



In Focus: A National Look at Sepsis



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In Focus: A National Look at Sepsis

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Introduction: What Is Sepsis?

Sepsis is a complex syndrome that is difficult to define. It is also difficult to diagnose because there is no “typical presentation”; the signs and symptoms are highly variable. *So, what is sepsis?* Commonly referred to as the body’s response to severe infection sepsis can be a serious condition calling for immediate medical care. Despite optimal care, patients with sepsis may become very ill, develop single or multiple organ dysfunction and eventually die.¹

In the medical community, definitions of sepsis have been developed and rethought due to advances in understanding the condition and the introduction of potential new therapies. To help physicians and clinical staff better recognize (and treat) sepsis, a group of 29 international sepsis experts convened a consensus conference in 2001 to update the 1991 consensus conference definition of sepsis.^{2, 3}

Key Definitions²

Infection: The pathologic process caused by the invasion of normally sterile tissue, fluid or body cavity by pathogenic or potentially pathogenic microorganisms.

Sepsis: The clinical syndrome defined by the presence of both infection and a systemic inflammatory response.

Severe sepsis: Sepsis, complicated with organ dysfunction.

Septic shock: Severe sepsis, made worse by a state of acute circulatory failure that is characterized by persistent arterial hypotension, which is unexplained by other causes and occurs despite adequate volume resuscitation.

Why Is Sepsis Important?

Sepsis is a leading cause of mortality; approximately 1,400 people die from this condition worldwide every day.¹ At 30% to 50%, the mortality rate associated with sepsis is markedly high.¹ A prospective observational study of 12 Canadian community and teaching hospital critical care units found that mortality for patients with severe sepsis was just more than 38%.⁴

Additionally, the personal and economic costs associated with sepsis are high. With more than 18 million cases of severe sepsis worldwide each year, the disease is linked to increased hospital resource utilization and prolonged stays in intensive care units.^{1, 5}

There is hope for the future, however. Although sepsis is a challenging disease to treat, during the past few years clinical trials have demonstrated improved outcomes when there is timely recognition of the signs and symptoms of sepsis and consistent implementation of evidence-based bundles of care.⁶

This report aims to provide a national picture of sepsis hospitalizations and mortality. Cases from hospitals' experiences will illustrate how the hospital standardized mortality ratio (HSMR) provided an effective lens for further insight and led to purposeful efforts by them to reduce sepsis mortality rates in their centres.

International Initiatives to Reduce Mortality

Safer Healthcare Now!

www.saferhealthcarenow.ca/EN/Interventions/Pages/default.aspx

This is a national grassroots initiative aimed at reducing the number of injuries and deaths related to adverse events such as infections. It provides increased awareness of concentrated interventions to prevent conditions that might lead to severe sepsis, such as ventilator-associated pneumonia and central line-associated infection. Additionally, in efforts to improve survival, rapid response team interventions and the Surviving Sepsis Campaign are being used in unison.

The Surviving Sepsis Campaign

www.survivingsepsis.org/About_the_Campaign/Pages/default.aspx

This campaign was developed by the European Society of Critical Care Medicine, the International Sepsis Forum and the Society of Critical Care Medicine. It was designed to help meet the challenges of sepsis and to improve its management, diagnosis and treatment. A two-year trial involving 18 countries, 166 sites and 15,022 patient charts showed a drop in mortality related to the implementation of the campaign's sepsis guidelines.

The Institute for Healthcare Improvement's Reducing Sepsis Mortality Collaborative

www.ihl.org/IHI/Topics/CriticalCare/Sepsis/

This year-long collaborative was launched in fall 2009. It focuses on a group of evidence-based interventions related to reducing sepsis mortality. When executed together—as opposed to individually—these interventions result in better outcomes.

What the Numbers Tell Us

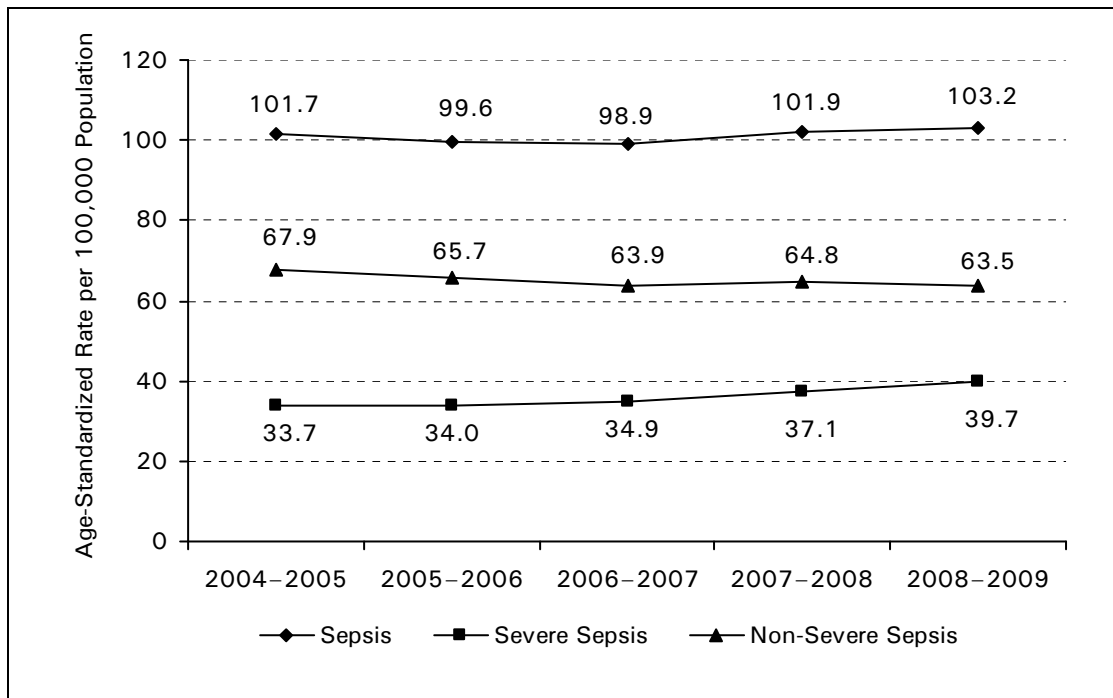
Sepsis Hospitalizations

Sepsis is a growing health care burden.^{1, 5, 8} In 2008–2009, 30,587 sepsis hospitalizationsⁱ were observed in Canada (outside Quebec), up from 26,803 hospitalizations in 2004–2005. In 4.0% of patients, sepsis occurred more than once in a year.

Severe sepsis (including septic shock) is associated with higher mortality and considerable health care resource use.^{5, 7, 8} In 2008–2009, severe sepsis was observed in 39.4%, or 12,063, of all sepsis hospitalizations.

While hospitalization rates for all sepsis remained similar from 2004–2005 to 2008–2009 ($P = 0.41$), hospitalization rates for severe sepsis increased by 17.8% ($P = 0.01$), after population growth and aging were taken into consideration (see Figure 1).

Figure 1 Sepsis Hospitalization Rates, Canada



Source

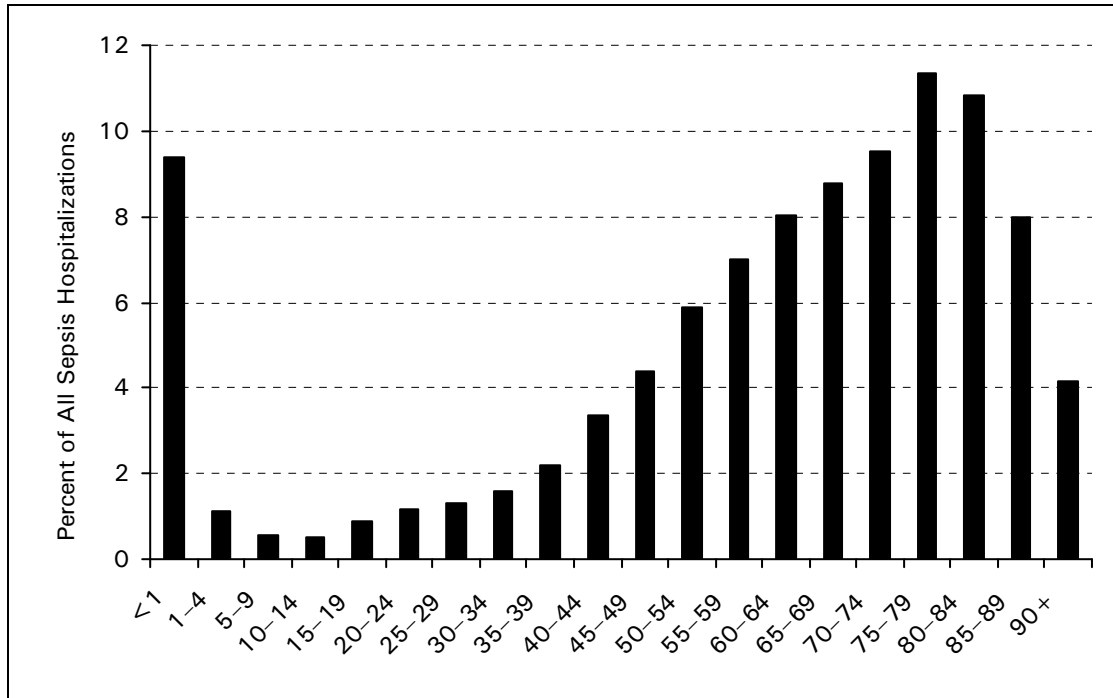
Discharge Abstract Database, Canadian Institute for Health Information.

i. Episode-based; see Technical Notes for more details.

Characteristics of Sepsis Patients

Older adults and young children accounted for the majority of sepsis cases. Patients who were 60 and older comprised 60.6% of all sepsis hospitalizations in 2008–2009 (Figure 2). The median age of sepsis patients was 66.

Figure 2 Sepsis Hospitalizations by Age Groups, 2008–2009



Source

Discharge Abstract Database, Canadian Institute for Health Information.

Among sepsis patients, there were more men than women: 54.6% of patients were men, while 45.4% were women.

Sepsis patients tended to have more pre-existing comorbiditiesⁱⁱ than patients hospitalized for other reasons. At least one pre-existing comorbidity was recorded in 44.5% of sepsis patients, compared to 23.1% of other patients. The most frequent comorbidities in sepsis patients were diabetes and cancers.

ii. Identified at the first admission with sepsis using the Charlson Index Score—a weighted, cumulative diagnosis-based score widely used in clinical research to predict in-hospital mortality (see Technical Notes for more details).

Table 1 Charlson Index Score,⁹ 2008–2009

Charlson Index Score	Among Sepsis Patients, Percent	Among All Other Hospitalizations, Percent
0	55.5	76.9
1 or 2	30.4	18.4
3 or More	14.1	4.7

Source

Discharge Abstract Database, Canadian Institute for Health Information.

The majority of patients who survived sepsis were discharged home (56.4%) in 2008–2009. About 21.1% of sepsis patients were discharged to home settings with external support and 15.8% went to continuing care facilities.

Organ Dysfunctions in Severe Sepsis Patients

Which organ systems failed and the number of systems that failed were shown to be associated with higher mortality in severe sepsis patients. Among patients with severe sepsis, the majority (62.6%) had one system affected by organ dysfunction in 2008–2009. The respiratory system was the most commonly affected one, followed by the renal and cardiovascular systems.

Acute Organ Failure in Severe Sepsis Patients, 2008–2009

Acute Organ Failure	Occurrence, Percent	Mortality, Percent (95% Confidence Interval)
Number of Systems Failing		
1 System	62.6	39.1 (38.0–40.2)
2 Systems	27.1	52.8 (51.1–54.5)
3 Systems or More	10.3	62.0 (59.3–64.7)
Organ Systems*		
Respiratory	54.5	48.3 (47.1–49.6)
Renal	51.6	49.9 (48.7–51.1)
Cardiovascular	19.8	45.8 (43.8–47.8)
Hepatic	4.9	70.0 (66.2–73.7)
Hematologic	9.4	51.4 (48.5–54.3)
Central Nervous System	9.9	44.7 (41.9–47.5)

Note

* Each system was counted independently.

Source

Discharge Abstract Database, Canadian Institute for Health Information.

Sepsis Mortality

In 2008–2009, 9,320 sepsis patients died in hospitals across Canada (outside Quebec), which represented 10.9% of all deaths occurring in hospitals. The crude mortality for all sepsis patients was 30.5% in 2008–2009 (45.2% for severe sepsis patients and 20.9% for patients whose sepsis did not progress to severe).

Some sepsis patients were more likely to die than others. We explored the extent to which different factors affected sepsis patients' odds of dying, after adjusting for the effect of the other factors (Table 2). The following was observed:

Age: Older sepsis patients had higher odds of dying in hospital than younger patients.

Sex: All other factors being equal, female sepsis patients had 8% higher odds of dying in hospital than male patients.

Pre-admission comorbidities: Sepsis patients with pre-existing comorbidities (identified using the Charlson Index Score) had higher odds of dying than patients without pre-existing comorbidities. The odds of dying were 38% higher in sepsis patients with a Charlson Index Score of 1 or 2 compared to patients with a Charlson Index Score of 0. This effect was more pronounced in patients with a Charlson Index Score of 3 or more, who had 2.3 times higher odds of dying than patients without pre-existing conditions.

Severity of sepsis: Patients with severe sepsis had about three times higher odds of dying than patients whose sepsis was not severe, after adjusting for the effect of other factors. Overall, 5,447, or 58.4%, sepsis patients who died had severe sepsis.

Sepsis occurring after admission to hospital (see Technical Notes for definition): Patients whose sepsis occurred after they were admitted to a hospital had 56% higher odds of dying than patients whose sepsis occurred before admission. Sepsis occurring after admission was observed in 23.6% of all sepsis patients and 32.4% of severe sepsis patients.

Table 2 Factors Affecting Sepsis Mortality in Hospital

	Odds Ratio	95% Confidence Interval
Age (each additional year)	1.034	1.033–1.034
Women compared to men	1.08	1.05–1.11
Charlson Index Score (compared to no Charlson Index comorbidities)		
1 or 2	1.38	1.34–1.42
3 or more	2.28	2.20–2.36
Severe sepsis compared to non-severe	3.01	2.93–3.09
Sepsis occurring after admission compared to sepsis occurring before admission	1.56	1.51–1.60

Note

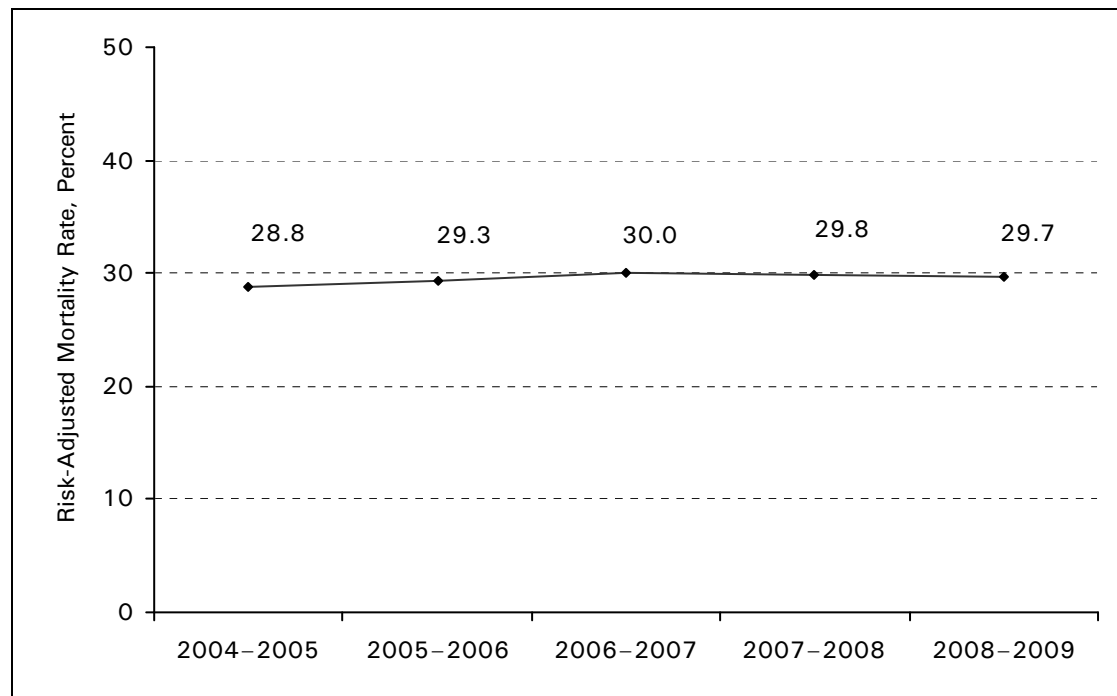
For patients admitted to acute hospitals outside of Quebec between April 2004 and March 2009.

Source

Discharge Abstract Database, Canadian Institute for Health Information.

There were no significant changes in risk-adjustedⁱⁱⁱ sepsis mortality rates over the five years (P = 0.11).

Figure 3 Risk-Adjusted In-Hospital Mortality Rate for All Sepsis Patients



Source

Discharge Abstract Database, Canadian Institute for Health Information.

iii. Rates were adjusted using a logistic regression model for age, gender, Charlson Index Score and sepsis occurring after admission as covariates.

Hospital Care

The median length of total hospital stay for patients with sepsis was 12 days in 2008–2009—approximately nine days longer than the median length of stay for hospitalizations due to other reasons (Table 3). Furthermore, patients with severe sepsis stayed in hospital about 11 days longer than patients whose sepsis was not severe.

Table 3 Median and Mean Total Length of Stay, 2008–2009

	Median (Mean) Length of Hospital Stay, Days
All Hospitalizations (Excluding Sepsis)	3 (6.80)
All Sepsis	12 (25.9)
Severe Sepsis	20 (37.6)
Non-Severe Sepsis	9 (18.3)

Source

Discharge Abstract Database, Canadian Institute for Health Information.

In 2008–2009, about 45.1% of all sepsis patients and about 57.3% of sepsis patients who died stayed in intensive care units (ICUs). The median length of an ICU stay for sepsis patients in 2008–2009 was 6.3 days—about 4 days longer than the ICU stay of patients admitted due to other reasons (Table 4). Patients with severe sepsis were 2.6 times more likely to be admitted to the ICU and stayed there about 6 days longer than patients whose sepsis was not severe.

Table 4 ICU Care, 2008–2009

	Percent Staying in the ICU	Median (Mean) ICU Length of Stay, Days
All Hospitalizations (Excluding Sepsis)	8.5	2.3 (4.7)
All Sepsis	45.1	6.3 (14.2)
Severe Sepsis	72.4	9.5 (18.2)
Non-Severe Sepsis	27.4	3.5 (7.5)

Source

Discharge Abstract Database, Canadian Institute for Health Information.

What Are Canadian Hospitals Doing to Reduce Sepsis Mortality?

A big-dot summary measure such as the HSMR can serve as a catalyst to take a deeper look at common causes of death, such as sepsis, and ways to improve quality of care. In the following section, three separate medical centres—Southlake Regional Health Centre in Newmarket, Ontario; St. Joseph’s Healthcare in Hamilton, Ontario; and Foothills Medical Centre in Calgary, Alberta—share their experiences with recognizing and treating sepsis, as well as how they are using *Safer Healthcare Now!* interventions as part of this. The HSMR can provide an effective lens for further insight; we can learn from these experiences with the specific and purposeful aim of reducing sepsis mortality rates.

CIHI’s Hospital Standardized Mortality Ratio: A Lens for Further Insight

Case 1: A Winning Sepsis Philosophy— Southlake Regional Health Centre, Newmarket, Ontario

It was CIHI’s HSMR that prompted the Southlake Regional Health Centre to look more closely at sepsis. Barbara Kendrick, Southlake’s director of quality and planning, says while their HSMR was less than 100, staff at the facility looked more closely into the numbers to determine if improvements could be made. Although the hospital’s mortality rates for sepsis were lower than the national average, staff questioned whether deaths due to other diagnoses might also be attributable to sepsis.

A review of all sepsis cases confirmed that protocols for early identification and treatment were not consistent across the hospital. “We were aware that there might be a delay in identifying sepsis on the wards, as well as in the emergency room, so we had some opportunities for improvement,” notes Kendrick. “The key was to shorten the time to treatment.”

What changes have taken place? A task force was created to adopt known best practices and draft standardized orders for early recognition and treatment. Nurses are trained to recognize sepsis early—to spot those patients at risk for sepsis. Ward nurses can also call in the rapid response team, which is composed of a critical care nurse and a respiratory therapist to assist in their assessment. Because of these changes, developing sepsis cases on the wards and in the ER are being picked up more quickly, and appropriate treatment is initiated as early as possible.

Kendrick says this has been a key patient safety initiative at Southlake, where the sepsis philosophy is now to treat as early as possible. She sums up, “We’ve seen a steady downward trend in our HSMR, but I think we’ve yet to see the full outcome of the work that we’ve done over the past year with sepsis.”

Case 2: Critical Care Response Team Successful at Fighting Sepsis— St. Joseph’s Healthcare, Hamilton, Ontario

Dr. Roman Jaeschke compares today’s critical care response team at St. Joseph’s Healthcare in Hamilton to a firefighting squadron: it’s composed of people who can instantly respond in times of crisis with the required skills. The team includes a critical care physician, a critical care nurse and a respiratory therapist. This team can deliver life-saving care to patients in any bed in the hospital; this type of care was previously limited to the ICU.

“Before, if the condition of a patient in a regular hospital bed suddenly deteriorated, time-sensitive critical care services could have been delayed while mobilizing the chain of command or securing a bed in the ICU,” explains Jaeschke, the team’s medical lead. “Obviously, that was an unsatisfactory situation.”

Concurrent to this innovation, St. Joseph’s began studying its numbers in CIHI’s HSMR. “We found sepsis was one of the most common causes of death in our hospital,” reports Dr. David Higgins, the chief of staff. “It wasn’t the only reason for bringing the team in, but it was part of the catalyst. We knew this was going to be a significant part of the puzzle.” And today, half of the team’s cases are sepsis patients.

In solving this puzzle, this team has been successful. Since its creation in 2007, Jaeschke says they have fewer “code blue” calls and fewer sepsis patients going to the ICU. And those that do go into the ICU aren’t there as long as they previously were. Acutely aware of sepsis’s 30% to 40% mortality rate, Jaeschke says the team’s goal is to intervene early and prevent patients from deteriorating rapidly or going into cardiac arrest.

Next steps? Higgins says the team plans to enhance its ability to identify and treat sepsis patients presenting to the emergency room.

Case 3: Emergency Room Sepsis Guidelines Lead the Way— Foothills Medical Centre, Calgary, Alberta

For years, Dr. Marc Francis suspected that sepsis patients were an under-recognized population. There were many cases, but they often weren’t identified early enough or treated aggressively enough. “With stroke, time is brain, with heart attacks, time is muscle and likewise with sepsis, delays in time increase mortality,” underscores Francis, who works in emergency medicine at Calgary’s Foothills Medical Centre. “Recognizing and treating sepsis is a time-critical process and we never really viewed it that way.”

The guidelines in the 2004 Surviving Sepsis Campaign prompted hospitals to develop an emergency room (ER) protocol to identify sepsis patients early and manage these patients effectively. “[Sepsis patients] can present in a subtle form yet have high mortality if you miss them,” Francis explains. “For every hour delay of sepsis shock before you get antibiotics on board, survival has been shown to decrease by 7.5%.”

Adopting the pre-emptive guidelines at the Foothills Medical Centre has meant success. Sepsis patients are now being identified and treated in the ER and they're being kept out of intensive care. "If we didn't treat them aggressively in the ER," Francis explains, "by the time patients got to the ICU, they were already very sick. Now, we're a key component of those critical first six hours."

As a result of these measures, there has been a mean reduction of 84 minutes in the time it takes to start antibiotics in severe sepsis. The analysis also found more patients are receiving the proper antibiotics and an increased number are getting them within an hour. These findings will be published in the *Canadian Journal of Emergency Medicine*.

"Whether that translates into a decrease in mortality remains to be seen," Francis clarifies. But clearly, this medical centre is on the right track.

Conclusions: How Does This Information Help?

Sepsis is an important contributor to in-hospital mortality and morbidity in Canada.

Heightening the general awareness and understanding of national sepsis hospitalization and mortality rates is a key starting point. Sepsis care is clearly an important area for quality improvement efforts.

Lowering the numbers of those succumbing to this medical condition can be a challenge, as sepsis is difficult to diagnose and treat. With early recognition of the signs and symptoms of severe sepsis and more consistent implementation of care guidelines, the high mortality associated with sepsis can be reduced and lives saved.

Through sharing strategies and lessons learned from experiences aimed at reducing sepsis mortality rates, health care professionals can discover continued opportunities for improvement when caring for patients with this highly complex and sometimes deadly syndrome.

Technical Notes

The **unit of analysis** was an episode of care. An episode of care refers to all contiguous inpatient acute care hospitalizations. To construct an episode of care a transfer was assumed to have occurred if the following conditions were met:

- Admission to an acute care institution occurred on the same day as or prior to discharge from preceding acute care institution; and
- For episodes with transfers between facilities, transactions were linked regardless of the most responsible diagnosis following the index admission.

From all of the analyses, patients whose gender was not recorded as "male" or "female," who were not admitted to acute care hospitals or were not Canadian residents were **excluded**. Because health card number, birthdate and admission and discharge dates were used to construct episodes of care, patients with missing or invalid health card numbers, dates of birth and admission or discharge dates were also excluded.

Definitions

Sepsis was identified using the following ICD-10-CA codes: A03.9, A02.1, A20.7, A21.7, A22.7, A23.9, A24.1, A26.7, A28.0, A28.2, A32.7, A39.2, A39.3, A39.4, A40.–, A41.–, A42.7, B00.7, B37.7, P36.–, P35.2, P37.2 and P37.5 coded as type (M), (1), (2), (3),^{iv} (W), (X) or (Y) (for a description of the codes, refer to International Statistical Classification of Diseases and Related Problems, available at http://secure.cihi.ca/cihiweb/en/downloads/ICD-10-CA_Vol1_2006.pdf).

Sepsis was considered **severe** if organ dysfunction in at least one of the six systems, typically used to evaluate organ dysfunctions in sepsis patients in studies that use administrative data,^{5, 7, 8} was recorded during an episode of care. The following ICD-10-CA [coded as types (M), (1), (2), (W), (X) and (Y)] and CCI codes were used:

System	ICD-10-CA Codes	CCI Codes
Respiratory	J96.0, J96.9, J80, R09.2	1.GZ.31.CA-ND, 1.GZ.31.CR-ND, 1.GZ.31.GP-ND with extent attribute = "EX"
Cardiovascular	R57.–, I95.1, I95.8, I95.9	
Renal	N17.–	
Hepatic	K72.0, K72.9, K76.3	
Neurologic	F05.0, F05.9, G93.1, G93.4, G93.80	
Hematologic	D69.5, D69.6, D65	

Severe sepsis also included septic shock. Since information on diagnosis timing was not available, the sequence of sepsis and organ dysfunctions diagnoses could not be determined. The number of comorbidities was determined using the **Charlson Index Score**,⁹ a weighted, cumulative score calculated using diagnosis codes found on the patient's discharge abstract. Based on Quan's methodology, the comorbid conditions below, coded as type (M), (1), (W), (X) and (Y) [and not type (2) on the same abstract] were used to calculate the Charlson Index Score for the index sepsis admission.

iv. Type 3 codes (excluding cases where sepsis was one of the P.– codes) were only used for the analyses if the following diagnoses were present on the same abstract as type (M), (1), (2), (W), (X) or (Y): T80.2, T81.4, T88.0, T82.6, T82.7, T83.5, T83.6, T84.5, T84.6, T84.7, T85.7, O03.0, O03.5, O04.0, O04.5, O05.0, O05.5, O07.3, O08.0, O75.3, O85.–, O98.2, O98.5 and O98.8; and type (9): Y60.– to Y89.–.

Comorbid Condition	ICD-10 Codes	Weight
Myocardial Infarction	I21.-, I22.-, I25.2	1
Congestive Heart Failure	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5, I42.6, I42.7, I42.8, I42.9, I43.-, I50.-, P29.0	1
Peripheral Vascular Disease	I70.-, I71.-, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9	1
Cerebrovascular Disease	G45.-, G46.-, H34.0, I60.-, I61.-, I62.-, I63.-, I64.-, I65.-, I66.-, I67.-, I68.-, I69.-	1
Dementia	F00.-, F01.-, F02.-, F03, F05.1, G30.-, G31.1	1
Chronic Pulmonary Disease	I27.8, I27.9, J40, J41.-, J42, J43.-, J44.-, J45.-, J46.-, J47, J60.-, J61.-, J62.-, J63.-, J64, J65, J66.-, J67.-, J68.4, J70.1, J70.3	1
Connective Tissue Disease/ Rheumatic Disease	M05.-, M06.-, M31.5, M32.-, M33.-, M34.-, M35.1, M35.3, M36.0	1
Peptic Ulcer Disease	K25.-, K26.-, K27.-, K28.-	1
Mild Liver Disease	B18.-, K70.0, K70.1, K70.2, K70.3, K70.9, K71.3, K71.4, K71.5, K71.7, K73.-, K74.-, K76.0, K76.2, K76.3, K76.4, K76.8, K76.9, Z94.4	1
Diabetes Without Complications	E10.0-, E10.1-, E10.6-, E10.9, E11.0-, E11.1-, E11.6-, E11.9, E13.0-, E13.1-, E13.6-, E13.9, E14.0-, E14.1-, E14.6-, E14.9	1
Diabetes With Complications	E10.2-, E10.3-, E10.4-, E10.5-, E10.7-, E11.2-, E11.3-, E11.4-, E11.5-, E11.7-, E13.2-, E13.3-, E13.4-, E13.5-, E13.7-, E14.2-, E14.3-, E14.4-, E14.5-, E14.7-	2
Paraplegia and Hemiplegia	G04.1, G11.4, G80.1, G80.2, G81.-, G82.-, G83.0, G83.1, G83.2-, G83.3, G83.4, G83.9	2
Renal Disease	I13.1, N03.2, N03.3, N03.4, N03.5, N03.6, N03.7, N05.2, N05.3, N05.4, N05.5, N05.6, N05.7, N18.-, N19, N25.0, Z49.0, Z49.1, Z49.2, Z94.0, Z99.2	2
Cancer	C00.-, C01.-, C02.-, C03.-, C04.-, C05.-, C06.-, C07, C08.-, C09.-, C10.-, C11.-, C12, C13.-, C14.-, C15.-, C16.-, C17.-, C18.-, C19, C20, C21.-, C22.-, C23, C24.-, C25.-, C26.-, C30.-, C31.-, C32.-, C33, C34.-, C37, C38.-, C39.-, C40.-, C41.-, C43.-, C45.-, C46.-, C47.-, C48.-, C49.-, C50.-, C51.-, C52, C53.-, C54.-, C55, C56.-, C57.-, C58, C60.-, C61, C62.-, C63.-, C64. C65, C66, C67.-, C68.-, C69.-, C70.-, C71.-, C72.-, C73, C74.-, C75.-, C76.-, C81.-, C82.-, C83.-, C84.-, C85.-, C88.-, C90.-, C91.-, C92.-, C93.-, C94.-, C95.-, C96.-, C97	2
Moderate or Severe Liver Disease	I85.0, I85.9, I86.4, I98.2-, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7	3
Metastatic Carcinoma	C77.-, C78.-, C79.-, C80	6
AIDS	B24	6

Sepsis was considered to **occur after admission to hospital** if

- Sepsis was coded as type (2) or (3)^v on its first occurrence during hospitalization; or
- Sepsis was coded as type (M), (1), (W), (X) or (Y) on its first occurrence, but the patient was transferred from another acute care hospital where she or he stayed for 48 hours or more.

Sepsis was considered to **occur before admission to hospital** if it was coded as type (M), (1), (W), (X) or (Y) on its first occurrence or, in cases that were transferred from another acute care hospital, the length of stay in the previous hospital was less than 48 hours.

Patients were considered **admitted to an ICU** if an ICU stay was recorded any time during the episode of care. Due to the limitations of the data, it was not possible to differentiate if the admission to ICU happened before or after a patient was diagnosed with sepsis.

Risk-Adjusted Mortality Rate

To calculate the all-cause in-hospital **risk-adjusted mortality rate (RAMR)**, a logistic regression model was fitted with age, gender, Charlson Index Score and sepsis occurring after admission as independent variables. Data from 2004–2005 to 2008–2009 was included in a logistic regression model to derive baseline coefficients. These coefficients were used to calculate the probability of in-hospital death for each sepsis episode. The expected number of in-hospital deaths was equal to the sum of the case probabilities. The RAMR was calculated by dividing the observed number of in-hospital deaths by the expected number of in-hospital deaths for that particular year and multiplying by the Canadian average in-hospital death rate for the five years.

Data Sources

CIHI's Discharge Abstract Database (DAD) was used to conduct data analyses. Hospitalizations with a discharge date between April 1, 2004, and March 31, 2009, were selected for the analyses. Due to the differences in data collection, Quebec data was not included in the publication.

v. Type 3 codes (excluding cases where sepsis was one of the P.- codes) were only used for the analyses if the following diagnoses were present on the same abstract as type (M), (1), (2), (W), (X) or (Y): T80.2, T81.4, T88.0, T82.6, T82.7, T83.5, T83.6, T84.5, T84.6, T84.7, T85.7, O03.0, O03.5, O04.0, O04.5, O05.0, O05.5, O07.3, O08.0, O75.3, O85.-, O98.2, O98.5 and O98.8; and type (9): Y60.- to Y89.-.

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About CIHI

The Canadian Institute for Health Information (CIHI) collects and analyzes information on health and health care in Canada and makes it publicly available. Canada's federal, provincial and territorial governments created CIHI as a not-for-profit, independent organization dedicated to forging a common approach to Canadian health information. CIHI's goal: to provide timely, accurate and comparable information. CIHI's data and reports inform health policies, support the effective delivery of health services and raise awareness among Canadians of the factors that contribute to good health.

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