

# National Analysis of Sepsis Hospitalizations and Factors Contributing to Sepsis In-Hospital Mortality in Canada

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## Abstract

**Sepsis is one of the leading causes of in-hospital mortality in Canada. Patient safety is an important component of sepsis prevention and control. The Canadian Institute for Health Information recently released a report that examines a national picture of sepsis hospitalizations and mortality. This article highlights and expands some of the key findings from this report. Specifically, we look here more closely at patients admitted through the emergency departments (ED) in order to determine if earlier recognition of sepsis in the ED would lead to improved patient outcomes.**

Sepsis is a leading cause of mortality; at 30–50%, the mortality rate associated with sepsis is markedly high (Surviving Sepsis Campaign 2008). A prospective observational study of 12 Canadian community and teaching hospital critical care units found that mortality for patients with severe sepsis was slightly over 38% (Martin et al. 2009). 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 use and prolonged stays in intensive care units (ICUs) (Angus et al. 2001; Surviving Sepsis Campaign 2008).

Sepsis is a complex syndrome that is difficult to define. It is also difficult to diagnose because there is no “typical presen-

tation”; the signs and symptoms are highly variable. In the medical community, definitions of sepsis have been developed and subsequently rethought due to both advances in the understanding of the condition and the introduction of potential new therapies (Levy et al. 2003; Members of the American College of Chest Physicians et al. 1992).

So, what is sepsis? It is the clinical syndrome defined by the presence of both whole-body infection and a systemic inflammatory response (Levy et al. 2003). When sepsis is complicated by organ dysfunction in at least one body system, it is referred to as severe sepsis. Septic shock occurs when severe sepsis is made worse by a state of acute circulatory failure. It is characterized by persistent arterial hypotension that is unexplained by other causes, and occurs despite adequate volume resuscitation.

A 2009 report by the Canadian Institute for Health Information (CIHI) provides a national picture of sepsis hospitalizations and mortality. This is the first time that the number of sepsis hospitalizations, mortality rate and characteristics of patients with sepsis have been captured for acute care hospitals at the national level. After the report was published, the scope of the sepsis study was expanded to look more closely at patients admitted through the emergency departments (EDs). Patients with sepsis were tracked prior to their admission to hospital in order to determine if earlier recognition of sepsis in the ED would have led to improved patient outcomes.

## Methods

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. Due to the differences in data collection, Quebec data were not included.

The unit of analysis was one hospitalization – that is, one episode of care. To account for transfers from one acute hospital to another, individual abstracts were combined to build episodes of care or hospitalizations. A transfer was assumed to have occurred if admission to an acute care institution occurred on the same day or prior to discharge from the preceding acute care institution.

Data on ED visits were extracted from the National Ambulatory Care Reporting System (NACRS) for the period from April 1, 2008, to March 31, 2009. This study was focused on Ontario emergency data from NACRS.

Patients with sepsis or severe sepsis were identified using specific codes from the International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada (ICD-10-CA), and the Canadian Classification of Health Interventions (CCI) (see Appendix 1). The number of pre-existing co-morbidities (having impact on patients' treatment and length of stay) was determined using the Charlson Index Score (Quan et al. 2005). The co-morbid conditions coded as type M, 1, W, X and Y (not type 2 on the same abstract) were used to calculate the Charlson Index Score for the first sepsis admission. Patients were considered admitted to an ICU if an ICU stay was recorded in the DAD at any time during the episode of care. Patients were considered directly admitted to an ICU from the ED if the discharge disposition on

their NACRS record was recorded as 5. Specific criteria based on diagnosis typing were used to determine if sepsis occurred before or after admission to hospital (Canadian Institute for Health Information 2009: 14).

## Results

### Sepsis Hospitalizations and Characteristics of Patients

In 2008–2009, a total of 30,587 sepsis hospitalizations 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 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 ( $p = .41$ ), hospitalization rates for severe sepsis increased by 17.8% ( $p = .01$ ), after population growth and aging were taken into consideration (Figure 1).

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. The median age of patients with sepsis was 66. Among patients with sepsis, there were more men than women: 54.6% of patients were men.

Patients with sepsis tended to have more pre-existing co-morbidities than did patients hospitalized for other reasons (Table 1). At least one pre-existing co-morbidity was recorded in 44.5% of patients with sepsis, as opposed to 23.1% of other patients. The most frequent co-morbidities in patients with sepsis were diabetes and cancer.

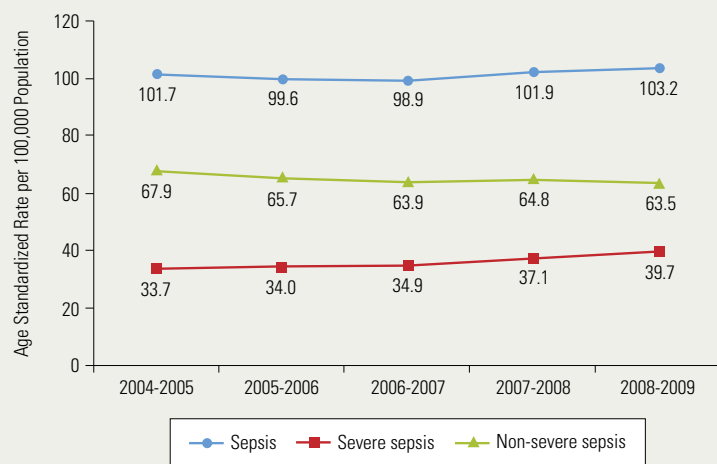
The majority (79%) of patients with sepsis were admitted via the EDs, while 12.4% were admitted directly, 6.6% were newborns and 2% came either from clinics or day-surgery centres of the reporting facilities. Most of patients who survived sepsis were discharged home (56.4%). About 21.1% of patients with sepsis were discharged to home settings with external support, and 15.8% went to continuing care facilities.

Among patients with severe sepsis, the majority (62.6%) had one system affected by organ dysfunction (Table 2). The respiratory system was the most commonly affected, followed by the renal and cardiovascular systems.

### Sepsis Mortality

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

**Figure 1. Sepsis hospitalization rates, Canada**



Source: Discharge Abstract Database, Canadian Institute for Health Information.

**Table 1. Charlson Index Score, 2008–2009**

Charlson Index Score	Among Patients with Sepsis (%)	Among All Other Hospitalizations (%)
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.

**Table 2. Acute organ failure in patients with severe sepsis, 2008–2009**

Number of Systems Failing	Percent Occurrence	Percent Mortality (95% CI)
1	62.6	39.1 (38.0–40.2)
2	27.1	52.8 (51.1–54.5)
3 or more	10.3	62.0 (59.3–64.7)
Organ System*	Percent Occurrence	Percent Mortality (95% CI)
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)
Hematological	9.4	51.4 (48.5–54.3)
Central nervous	9.9	44.7 (41.9–47.5)

CI = confidence interval.

\*Each system was counted independently.

Source: Discharge Abstract Database, Canadian Institute for Health Information.

Some patients with sepsis were more likely to die than others. Older age, female gender, the presence of pre-admission co-morbidities, severe sepsis and sepsis that occurred after admission to hospital were associated with significantly higher odds of dying in patients with sepsis (Table 3).

There were no significant changes in risk-adjusted sepsis mortality rates over the five years ( $p = .11$ ; Figure 2). 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 total length of hospital stay for patients with sepsis was 12 days in 2008–2009 – approximately nine days longer than the median length of stay due to other reasons (Table 4). Furthermore, patients with severe sepsis stayed in hospital about 11 days longer than patients whose sepsis was not severe.

About 45.1% of all patients with sepsis and about 57.3% of patients with sepsis who died had stayed in ICUs (Table 5). The median length of an ICU stay for patients with sepsis in 2008–2009 was 6.3 days – about four days longer than the ICU stay of patients admitted for other reasons. Patients with severe sepsis were 2.6 times more likely to be admitted to the ICU and stayed there about six days longer than patients whose sepsis was not severe.

## Early Recognition of Sepsis and Its Effect on Patient Outcomes: An Analysis of Ontario ED Data

Early recognition and consistent implementation of evidence-based bundles of care have been shown to improve outcomes for patients with sepsis (Levy et al. 2010). In this analysis of Ontario 2008–2009 NACRS data, the existing study cohort was tracked prior to in-hospital sepsis admission. Data on ED visits that occurred on the same day as in-hospital sepsis admission was used to determine if sepsis was recognized in the EDs and how it affected patient outcomes.

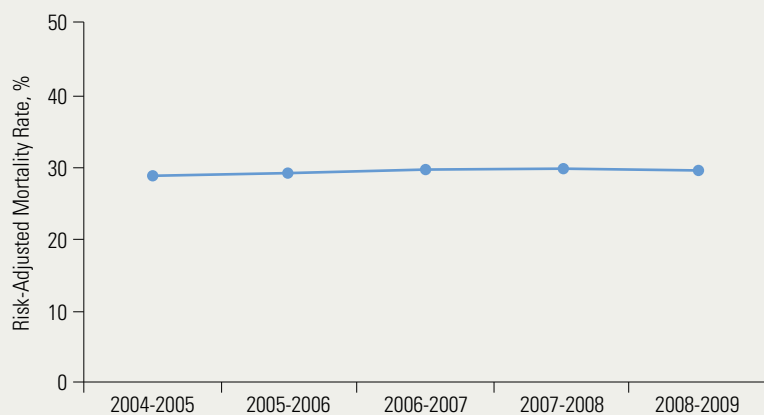
A total of 16,152 patients (52.8% of the existing sepsis cohort) were treated in Ontario acute care hospitals. Of these, 12,508 (77.4%) had an ED visit that took place on the same day prior to in-hospital admission. For the majority of patients (10,173 [81.3%]), sepsis was identified as occurring before admission to the hospital. These patients comprised a

cohort for further analyses as they may have already presented signs and symptoms of sepsis in the ED.

The majority of hospitalized patients with sepsis did not receive a sepsis diagnosis in the ED. Out of the cohort of 10,173 patients identified as having sepsis prior to admission, only 2,688 (26.4%) had sepsis identified and recorded on their ED chart during their ED visit. For patients where sepsis was not identified on the ED chart, various conditions were listed as main problems (Table 6).

Patients for whom sepsis was identified in the ED experi-

**Figure 2. Risk-adjusted in-hospital mortality rate for all patients with sepsis**



Source: Discharge Abstract Database, Canadian Institute for Health Information.

**Table 3. Factors affecting sepsis mortality in hospital\***

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

CI = confidence interval.

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

Source: Discharge Abstract Database, Canadian Institute for Health Information.

patients for whom sepsis was not identified in the ED (odds ratio [OR] = 0.88, 95% confidence interval [CI] 0.80–0.97).

There are several potential reasons for this finding. First, patients for whom sepsis was diagnosed in the ED were perhaps more promptly admitted – either to the hospital wards or to the ICU – because appropriate triage and disposition are key components of the sepsis treatment protocol (Nguyen et al. 2006). For example, an average length of stay in the ED for patients for whom sepsis was diagnosed in the ED was 5.6 hours, compared with 6.4 hours for patients for whom sepsis was not diagnosed. Furthermore, for patients admitted to an ICU directly who had sepsis on the ED chart, the ED length of stay was also shorter (5.0 hours compared with 5.4 hours for patients without sepsis on the ED chart).

Second, more patients for whom sepsis was diagnosed in the ED were admitted to the ICU directly: 29.2% versus 17.3% of patients for whom sepsis was not diagnosed (OR 2.02, 95% CI 1.82–2.24, after adjusting for age, sex and Charlson Index Score). Among patients admitted directly to an ICU, those for whom sepsis was recognized in the ED also experienced lower mortality (crude rates 33.8% versus 43.5%; OR 0.66, 95% CI 0.54–0.80).

Third, although administrative data do not capture the time between assessment and treatment, it is likely that if sepsis were recognized in the ED, then the appropriate management and treatment would start earlier (Nguyen et al. 2006). Implementation of the 2004 Surviving Sepsis Campaign guidelines have led hospitals to develop standardized ED protocols to prevent ICU admissions, if possible, and to improve outcomes of patients with sepsis in the ICU (Canadian Institute for Health Information 2009). Thus, subject to the accuracy of sepsis documentation in the ED, this study confirms that timely recognition and appropriate management of sepsis in the ED lead to improved patient outcomes.

enced lower crude mortality than did patients for whom sepsis was not identified (29.1% versus 32.8%, respectively). A logistic regression model was applied to estimate whether the presence of sepsis in the ED chart was a significant predictor of a lower mortality rate, after adjusting for the effects of sex, age and the Charlson Index score. After adjustment, patients for whom sepsis was identified in the ED had lower odds of dying compared with

**Limitations**

This study is subject to the limitations of the administrative database. First, the use of ICD-10-CA codes to identify sepsis cases is subject to the accuracy of documentation and coding. However, the codes selected to identify sepsis and severe sepsis in our study were used previously in the other sepsis studies that included administrative data (Angus et al. 2001; Dombrowskiy

**Table 4. Median and mean total LOSs, 2008–2009**

	Median LOS, Days (Mean)
All hospitalizations (excluding sepsis)	3 (6.80)
All sepsis	12 (25.9)
Severe sepsis	20 (37.6)
Non-severe sepsis	9 (18.3)

LOS = length of stay.  
Source: Discharge Abstract Database, Canadian Institute for Health Information.

**Table 5. ICU care, 2008–2009**

	Percent Staying in the ICU	Median ICU LOS, Days (Mean)
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)

ICU = intensive care unit; LOS = length of stay.  
Source: Discharge Abstract Database, Canadian Institute for Health Information.

et al. 2007; Martin et al. 2003). Martin et al. (2003) found, in the validation study, that using the codes from administrative databases to define sepsis resulted in acceptable predictive values. In addition, the distribution of the codes in our study did not substantially change over the study period (see Appendix 1, Table A1). Second, the DAD lacks data regarding the time of onset of specific conditions. Therefore, we could not determine whether the organ dysfunctions used to define severe sepsis occurred before or after an episode of sepsis. Despite these limitations, this study has the important advantage of being able to capture sepsis hospitalizations at the national level using a consistent approach.

**Conclusion**

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

**Table 6. Top 10 conditions recorded as main problems**

Main Problem	Number (%*)
Other disorders of urinary system	782 (10.4)
Pneumonia, organism unspecified	780 (10.4)
Fever of other and unknown origin	510 (6.8)
Abdominal and pelvic pain	230 (3.1)
Cellulitis	171 (2.3)
Other symptoms and signs involving cognitive functions and awareness	152 (2.0)
Heart failure	145 (1.9)
Malaise and fatigue	142 (1.9)
Other non-infective gastroenteritis and colitis	137 (1.8)
Acute renal failure	135 (1.8)
All other diagnoses	4,301 (57.5)

\*Percentage of total number of patients in sepsis cohort without sepsis on emergency department chart.  
Source: National Ambulatory Care Reporting System, Canadian Institute for Health Information.

condition can be a challenge as sepsis is difficult to diagnose and treat. But with early recognition of the signs and symptoms of sepsis, together with a more consistent implementation of care guidelines, the high mortality associated with sepsis can be reduced and lives can be saved. **HQ**

**Appendix 1: Algorithms Used To Identify Patients with Sepsis and Severe Sepsis in the DAD**

Patients with *sepsis* were identified in the DAD by using the ICD-10-CA codes presented in Table A1. The codes were selected based on the previous studies (Martin et al. 2003; Dombrovskiy et al. 2007), with input from classification specialists. The equivalent International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes were previously validated by Martin et al. (2003). The distribution of the codes was stable over the study period (see Table A1). Diagnosis types M, 1, 2, W, X or Y were used. Diagnosis type 3 (excluding cases where sepsis was one of the P.– codes) was only used if the following diagnoses were present on the same abstract as types M, 1, 2, W, X or Y: T80.2, T81.4, T88.0,

**Table A1. ICD-10-CA codes used to identify patients with sepsis in the Discharge Abstract Database**

ICD-10-CA Codes*	Description	Percentage of Codes among Sepsis Cases				
		2004–2005	2005–2006	2006–2007	2007–2008	2008–2009
A03.9	Shigellosis, unspecified	0.05	0.07	0.04	0.07	0.08
A02.1	<i>Salmonella</i> septicaemia	0.23	0.31	0.27	0.23	0.28
A28.0	Pasteurellosis	0.06	0.08	0.07	0.04	0.05
A32.7	Listerial septicaemia	0.09	0.10	0.11	0.07	0.22
A39.2	Acute meningococcaemia	0.08	0.10	0.04	0.07	0.08
A39.4	Meningococcaemia, unspecified	0.12	0.08	0.08	0.06	0.06
A40	Streptococcal septicaemia	7.62	8.18	8.33	8.37	8.39
A41.0	Septicaemia due to <i>Staphylococcus aureus</i>	9.07	9.08	8.95	9.13	9.05
A41.1	Septicaemia due to other specified staphylococcus	5.41	5.28	4.64	4.54	4.31
A41.2	Septicaemia due to unspecified staphylococcus	0.97	0.87	0.79	0.83	0.72
A41.3	Septicaemia due to <i>Haemophilus influenzae</i>	0.31	0.36	0.32	0.31	0.30
A41.4	Septicaemia due to anaerobes	0.55	0.47	0.44	0.50	0.49
A41.50	Septicaemia due to <i>Escherichia coli</i>	9.99	10.56	10.16	10.52	10.84
A41.51	Septicaemia due to <i>Pseudomonas</i>	1.68	1.89	1.92	1.66	1.85
A41.52	Septicaemia due to <i>Serratia</i>	0.34	0.41	0.30	0.26	0.28
A41.58	Septicaemia due to other gram-negative organisms	3.87	3.99	3.94	3.88	3.82
A41.80	Septicaemia due to <i>Enterococcus</i>	2.70	2.65	2.50	2.53	2.78
A41.88	Other specified septicaemia	4.56	4.64	4.48	4.26	4.26
A41.9	Septicaemia, unspecified	40.64	40.26	42.17	42.93	43.36
B00.7	Disseminated herpesviral disease	0.05	0.04	0.04	0.07	0.03
B37.7	Candidal septicaemia	1.18	1.15	1.12	1.06	1.11
P36	Bacterial sepsis of newborn	9.63	8.68	8.45	7.97	6.92
P35.2	Congenital herpesviral [herpes simplex] infection	0.08	0.08	0.09	0.07	0.12
P37.5	Neonatal candidiasis	0.7	0.6	0.66	0.52	0.55

ICD-10-CA = International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada.

\*Other ICD-10-CA codes that were included (A21.7, A22.7, A23.9, A24.1, A26.7, A28.2, A39.3, A42.7, P37.2) had less than five cases in a year and are therefore not presented. These cases comprised <0.1% of all sepsis cases.

Source: Discharge Abstract Database, Canadian Institute for Health Information.

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.–. In the analysis of NACRS data, patients were considered to have sepsis if the diagnosis codes in the Table A1 were coded as “main” or “other problems.”

Severe sepsis (including septic shock) was defined as sepsis complicated by organ dysfunction in at least one of the six organ systems (Table A2). The codes were selected based on the previous studies (Angus et al. 2001; Dombrovskiy et al. 2007; Martin et al. 2003) and input from classification specialists. The ICD-10-CA codes, typed as M, 1, 2, W, X and Y, and CCI (with extent attribute = “EX”) codes presented in Table A2 were used.

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**Table A2. ICD-10-CA and CCI codes used to identify patients with severe sepsis in the Discharge Abstract Database**

System	ICD-10-CA and CCI Codes	Description
Respiratory	J96.0 J96.9 J80 R09.2 1.GZ.31.CA-ND, 1.GZ.31.CR-ND, 1.GZ.31.GP-ND	Acute respiratory failure Respiratory failure, unspecified Adult respiratory distress syndrome Respiratory arrest Mechanical ventilation
Cardiovascular	R57 I95.1 I95.8 I95.9	Shock Orthostatic hypotension Other hypotension Hypotension, unspecified
Renal	N17	Acute renal failure
Hepatic	K72.0 K72.9 K76.3	Acute and subacute hepatic failure Hepatic failure, unspecified Infarction of liver
Neurological	F05.0 F05.9 G93.1 G93.4 G93.80	Delirium not superimposed on dementia Delirium, unspecified Anoxic brain damage Encephalopathy, unspecified Metabolic encephalopathy
Hematological	D69.5 D69.6 D65	Secondary thrombocytopenia Thrombocytopenia, unspecified Disseminated intravascular coagulation

CCI = Canadian Classification of Health Interventions; ICD-10-CA = International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Canada.

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