End of questionnaire

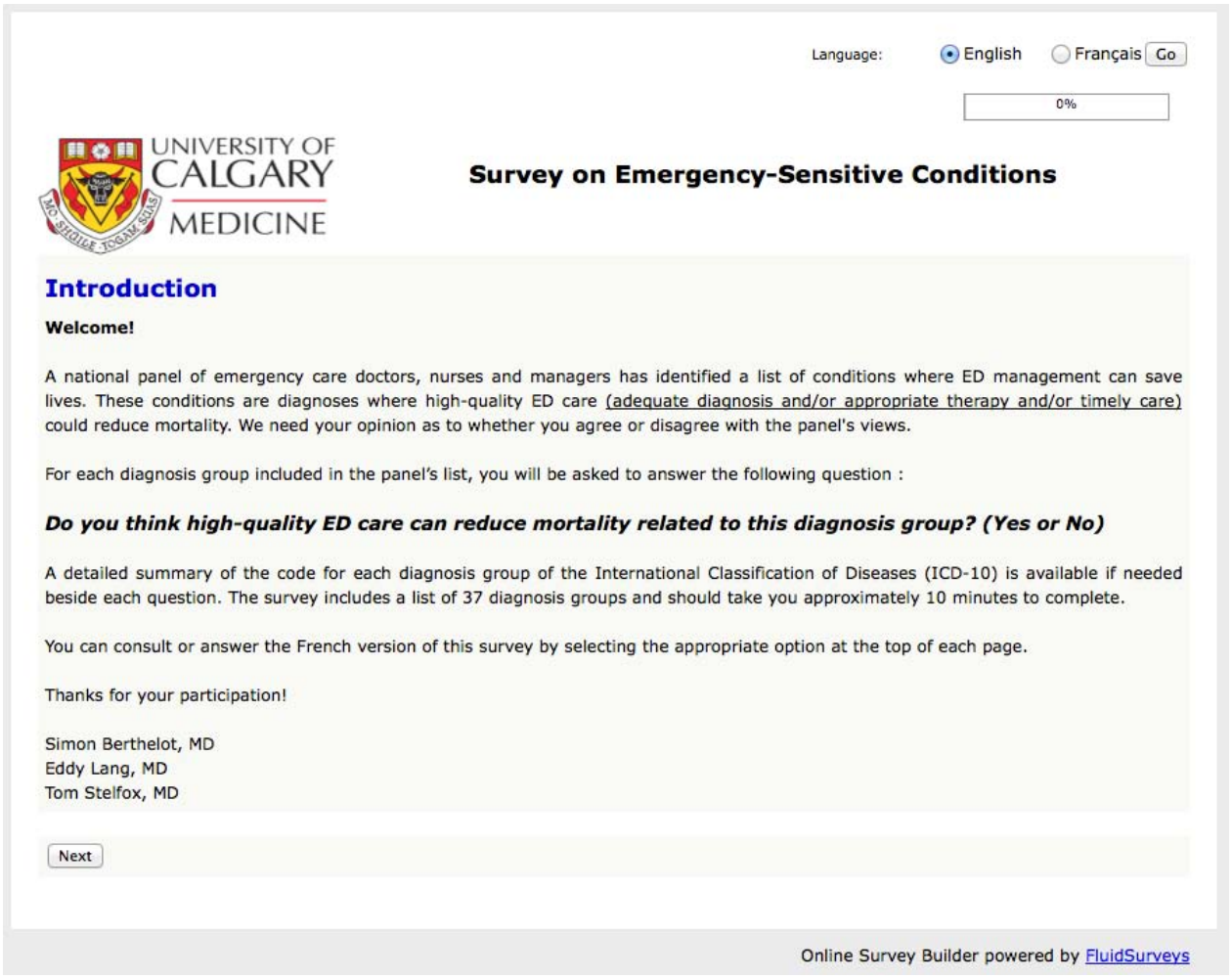
Thank you for your work.

Your ratings will be summarized along with other experts' ratings. The results of this first round will be distributed for your review prior to the teleconference. If you have any worries about this questionnaire or the following steps of the consensus process, please feel free to send an email (email Simon Berthelot) or call (403 464-6515) Simon Berthelot at any time.

We look forward to meeting with you on June 13th.

Simon Berthelot
Eddy Lang
Tom Stelfox

Appendix C. Web-survey instrument



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Survey on Emergency-Sensitive Conditions

Introduction

Welcome!

A national panel of emergency care doctors, nurses and managers has identified a list of conditions where ED management can save lives. These conditions are diagnoses where high-quality ED care (adequate diagnosis and/or appropriate therapy and/or timely care) could reduce mortality. We need your opinion as to whether you agree or disagree with the panel's views.

For each diagnosis group included in the panel's list, you will be asked to answer the following question :

Do you think high-quality ED care can reduce mortality related to this diagnosis group? (Yes or No)

A detailed summary of the code for each diagnosis group of the International Classification of Diseases (ICD-10) is available if needed beside each question. The survey includes a list of 37 diagnosis groups and should take you approximately 10 minutes to complete.

You can consult or answer the French version of this survey by selecting the appropriate option at the top of each page.

Thanks for your participation!

Simon Berthelot, MD
Eddy Lang, MD
Tom Stelfox, MD

Next

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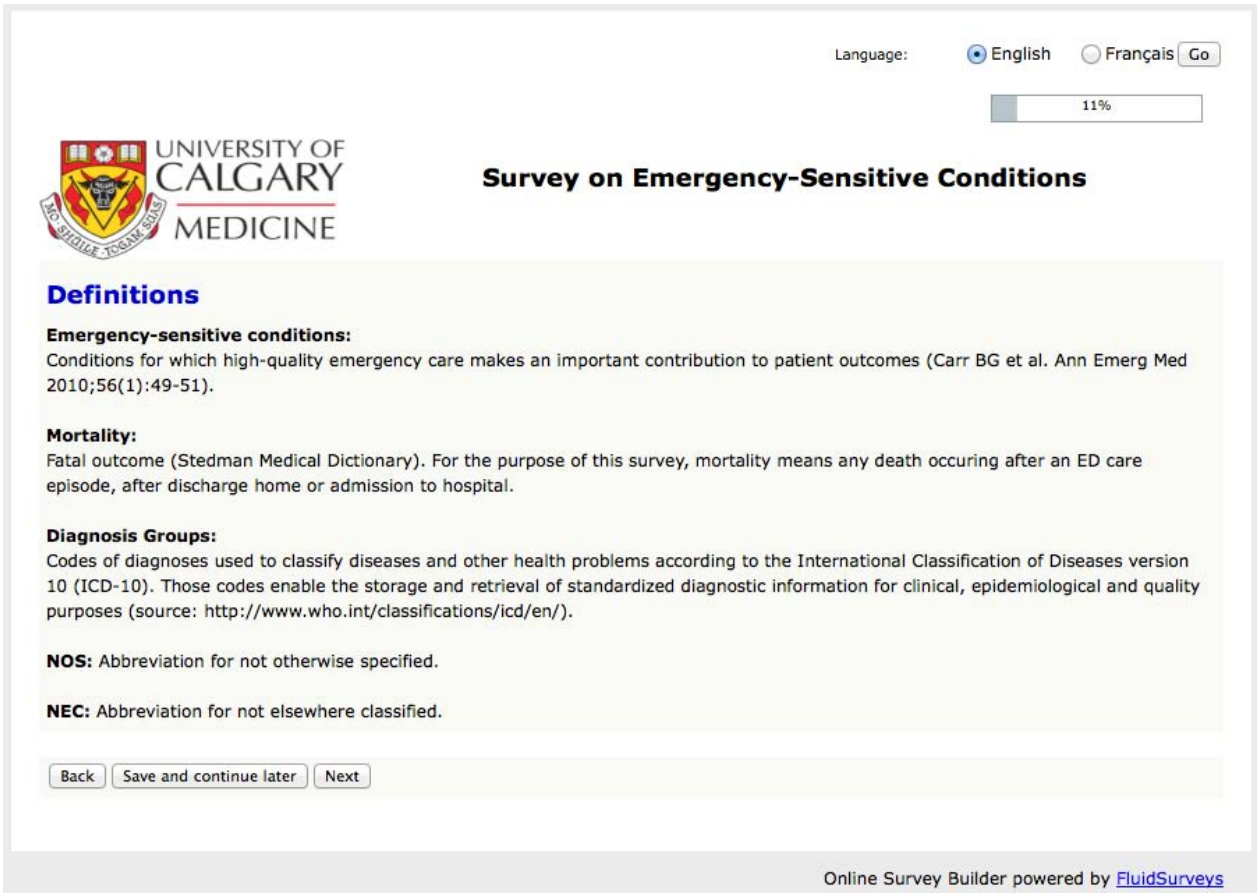
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Survey on Emergency-Sensitive Conditions
Definitions
Emergency-sensitive conditions:
Conditions for which high-quality emergency care makes an important contribution to patient outcomes (Carr BG et al. Ann Emerg Med 2010;56(1):49-51).
Mortality:
Fatal outcome (Stedman Medical Dictionary). For the purpose of this survey, mortality means any death occuring after an ED care episode, after discharge home or admission to hospital.
Diagnosis Groups:
Codes of diagnoses used to classify diseases and other health problems according to the International Classification of Diseases version 10 (ICD-10). Those codes enable the storage and retrieval of standardized diagnostic information for clinical, epidemiological and quality purposes (source: http://www.who.int/classifications/icd/en/).
NOS: Abbreviation for not otherwise specified.
NEC: Abbreviation for not elsewhere classified.
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Survey on Emergency-Sensitive Conditions

Gender?

( ) Female
( ) Male

In which province or territory do you work?

( ) Alberta
( ) British Columbia
( ) Manitoba
( ) Newfoundland and Labrador
( ) New Brunswick
( ) Northwest Territories
( ) Nova Scotia
( ) Nunavut
( ) Ontario
( ) Prince Edward Island
( ) Québec
( ) Saskatchewan
( ) Yukon
( ) Other, please specify...

You are a:

( ) nurse
( ) doctor
( ) other, please specify...

How many years of experience do you have in the emergency department?

In what type(s) of hospital do you work?

( ) Teaching
( ) Not teaching
( ) Both
( ) Not applicable

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Survey on Emergency-Sensitive Conditions

Do you think high-quality ED care (adequate diagnosis and/or appropriate therapy and/or timely care) can reduce mortality related to each of the following diagnosis groups?

A41 Sepsis

( ) Yes
( ) No

Description of A41

(•) Show/Hide

ICD-10 Description

A41.0 Sepsis due to Staphylococcus aureus
A41.1 Sepsis due to other specified staphylococcus and includes: Sepsis due to coagulase-negative staphylococcus
A41.2 Sepsis due to unspecified staphylococcus
A41.3 Sepsis due to Haemophilus influenzae
A41.4 Sepsis due to anaerobes but excludes: gas gangrene (A48.0)
A41.5 Sepsis due to other Gram-negative organisms
A41.50 Sepsis due to Escherichia coli [E.coli]
A41.51 Sepsis due to Pseudomonas and includes: Pseudomonas aeroginosa
A41.52 Sepsis due to Serratia
A41.58 Sepsis due to other gram-negative organisms and includes: Gram-negative sepsis NOS
A41.8 Other specified sepsis
A41.80 Sepsis due to enterococcus but excludes: due to Streptococcus D (A40.2)
A41.88 Other specified sepsis
A41.9 Sepsis, unspecified and includes: Septicaemia Use additional code (R57.2) to identify septic shock

E11 Diabetes mellitus type 2

( ) Yes
( ) No

Description of E11

( ) Show/Hide

E86 Volume depletion

( ) Yes
( ) No

Description of E86

( ) Show/Hide

E87 Other disorders of fluid, electrolyte and acid-base balance

( ) Yes
( ) No

Description of E87

( ) Show/Hide

F05 Delirium, not induced by alcohol and other psychoactive substances

- ◯ Yes
- ◯ No

Description of F05

- ◯ Show/Hide

G93 Other disorders of brain

- ◯ Yes
- ◯ No

Description of G93

- ◯ Show/Hide

I21 Acute Myocardial Infarction (AMI)

- ◯ Yes
- ◯ No

Description of I21

- ◯ Show/Hide

I24 Other acute ischemic heart disease

- ◯ Yes
- ◯ No

Description of I24

- ◯ Show/Hide

I26 Pulmonary embolism

- ◯ Yes
- ◯ No

Description of I26

- ◯ Show/Hide

I46 Cardiac arrest

- ◯ Yes
- ◯ No

Description of I46

- ◯ Show/Hide

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Survey on Emergency-Sensitive Conditions

Do you think high-quality ED care (adequate diagnosis and/or appropriate therapy and/or timely care) can reduce mortality related to each of the following diagnosis groups?

I50 Heart failure

( ) Yes
( ) No

Description of I50

( ) Show/Hide

I60 Subarachnoid haemorrhage

( ) Yes
( ) No

Description of I60

( ) Show/Hide

I61 Intracerebral haemorrhage

( ) Yes
( ) No

Description of I61

( ) Show/Hide

I62 Other non traumatic intracranial haemorrhage

( ) Yes
( ) No

Description of I62

( ) Show/Hide

I63 Cerebral infarction

( ) Yes
( ) No

Description of I63

( ) Show/Hide

I64 Stroke, not specified as haemorrhage or infarction

( ) Yes
( ) No

Description of I64

( ) Show/Hide

I71 Aortic aneurism and dissection

( ) Yes
( ) No

Description of I71

( ) Show/Hide

J18 Pneumonia

- Yes
- No

Description of J18

- Show/Hide

J44 Other chronic obstructive pulmonary disease

- Yes
- No

Description of J44

- Show/Hide

J69 Pneumonitis due to solids and liquids

- Yes
- No

Description of J69

- Show/Hide

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Survey on Emergency-Sensitive Conditions

Do you think high-quality ED care (adequate diagnosis and/or appropriate therapy and/or timely care) can reduce mortality related to each of the following diagnosis groups?

J80 Adult respiratory distress syndrome

- Yes
- No

Description of J80

- Show/Hide

J96 Respiratory failure, not elsewhere classified

- Yes
- No

Description of J96

- Show/Hide

K26 Duodenal ulcer

- Yes
- No

Description of K26

- Show/Hide

K55 Vascular disorders of intestine

- Yes
- No

Description of K55

- Show/Hide

K56 Paralytic ileus and intestinal obstruction without hernia

- ◯ Yes
- ◯ No

Description of K56

- ◯ Show/Hide

K57 Diverticular disease of intestine

- ◯ Yes
- ◯ No

Description of K57

- ◯ Show/Hide

K65 Peritonitis

- ◯ Yes
- ◯ No

Description of K65

- ◯ Show/Hide

K72 Hepatic failure

- ◯ Yes
- ◯ No

Description of K72

- ◯ Show/Hide

K85 Acute pancreatitis

- ◯ Yes
- ◯ No

Description of K85

- ◯ Show/Hide

K92 Other diseases of digestive system

- ◯ Yes
- ◯ No

Description of K92

- ◯ Show/Hide

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Survey on Emergency-Sensitive Conditions

Do you think high-quality ED care (adequate diagnosis and/or appropriate therapy and/or timely care) can reduce mortality related to each of the following diagnosis groups?

L03 Cellulitis

- ◯ Yes
- ◯ No

Description of L03

- ◯ Show/Hide

N17 Acute renal failure

- ◯ Yes
- ◯ No

Description of N17

- ◯ Show/Hide

R57 Shock, not elsewhere classified

- ◯ Yes
- ◯ No

Description of R57

- ◯ Show/Hide

S06 Intracranial injury

- ◯ Yes
- ◯ No

Description of S06

- ◯ Show/Hide

S32 Fracture of lumbar spine and pelvis

- ◯ Yes
- ◯ No

Description of S32

- ◯ Show/Hide

S72 Fracture of femur

- ◯ Yes
- ◯ No

Description of S72

- ◯ Show/Hide

T82 Complications of cardiac and vascular prosthetic devices, implants and grafts

- ◯ Yes
- ◯ No

Description of T82

- ◯ Show/Hide

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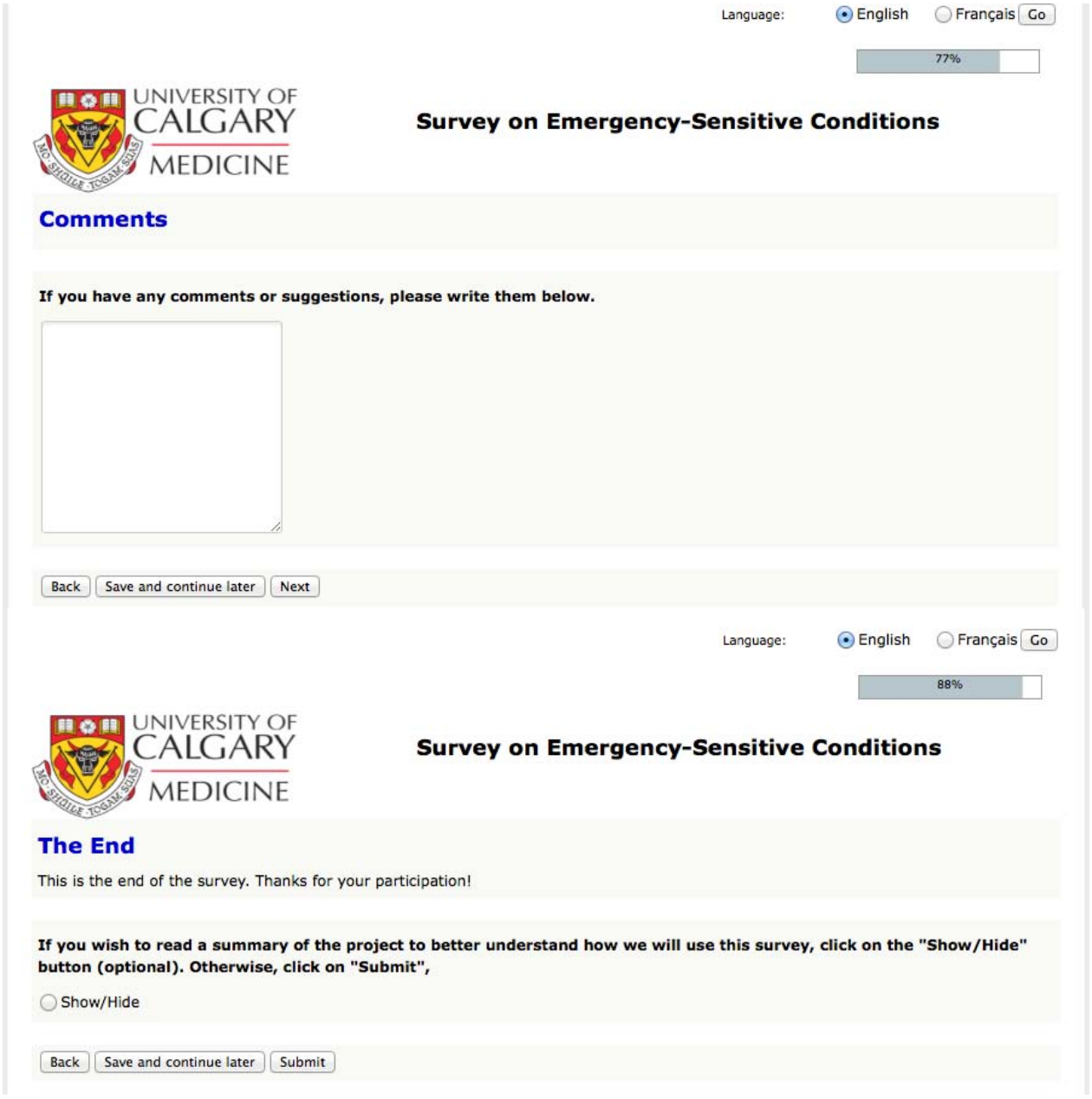
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Comments
If you have any comments or suggestions, please write them below.
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Survey on Emergency-Sensitive Conditions
The End
This is the end of the survey. Thanks for your participation!
If you wish to read a summary of the project to better understand how we will use this survey, click on the "Show/Hide" button (optional). Otherwise, click on "Submit",
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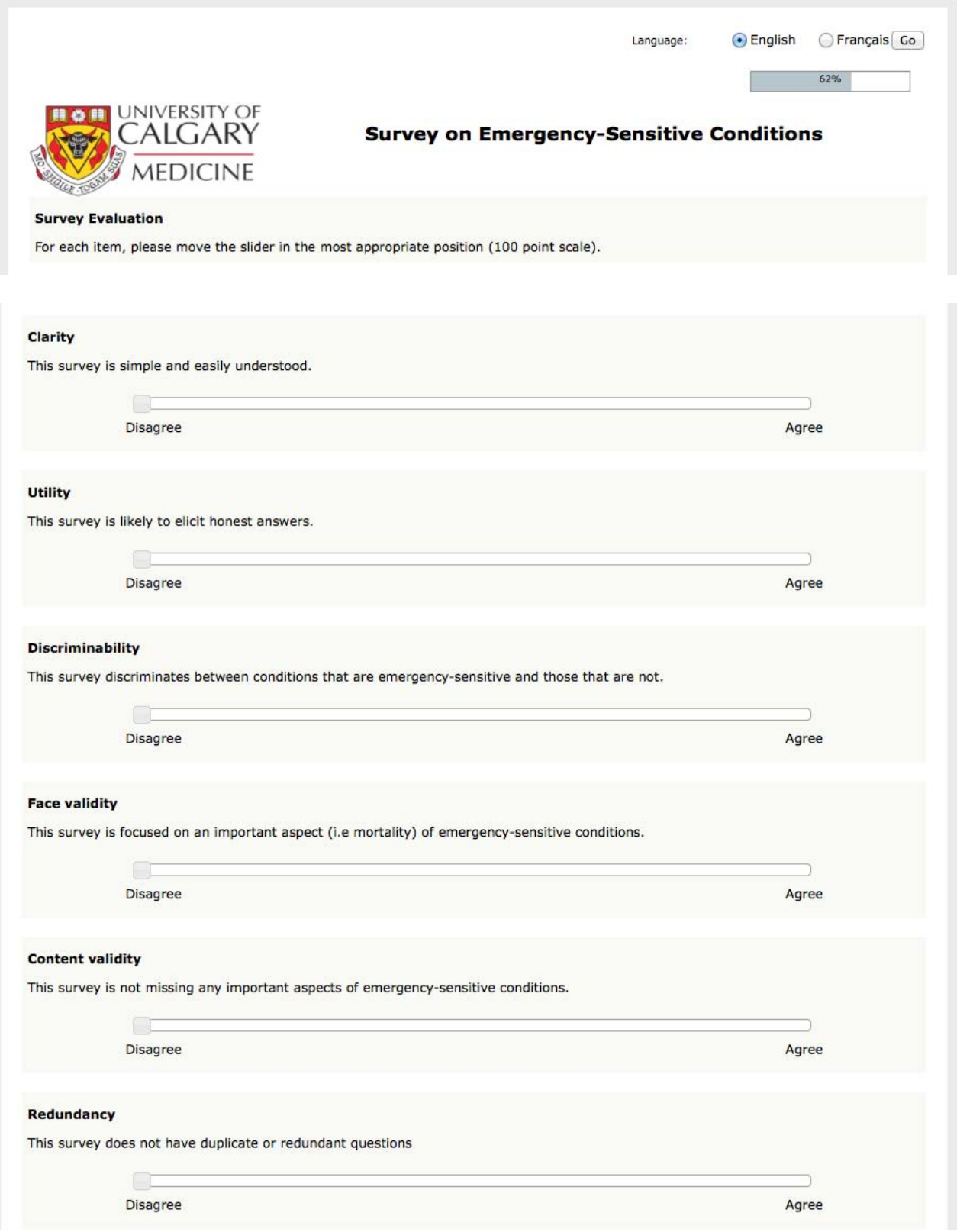
Appendix D. Clinical sensibility testing



Appendix E. Hospital peer-groups definition

Teaching	Hospitals with full membership to the Association of Canadian Academic Healthcare Organizations (ACAHO) or teaching hospitals according to the Association québécoise des établissements en santé et services sociaux (AQESS)
Community - Large	2 of the following 3 criteria: ▪ ≥ 8000 inpatient cases ▪ ≥ 10 000 weighted cases ▪ ≥ 50 000 inpatient days
Community - Medium	Do not meet large-community group criteria ≥ 2000 weighted cases (approximately ≥ 50 beds)
Community - Small	Do not meet large-community group criteria < 2000 weighted cases (approximately < 50 beds)

Reproduced from : CIHI. Hospital Standardized Mortality Ratio (HSMR): Technical Notes. Public Release. Ottawa, February 2012.

Appendix F. Charlson index score groups

Charlson Group	Charlson score	
	Outside Québec	**In Québec**
0	0	0 and 1
1	1 and 2	2, 3 and 4
2	≥ 3	≥ 5

Reproduced from : CIHI. Hospital Standardized Mortality Ratio (HSMR): Technical Notes. Public Release. Ottawa, February 2012.

Appendix G. Variable codification

Variables	Names	Type	Codes	Comments
Dead at 48h after admission	dead_2	Categorical	Alive = 0 ; Dead = 1	Outcome
Dead at 7 days after admission	dead_7	Categorical	Alive = 0 ; Dead = 1	Outcome
Dead at 30 days after admission	dead_30	Categorical	Alive = 0 ; Dead = 1	Outcome
Dead at hospital discharge	dead_disc	Categorical	Alive = 0 ; Dead = 1	Outcome
Year	y	Categorical	2009=2009-10; 2010=2010-11; 2011=2011-12	Fiscal years from April 1st to March 31st
Patient with one of the 37 emergency-sensitive diagnosis groups	dg37	Categorical	Not one of 37 DGs=0; One of 37 DGs=1	As most responsible diagnosis on the discharge summary; see table 3 of chapter 2 for full listing
Age	a	Measured	N/A	
Gender	g	Categorical	Female = 0; Male = 1	Excluded from final model
Length of stay	lx	Categorical Multilevel exposure	1 day = baseline 2 days = l1 3-9 days = l2 10-15 days = l3 16-21 days = l4 22-365 days = l5	Used for the predictive model at hospital discharge only
Transfer from another acute care facility	trans_from	Categorical	Not transferred= 0 ; transferred = 1	Excluded from final model
Charlson score groups	cx	Categorical Multilevel exposure	Group 0 = baseline Group 1 = c1 Group 2 = c2	See Appendix F for Charlson score classification
Peer-groups	peer	Categorical Multilevel exposure	Teaching = 1 Community-Large = 2 Community-Medium = 3 Community-Small = 4	See Appendix E for peer-groups definition
Diagnosis Groups	3 digit code of the ICD-10	Categorical Multilevel exposure	e.g. A41 Sepsis = a41	See Appendix A and table 5 of chapter 2 for full listing

Appendix H. Logistic regression output for the final predictive model

Teaching

```
logit  dead_disc a l1 l2 l3 l4 l5 c1 c2 a41 e11 e86 e87 f05 g93 i21 i24 i26
i46 i50 i60 i61 i62 i63 i64 i71 j18 j44 j69 j96 k26 k55 k56 k57 k65 k72 k85
k92 l03 n17 r57 s06 s32 s72 t82 if peer==1 & dg37==1 & y==2009

Iteration 0:   log likelihood = -36925.668
 Iteration 1:   log likelihood = -32241.375
 Iteration 2:   log likelihood = -31305.609
 Iteration 3:   log likelihood = -31279.752
 Iteration 4:   log likelihood = -30500.769  (backed up)
 Iteration 5:   log likelihood = -30207.072
 Iteration 6:   log likelihood = -30171.475
 Iteration 7:   log likelihood = -29948.009
 Iteration 8:   log likelihood = -29917.509
 Iteration 9:   log likelihood = -29904.866
 Iteration 10:  log likelihood = -29904.829
 Iteration 11:  log likelihood = -29904.829

 Logistic regression                                     Number of obs   =     113878
                                                         LR chi2(44)     =   14041.68
                                                         Prob > chi2     =     0.0000
 Log likelihood = -29904.829                             Pseudo R2       =     0.1901

 ------------------------------------------------------------------------------
    dead_disc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
 -------------+----------------------------------------------------------------
            a |   .0438514   .0008254    53.13   0.000     .0422336    .0454691
           l1 |  -.9462749   .0454373   -20.83   0.000     -1.03533   -.8572193
           l2 |  -1.509302    .033337   -45.27   0.000    -1.574641   -1.443962
           l3 |  -1.507067   .0413304   -36.46   0.000    -1.588073   -1.426061
           l4 |  -1.369805   .0492054   -27.84   0.000    -1.466246   -1.273364
           l5 |  -1.127748    .038913   -28.98   0.000    -1.204016    -1.05148
           c1 |   .4925243   .0247954    19.86   0.000     .4439261    .5411225
           c2 |   1.232294   .0347795    35.43   0.000     1.164128    1.300461
          a41 |  -1.063262   .2185315    -4.87   0.000    -1.491576   -.6349479
          e11 |  -3.282765   .2292467   -14.32   0.000     -3.73208    -2.83345
          e86 |  -3.352615   .2626729   -12.76   0.000    -3.867444   -2.837785
          e87 |  -4.007586   .2565328   -15.62   0.000    -4.510381   -3.504791
          f05 |  -3.265807   .2347034   -13.91   0.000    -3.725817   -2.805796
          g93 |  -.4583658   .2379811    -1.93   0.054    -.9248003    .0080686
          i21 |  -2.668549   .2181994   -12.23   0.000    -3.096212   -2.240886
          i24 |  -3.314832   .2829143   -11.72   0.000    -3.869333    -2.76033
          i26 |  -2.727129   .2318166   -11.76   0.000    -3.181481   -2.272777
          i46 |   .9172314   .2581166     3.55   0.000     .4113322    1.423131
          i50 |  -2.612105   .2171833   -12.03   0.000    -3.037776   -2.186433
          i60 |  -.9754874   .2291757    -4.26   0.000    -1.424664   -.5263112
          i61 |  -1.021733   .2224907    -4.59   0.000    -1.457807   -.5856596
          i62 |   -1.68499   .2331875    -7.23   0.000    -2.142029   -1.227951
          i63 |  -2.161975   .2182956    -9.90   0.000    -2.589826   -1.734123
          i64 |  -2.463163   .2277085   -10.82   0.000    -2.909463   -2.016862
          i71 |  -1.372928   .2312865    -5.94   0.000    -1.826242   -.9196153
          j18 |  -2.572205   .2180173   -11.80   0.000    -2.999511   -2.144899
          j44 |  -2.815012   .2179605   -12.92   0.000    -3.242207   -2.387817
          j69 |  -1.200329    .220687    -5.44   0.000    -1.632867   -.7677901
          j96 |  -.7722939   .2235287    -3.46   0.001    -1.210402   -.3341856
          k26 |  -2.711787   .2489836   -10.89   0.000    -3.199786   -2.223788
          k55 |  -1.764153   .2281676    -7.73   0.000    -2.211353   -1.316952
          k56 |  -3.273886   .2252873   -14.53   0.000    -3.715441   -2.832331
          k57 |  -3.572173   .2440955   -14.63   0.000    -4.050592   -3.093755
          k65 |  -2.199733   .2591256    -8.49   0.000     -2.70761   -1.691856
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         k72 |   -1.56988   .2346413    -6.69   0.000    -2.029768   -1.109991
         k85 |  -3.463403   .2492154   -13.90   0.000    -3.951857    -2.97495
         k92 |  -3.245873   .2323013   -13.97   0.000    -3.701175   -2.790571
         l03 |  -4.059222   .2499479   -16.24   0.000    -4.549111   -3.569333
         n17 |  -2.651337   .2244041   -11.82   0.000    -3.091161   -2.211513
         r57 |  -.1933456   .2357363    -0.82   0.412    -.6553804    .2686891
         s06 |  -1.501489   .2187436    -6.86   0.000    -1.930218   -1.072759
         s32 |  -3.750145   .2582358   -14.52   0.000    -4.256278   -3.244012
         s72 |  -3.041078   .2203039   -13.80   0.000    -3.472866    -2.60929
         t82 |  -3.141238   .2500398   -12.56   0.000    -3.631307   -2.651169
       _cons |  -2.074763   .2207917    -9.40   0.000    -2.507507   -1.642019
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Community-Large

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logit  dead_disc a l1 l2 l3 l4 l5 c1 c2 a41 e11 e86 e87 f05 g93 i21 i24 i26
i46 i50 i60 i61 i62 i63 i64 i71 j18 j44 j69 j96 k26 k55 k56 k57 k65 k72 k85
k92 l03 n17 r57 s06 s32 s72 t82 if peer==2 & dg37==1 & y==2009


Iteration 0:   log likelihood = -64902.703
 Iteration 1:   log likelihood = -56974.193
 Iteration 2:   log likelihood = -56579.852
 Iteration 3:   log likelihood = -56488.389
 Iteration 4:   log likelihood = -56488.155  (backed up)
 Iteration 5:   log likelihood = -56488.039  (backed up)
 Iteration 6:   log likelihood = -56488.009  (backed up)
 Iteration 7:   log likelihood = -55224.433  (backed up)
 Iteration 8:   log likelihood = -53342.652
 Iteration 9:   log likelihood = -52454.916
 Iteration 10:  log likelihood = -52021.846
 Iteration 11:  log likelihood = -52006.413
 Iteration 12:  log likelihood = -52006.383
 Iteration 13:  log likelihood = -52006.383

 Logistic regression                               Number of obs   =     204032
                                                   LR chi2(44)     =   25792.64
                                                   Prob > chi2     =     0.0000
 Log likelihood = -52006.383                       Pseudo R2       =     0.1987

 ------------------------------------------------------------------------------
    dead_disc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
 -------------+----------------------------------------------------------------
            a |   .0536917   .0007155    75.04   0.000     .0522893    .0550941
           l1 |  -.8799197   .0348069   -25.28   0.000      -.94814   -.8116994
           l2 |  -1.433908   .0254305   -56.39   0.000    -1.483751   -1.384065
           l3 |  -1.452283   .0314883   -46.12   0.000    -1.513999   -1.390567
           l4 |  -1.331607   .0381018   -34.95   0.000    -1.406285   -1.256929
           l5 |  -1.007588   .0306313   -32.89   0.000    -1.067624   -.9475515
           c1 |   .5586348    .018378    30.40   0.000     .5226146    .5946551
           c2 |   1.191164   .0264302    45.07   0.000     1.139361    1.242966
          a41 |  -1.181104   .1455041    -8.12   0.000    -1.466287    -.895921
          e11 |  -3.337439   .1562284   -21.36   0.000    -3.643641   -3.031237
          e86 |   -3.24309    .175122   -18.52   0.000    -3.586323   -2.899857
          e87 |  -3.913867   .1748642   -22.38   0.000    -4.256594   -3.571139
          f05 |  -3.212476    .160749   -19.98   0.000    -3.527538   -2.897414
          g93 |   .2885739   .1655366     1.74   0.081    -.0358719    .6130196
          i21 |   -2.71502   .1447655   -18.75   0.000    -2.998756   -2.431285
          i24 |  -3.739527   .1729811   -21.62   0.000    -4.078564    -3.40049
          i26 |  -2.700414   .1589312   -16.99   0.000    -3.011913   -2.388914
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          i46 |   .6060727    .170612     3.55   0.000     .2716794    .9404661
          i50 |  -2.701929   .1442374   -18.73   0.000    -2.984629   -2.419229
          i60 |  -.6572007   .1822255    -3.61   0.000    -1.014356   -.3000452
          i61 |  -.8850416   .1520343    -5.82   0.000    -1.183023   -.5870597
          i62 |  -1.447851   .1690587    -8.56   0.000      -1.7792   -1.116501
          i63 |  -2.180714   .1464787   -14.89   0.000    -2.467807   -1.893621
          i64 |  -2.381228   .1497157   -15.91   0.000    -2.674665   -2.087791
          i71 |  -1.179013   .1678571    -7.02   0.000    -1.508007   -.8500197
          j18 |  -2.375031   .1443904   -16.45   0.000    -2.658031   -2.092031
          j44 |  -2.707741   .1442414   -18.77   0.000    -2.990449   -2.425033
          j69 |  -1.042204   .1480476    -7.04   0.000    -1.332372    -.752036
          j96 |  -.8421117    .150817    -5.58   0.000    -1.137707   -.5465158
          k26 |  -2.887902   .1798607   -16.06   0.000    -3.240423   -2.535382
          k55 |  -1.822389   .1558658   -11.69   0.000    -2.127881   -1.516898
          k56 |   -3.27977   .1519721   -21.58   0.000     -3.57763    -2.98191
          k57 |  -3.701611   .1689978   -21.90   0.000    -4.032841   -3.370382
          k65 |  -1.930072   .1933969    -9.98   0.000    -2.309122   -1.551021
          k72 |  -1.418851   .1656021    -8.57   0.000    -1.743426   -1.094277
          k85 |  -3.320483   .1643198   -20.21   0.000    -3.642544   -2.998422
          k92 |  -3.240485   .1564095   -20.72   0.000    -3.547042   -2.933928
          l03 |  -3.914008   .1731954   -22.60   0.000    -4.253464   -3.574551
          n17 |  -2.377116   .1491427   -15.94   0.000     -2.66943   -2.084801
          r57 |  -.1192089   .1590321    -0.75   0.454     -.430906    .1924883
          s06 |  -2.009958   .1538527   -13.06   0.000    -2.311504   -1.708413
          s32 |  -3.859618   .1747614   -22.09   0.000    -4.202144   -3.517092
          s72 |  -3.207141   .1468164   -21.84   0.000    -3.494895   -2.919386
          t82 |  -3.251741   .2066024   -15.74   0.000    -3.656675   -2.846808
        _cons |  -2.945204   .1491968   -19.74   0.000    -3.237624   -2.652783
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Community-Medium

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logit  dead_disc a l1 l2 l3 l4 l5 c1 c2 a41 e11 e86 e87 f05 g93 i21 i24 i26
i46 i50 i60 i61 i62 i63 i64 i71 j18 j44 j69 j96 k26 k55 k56 k57 k65 k72 k85
k92 l03 n17 r57 s06 s32 s72 t82 if peer==3 & dg37==1 & y==2009


Iteration 0:   log likelihood = -28303.869
 Iteration 1:   log likelihood =  -25345.84
 Iteration 2:   log likelihood = -25332.517
 Iteration 3:   log likelihood = -24593.331
 Iteration 4:   log likelihood = -24592.065
 Iteration 5:   log likelihood = -24591.993  (backed up)
 Iteration 6:   log likelihood = -24591.957  (backed up)
 Iteration 7:   log likelihood = -24591.953  (backed up)
 Iteration 8:   log likelihood =  -24591.95  (backed up)
 Iteration 9:   log likelihood = -24591.949  (backed up)
 Iteration 10:  log likelihood = -24591.949  (backed up)
 Iteration 11:  log likelihood = -24591.949  (backed up)
 Iteration 12:  log likelihood = -23851.761  (backed up)
 Iteration 13:  log likelihood = -23325.691  (backed up)
 Iteration 14:  log likelihood = -23086.803
 Iteration 15:  log likelihood =  -23067.74
 Iteration 16:  log likelihood =  -23067.39
 Iteration 17:  log likelihood =  -23067.39

 Logistic regression                               Number of obs   =      97695
                                                   LR chi2(44)     =   10472.96
                                                   Prob > chi2     =     0.0000
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Log likelihood = -23067.39 Pseudo R2 = 0.1850

dead_disc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
a	.059821	.0011567	51.72	0.000	.0575539	.0620881
l1	-.7944053	.0511091	-15.54	0.000	-.8945773	-.6942334
l2	-1.168693	.0369504	-31.63	0.000	-1.241115	-1.096272
l3	-1.131147	.0472304	-23.95	0.000	-1.223717	-1.038577
l4	-.8947472	.0580291	-15.42	0.000	-1.008482	-.7810121
l5	-.6422303	.0476615	-13.47	0.000	-.7356451	-.5488155
c1	.5743908	.0275512	20.85	0.000	.5203916	.6283901
c2	1.228862	.0407555	30.15	0.000	1.148983	1.308742
a41	-.5956079	.2430291	-2.45	0.014	-1.071936	-.1192797
e11	-2.595265	.2590471	-10.02	0.000	-3.102988	-2.087542
e86	-2.685966	.2862721	-9.38	0.000	-3.247049	-2.124883
e87	-2.848796	.2754162	-10.34	0.000	-3.388602	-2.30899
f05	-2.268231	.2643146	-8.58	0.000	-2.786278	-1.750184
g93	.8395247	.2908764	2.89	0.004	.2694175	1.409632
i21	-1.885229	.2403286	-7.84	0.000	-2.356264	-1.414193
i24	-2.951073	.2734709	-10.79	0.000	-3.487066	-2.41508
i26	-1.843009	.2588969	-7.12	0.000	-2.350438	-1.335581
i46	1.188788	.2819291	4.22	0.000	.6362173	1.741359
i50	-1.76635	.2399024	-7.36	0.000	-2.236551	-1.29615
i60	.0234959	.3281693	0.07	0.943	-.6197042	.666696
i61	-.0379558	.253181	-0.15	0.881	-.5341814	.4582697
i62	-.583673	.2823728	-2.07	0.039	-1.137114	-.0302325
i63	-1.35196	.2449863	-5.52	0.000	-1.832124	-.8717955
i64	-1.240303	.2434012	-5.10	0.000	-1.71736	-.7632451
i71	-.4992309	.2926379	-1.71	0.088	-1.072791	.0743288
j18	-1.64152	.2403179	-6.83	0.000	-2.112535	-1.170506
j44	-1.913258	.2396984	-7.98	0.000	-2.383059	-1.443458
j69	-.0740924	.2500193	-0.30	0.767	-.5641213	.4159364
j96	.1122964	.2525822	0.44	0.657	-.3827555	.6073484
k26	-2.04518	.3160952	-6.47	0.000	-2.664715	-1.425645
k55	-.8975497	.2632503	-3.41	0.001	-1.413511	-.3815886
k56	-2.239887	.2466932	-9.08	0.000	-2.723397	-1.756377
k57	-2.705834	.2687549	-10.07	0.000	-3.232584	-2.179084
k65	-1.071743	.3151893	-3.40	0.001	-1.689503	-.4539834
k72	-.3896356	.2724461	-1.43	0.153	-.9236203	.144349
k85	-2.708904	.2742858	-9.88	0.000	-3.246495	-2.171314
k92	-2.348833	.2538467	-9.25	0.000	-2.846364	-1.851303
l03	-2.989624	.2734106	-10.93	0.000	-3.525499	-2.453749
n17	-1.524304	.2482255	-6.14	0.000	-2.010816	-1.037791
r57	.4071675	.2606028	1.56	0.118	-.1036046	.9179396
s06	-1.424289	.2640088	-5.39	0.000	-1.941736	-.9068408
s32	-2.785914	.2745038	-10.15	0.000	-3.323931	-2.247896
s72	-2.703466	.2469069	-10.95	0.000	-3.187394	-2.219537
t82	-2.618024	.417401	-6.27	0.000	-3.436115	-1.799933
_cons	-4.566225	.2504528	-18.23	0.000	-5.057103	-4.075346

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Community-Small

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logit  dead_disc a l1 l2 l3 l4 l5 c1 c2 a41 e11 e86 e87 f05 g93 i21 i24 i26
i46 i50 i60 i61 i62 i63 i64 i71 j18 j44 j69 j96 k26 k55 k56 k57 k65 k72 k85
k92 l03 n17 r57 s06 s32 s72 t82 if peer==4 & dg37==1 & y==2009

Iteration 0:   log likelihood = -11904.113
 Iteration 1:   log likelihood = -10888.019
 Iteration 2:   log likelihood = -10841.784
 Iteration 3:   log likelihood = -10672.064
 Iteration 4:   log likelihood = -10367.682
 Iteration 5:   log likelihood = -10362.348
 Iteration 6:   log likelihood = -10360.177
 Iteration 7:   log likelihood = -10359.196
 Iteration 8:   log likelihood = -10358.729  (backed up)
 Iteration 9:   log likelihood = -10358.501  (backed up)
 Iteration 10:  log likelihood = -10358.389  (backed up)
 Iteration 11:  log likelihood = -10358.333  (backed up)
 Iteration 12:  log likelihood = -10358.305  (backed up)
 Iteration 13:  log likelihood = -10358.291  (backed up)
 Iteration 14:  log likelihood = -10358.284  (backed up)
 Iteration 15:  log likelihood = -10358.281  (backed up)
 Iteration 16:  log likelihood = -10358.279  (backed up)
 Iteration 17:  log likelihood = -10358.278  (backed up)
 Iteration 18:  log likelihood = -10358.278  (backed up)
 Iteration 19:  log likelihood = -10358.278  (backed up)
 Iteration 20:  log likelihood = -10358.278  (backed up)
 Iteration 21:  log likelihood = -10358.278  (backed up)
 Iteration 22:  log likelihood = -10137.088  (backed up)
 Iteration 23:  log likelihood = -9877.7583  (backed up)
 Iteration 24:  log likelihood = -9738.4978  (backed up)
 Iteration 25:  log likelihood = -9678.8339
 Iteration 26:  log likelihood = -9594.5738
 Iteration 27:  log likelihood = -9586.4414
 Iteration 28:  log likelihood = -9585.8675
 Iteration 29:  log likelihood = -9585.8674

 Logistic regression                                     Number of obs   =      49783
                                                         LR chi2(44)     =    4636.49
                                                         Prob > chi2     =     0.0000
 Log likelihood = -9585.8674                             Pseudo R2       =     0.1947

 ------------------------------------------------------------------------------
    dead_disc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
 -------------+----------------------------------------------------------------
            a |   .0676282   .0019425    34.81   0.000     .0638209    .0714355
           l1 |  -.5331734   .0755425    -7.06   0.000     -.681234   -.3851127
           l2 |  -.8379084   .0566217   -14.80   0.000    -.9488848    -.726932
           l3 |  -.7140755   .0747164    -9.56   0.000     -.860517    -.567634
           l4 |  -.4999901   .0955296    -5.23   0.000    -.6872246   -.3127555
           l5 |  -.1725839   .0778786    -2.22   0.027    -.3252231   -.0199447
           c1 |   .5511962   .0434272    12.69   0.000     .4660805    .6363119
           c2 |   1.360379   .0657577    20.69   0.000     1.231496    1.489262
          a41 |   .3618797   .4628764     0.78   0.434    -.5453413    1.269101
          e11 |   -1.64603     .47416    -3.47   0.001    -2.575366   -.7166931
          e86 |  -.9571739      .4773    -2.01   0.045    -1.892665   -.0216831
          e87 |  -1.879945   .5007325    -3.75   0.000    -2.861362    -.898527
          f05 |  -1.824698    .517902    -3.52   0.000    -2.839767   -.8096284
          g93 |  -.7323979   1.128228    -0.65   0.516    -2.943684    1.478888
          i21 |  -.6078716   .4575043    -1.33   0.184    -1.504563    .2888203
          i24 |  -1.901978   .5132694    -3.71   0.000    -2.907968   -.8959886
          i26 |  -.4672876   .4898567    -0.95   0.340    -1.427389    .4928139
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          i46 |   3.011467   .5403884     5.57   0.000     1.952326    4.070609
          i50 |  -.4972771    .456174    -1.09   0.276    -1.391362    .3968075
          i60 |   -.087921   .7952761    -0.11   0.912    -1.646633    1.470791
          i61 |   1.040305   .4876659     2.13   0.033     .0844978    1.996113
          i62 |   .8913543   .5126535     1.74   0.082    -.1134281    1.896137
          i63 |   -.446269   .4733718    -0.94   0.346    -1.374061    .4815227
          i64 |    .252821   .4595596     0.55   0.582    -.6478992    1.153541
          i71 |   1.274574   .5215138     2.44   0.015     .2524256    2.296722
          j18 |  -.4467096   .4559847    -0.98   0.327    -1.340423    .4470039
          j44 |  -.7864757   .4560066    -1.72   0.085    -1.680232    .1072808
          j69 |   1.081196   .4741284     2.28   0.023     .1519219    2.010471
          j96 |   1.519111   .4815114     3.15   0.002     .5753656    2.462855
          k26 |  -1.253159   .7577235    -1.65   0.098    -2.738269     .231952
          k55 |   .4105314   .5419449     0.76   0.449    -.6516611    1.472724
          k56 |  -1.469613    .46852    -3.14   0.002    -2.387896   -.5513312
          k57 |  -2.866435   .6116989    -4.69   0.000    -4.065343   -1.667527
          k65 |   .1206766   .5745966     0.21   0.834    -1.005512    1.246865
          k72 |   1.018427   .5028204     2.03   0.043     .0329174    2.003937
          k85 |  -2.138212   .5459394    -3.92   0.000    -3.208233    -1.06819
          k92 |  -1.141653   .4706087    -2.43   0.015    -2.064029   -.2192771
          l03 |  -1.977683   .5005582    -3.95   0.000    -2.958759   -.9966066
          n17 |   .0007138   .4659742     0.00   0.999    -.9125789    .9140065
          r57 |   1.087415   .5079459     2.14   0.032     .0918596    2.082971
          s06 |  -.4578836   .5000271    -0.92   0.360    -1.437919    .5221514
          s32 |  -2.251976   .5251536    -4.29   0.000    -3.281258   -1.222694
          s72 |  -2.160606   .4863517    -4.44   0.000    -3.113838   -1.207374
          t82 |  -1.412448   .8583596    -1.65   0.100    -3.094802    .2699055
        _cons |  -6.873864   .4737793   -14.51   0.000    -7.802454   -5.945274
------------------------------------------------------------------------------

.
```

Appendix I. Hosmer-Lemeshow Goodness-of-fit tests for the full predictive models* with 37 Diagnosis Groups (output)

Teaching

```
Logistic model for dead_disc, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 |  Exp_1 | Obs_0 |   Exp_0 | Total |
  |-------+--------+-------+--------+-------+---------+-------|
  |     1 | 0.0129 |    41 |   91.7 | 11490 | 11439.3 | 11531 |
  |     2 | 0.0209 |   133 |  206.0 | 11402 | 11329.0 | 11535 |
  |     3 | 0.0337 |   282 |  337.9 | 11440 | 11384.1 | 11722 |
  |     4 | 0.0410 |   392 |  405.6 | 10428 | 10414.4 | 10820 |
  |     5 | 0.0615 |   738 |  607.2 | 10733 | 10863.8 | 11471 |
  |-------+--------+-------+--------+-------+---------+-------|
  |     6 | 0.0784 |   748 |  770.1 | 10522 | 10499.9 | 11270 |
  |     7 | 0.0997 |  1106 | 1027.6 | 10382 | 10460.4 | 11488 |
  |     8 | 0.1445 |  1589 | 1490.9 | 10333 | 10431.1 | 11922 |
  |     9 | 0.2348 |  2057 | 1938.3 |  8678 |  8796.7 | 10735 |
  |    10 | 0.9804 |  4259 | 4469.7 |  7125 |  6914.3 | 11384 |
  +--------------------------------------------------------+

       number of observations =    113878
             number of groups =        10
     Hosmer-Lemeshow chi2(8) =    134.16
                 Prob > chi2 =    0.0000
```

Community-Large

```
Logistic model for dead_disc, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 |  Exp_1 | Obs_0 |   Exp_0 | Total |
  |-------+--------+-------+--------+-------+---------+-------|
  |     1 | 0.0100 |    51 |  122.1 | 20692 | 20620.9 | 20743 |
  |     2 | 0.0204 |   239 |  325.9 | 20521 | 20434.1 | 20760 |
  |     3 | 0.0328 |   424 |  509.7 | 19396 | 19310.3 | 19820 |
  |     4 | 0.0400 |   675 |  731.9 | 19621 | 19564.1 | 20296 |
  |     5 | 0.0591 |  1188 | 1063.8 | 19770 | 19894.2 | 20958 |
  |-------+--------+-------+--------+-------+---------+-------|
  |     6 | 0.0812 |  1270 | 1314.7 | 18770 | 18725.3 | 20040 |
  |     7 | 0.0970 |  1902 | 1743.9 | 18312 | 18470.1 | 20214 |
  |     8 | 0.1395 |  2752 | 2578.1 | 18324 | 18497.9 | 21076 |
  |     9 | 0.2287 |  3748 | 3539.8 | 16234 | 16442.2 | 19982 |
  |    10 | 0.9695 |  7511 | 7830.1 | 12632 | 12312.9 | 20143 |
  +--------------------------------------------------------+

       number of observations =    204032
             number of groups =        10
     Hosmer-Lemeshow chi2(8) =    166.69
                 Prob > chi2 =    0.0000
```

Community-Medium

```
Logistic model for dead_disc, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 |  Exp_1 | Obs_0 |   Exp_0 | Total |
  |-------+--------+-------+--------+-------+---------+-------|
  |     1 | 0.0081 |    17 |   40.6 |  9866 |  9842.4 |  9883 |
  |     2 | 0.0165 |    87 |  131.2 | 10117 | 10072.8 | 10204 |
  |     3 | 0.0289 |   160 |  207.1 |  9268 |  9220.9 |  9428 |
  |     4 | 0.0363 |   279 |  318.8 |  9331 |  9291.2 |  9610 |
  |     5 | 0.0495 |   428 |  412.4 |  9298 |  9313.6 |  9726 |
  |-------+--------+-------+--------+-------+---------+-------|
  |     6 | 0.0686 |   627 |  612.0 |  9612 |  9627.0 | 10239 |
  |     7 | 0.0938 |   857 |  795.6 |  8937 |  8998.4 |  9794 |
  |     8 | 0.1286 |  1033 | 1004.9 |  8287 |  8315.1 |  9320 |
  |     9 | 0.1960 |  1701 | 1535.1 |  8076 |  8241.9 |  9777 |
  |    10 | 0.9496 |  3070 | 3201.3 |  6644 |  6512.7 |  9714 |
  +--------------------------------------------------------+

       number of observations =     97695
             number of groups =        10
      Hosmer-Lemeshow chi2(8) =     81.30
                  Prob > chi2 =    0.0000
```

Community-Small

```
Logistic model for dead_disc, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 |  Exp_1 | Obs_0 |  Exp_0 | Total |
  |-------+--------+-------+--------+-------+--------+-------|
  |     1 | 0.0032 |     2 |    7.7 |  5102 | 5096.3 |  5104 |
  |     2 | 0.0089 |    18 |   29.9 |  4857 | 4845.1 |  4875 |
  |     3 | 0.0163 |    60 |   62.9 |  4991 | 4988.1 |  5051 |
  |     4 | 0.0257 |   123 |  134.8 |  5835 | 5823.2 |  5958 |
  |     5 | 0.0358 |   115 |  137.8 |  4257 | 4234.2 |  4372 |
  |-------+--------+-------+--------+-------+--------+-------|
  |     6 | 0.0483 |   190 |  187.3 |  4360 | 4362.7 |  4550 |
  |     7 | 0.0687 |   307 |  297.0 |  4646 | 4656.0 |  4953 |
  |     8 | 0.0960 |   446 |  444.5 |  4777 | 4778.5 |  5223 |
  |     9 | 0.1552 |   656 |  615.3 |  4210 | 4250.7 |  4866 |
  |    10 | 0.9663 |  1293 | 1292.9 |  3538 | 3538.1 |  4831 |
  +--------------------------------------------------------+

       number of observations =     49783
             number of groups =        10
      Hosmer-Lemeshow chi2(8) =     17.60
                  Prob > chi2 =    0.0245
```

Appendix J. Intraclass correlation coefficient calculation output

```
icc ED_HSMR_disc_37 inst y, consistency
(87 targets omitted from computation because not rated by all raters)

Intraclass correlations
Two-way random-effects model
Consistency of agreement

Random effects: inst             Number of targets =       204
Random effects: y                Number of raters  =         2

------------------------------------------------------------------
       ED_HSMR_disc_37 |        ICC       [95% Conf. Interval]
-----------------------+------------------------------------------
            Individual |   .6359884       .5465572    .7110764
               Average |   .7774974        .706805    .8311451
------------------------------------------------------------------
F test that
  ICC=0.00: F(203.0, 203.0) = 4.49            Prob > F = 0.000
```

Appendix K. Letter of Invitation for Panelists

Dear X,

We are emailing you to ask for your expertise and input in completing an important study that will help us measure Emergency Department quality and performance. We are a research team (and are hoping you will join us as a member) aiming to develop a new in-hospital standardized mortality ratio (HSMR) for emergency-sensitive conditions. A number of experts by consensus have recommended the monitoring of either the overall or condition-specific mortality rate in patients after an ED consultation. The *Canadian Institute for Health Information* (CIHI) already estimates for each individual Canadian Hospital the HSMR derived from the 72 Diagnosis-Related Groups (DRG) accounting for the top 80% of in-hospital deaths. However, since this HSMR includes a number of conditions that are of questionable relevance to emergency medicine, we believe and are testing the hypothesis that a mortality ratio specifically capturing the outcomes of patients with emergency-sensitive conditions would better reflect ED care. We could define emergency-sensitive conditions as diagnoses/conditions that are: 1) frequently treated in most EDs and 2) are ED-management dependent for their outcomes.

Given your expertise in X we would like to invite you to participate in a CONSENSUS PANEL OF EXPERTS to generate this list of emergency-sensitive conditions. The list will be used further to calculate a HSMR more specific to ED patients' pathway and continuum of care.

We are inviting 12 Canadian experts in emergency medicine and nursing, in ED management, and in quality of care and performance measurement in the ED to participate on this panel. We will use the RAND/UCLA Appropriateness Method, a consensus method for facilitating decision-making. During two rounds of remote reviews using an electronic survey instrument, panel members will independently rate the list of 72 DRGs used by CIHI to calculate the all-case Canadian HSMR. More specifically:

- Round 1 – Rating each of the 72 DRGs to select the ones that could be qualified as emergency-sensitive conditions. From May 1st – May 22nd 2012 (2 to 4 hour time commitment)
- Teleconference on June 13th 2012. Deliberative phase meant to discuss the disagreements arisen from Round 1 (4 hour time commitment maximum)
- Round 2 – New rating process from June 13th-June 27th 2012 (2 hour time commitment)
- Round 3 – Optional; this round will be held in September 2012 if disagreements persist after 2 rounds.

We plan to disseminate the results of the consensus method in a group authored peer reviewed publication (alphabetic order by last name), conference presentation and wiki (post-publication).

We have attached two documents containing additional information regarding the consensus process for your information should you wish to review:
- Summary of the project and the consensus process;
- Copy of our research proposal.

We recognize how busy you are and greatly appreciate you considering our invitation. We would appreciate a response before April 20th if possible to help us with our planning. If you cannot participate we would welcome suggestions for other experts that we should consider inviting.

Sincerely,

Simon Berthelot MD, CFPC(EM), FRCPC, ABEM
Research Fellow, Department of Emergency Medicine, Calgary Zone
Medical Advisor for Québec Healthcare Ministry
siberth@me.com

Eddy Lang, MDCM, CFPC(EM), CSPQ
Senior Researcher, Alberta Health Services
Associate Professor, University of Calgary
Eddy.Lang@albertahealthservices.ca

Grant Innes, MD, FRCPC
Department Head, Emergency Medicine
Chair, Emergency Medicine, University of Calgary
Grant.Innes@albertahealthservices.ca

H. Tom Stelfox, MD, PhD, FRCPC
Assistant Professor of Critical Care Medicine
Performance Improvement Patient Safety Committee Co-Chair, Trauma Association of Canada
tstelfox@ucalgary.ca