Weekend Admissions and In-Hospital Mortality

Report

June 2014

Health System Performance

CIHI ICIS
Canadian Institute for Health Information
Institut canadien d'information sur la santé

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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.

Our Values

Respect, Integrity, Collaboration, Excellence, Innovation

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Acknowledgements

The Canadian Institute for Health Information (CIHI) would like to acknowledge and thank the many individuals and teams that contributed to the development of this report.

We would like to express our gratitude to everyone involved for their insight, experience and enthusiasm, which contributed significantly to the success of this study.

We would like to acknowledge and express our appreciation to the following experts for their review and invaluable feedback:

- **Chaim Bell**, MD, PhD, FRCP, CIHR/CPSI Chair in Patient Safety and Continuity of Care, Mount Sinai Hospital; Research Director, Antimicrobial Stewardship Program, Mount Sinai Hospital/University Health Network; Associate Professor of Medicine and Health Policy, Management and Evaluation, University of Toronto
- **Cathy DeGrasse**, BScN, MScN, Clinical Director, Cancer Program, The Ottawa Hospital
- **Lauren Lapointe-Shaw**, MD, FRCPC, Clinical Assistant, Department of Internal Medicine, Mount Sinai Hospital/University Health Network
- **Heather Sherrard**, BScN, MHA, Executive Vice President, Clinical Services, University of Ottawa Heart Institute
- **Dianne Tomarchio**, RN, BScN, Quality Improvement Manager, Rouge Valley Health System

It should be noted that the analyses and conclusions in this report do not necessarily reflect the opinions of the affiliated organizations.

The CIHI leadership team that provided guidance and support in the development of this report included

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This report could not have been completed without the generous support and assistance of the Clinical Administrative Databases team, CIHI’s Quebec office and many other CIHI staff members who worked on the publication, communications and distribution and who provided ongoing support to the core team.

Executive Summary

Are hospitals less safe on the weekends? Recent studies in the United Kingdom and elsewhere have suggested that certain patient groups have a higher death rate when they are admitted to hospital on a Saturday or Sunday. The purpose of this study was to determine whether patients admitted to Canada's acute care hospitals on weekends have a higher risk of dying than those admitted on a weekday and, if so, to identify any factors that might help explain the result.

This study examined hospital data for 9 million patients admitted to Canadian hospitals between 2010 and 2013. The study found that the risk of dying was slightly higher for some groups of patients when they were hospitalized on the weekend. The risk of death for children, as well as for patients admitted for obstetrical or mental health care, did not differ between weekdays and weekends. Patients coming for elective surgery and other planned care were overwhelmingly (97%) admitted on weekdays, so a valid comparison of death could not be made between weekend and weekday admissions for this group. However, the study found that patients admitted for urgent (unexpected) problems on a weekend had 4% higher odds of dying compared with patients admitted during the work week. Among urgent patients, those who underwent surgical procedures had 7% higher odds of dying, while medical patients had 3% increased odds of dying. This means that if patients admitted on weekends had the same mortality rate as patients admitted on weekdays, there would be 400 fewer in-hospital deaths among urgent patients (out of 75,000 yearly in-hospital deaths in total).

Although the odds of dying are higher for urgent patients admitted on the weekends, a number of factors may influence the interpretation of the results:

- **Fewer urgent patients admitted on weekends:** 11% fewer urgent patients were hospitalized on a weekend day than on a weekday. This drop in admissions suggests that there are differences between patients admitted on weekends and those admitted on weekdays.
- **Higher weekend mortality for some urgent conditions but not others:** We looked at two conditions where timely intervention is critical—heart attack and stroke—to find out whether the increase in mortality comes from a higher level of urgency among patients admitted on a weekend or a lower level of health care services provided on a weekend. We found that heart attack patients admitted on the weekend waited longer for diagnostic procedures and treatments and had 8% higher odds of dying. On the other hand, stroke patients also waited longer on a weekend for diagnostic procedures, but we found no increase in death rates among them.
- **Available data may not fully capture patient severity:** Patients whose conditions are more severe have a higher risk of dying. We were able to adjust for a number of factors associated with severity, such as a patient's age, gender, reason for admission and other health conditions that might complicate care. However, the data available for this study did not allow us to assess differences in severity within the same disease for patients coming on weekends versus weekdays.

The increased mortality among patients hospitalized on the weekend is a complex issue, and determining the exact cause is challenging; however, casting some light on the issue might help us find ways to improve it.

Although there is increased mortality among patients admitted on the weekend, compared with those admitted on weekdays, the absolute risk is still very small. Therefore, patients who need urgent care should seek medical attention with no delay.

Background

If a loved one is admitted to a hospital, is there reason to be more worried if it is Sunday rather than Tuesday? Some people think that the answer is yes due to the "weekend effect." This term refers to an increased rate of death among patients admitted to a hospital on a weekend compared with patients admitted on a weekday.

There are two possible reasons one might see increased mortality on the weekend. Patients admitted on the weekend may be sicker than patients admitted during the week,[1] or hospital services on the weekend may be less available or of poorer quality than services provided during the week.[2, 3]

Although some media reports suggest that the weekend effect could be an issue in Canada,[4–8] previous research has shown mixed results. Table 1 summarizes the results of Canadian research. Most studies have been limited to a specific patient population, either by province or by patient type (such as patients in the intensive care unit [ICU] or major trauma patients). Results for international studies are summarized in Appendix A.

Table 1: Review of Literature on the Weekend Effect in Canadian Acute Care Hospitals

Publication Year, Lead Author	Region	Data Years	Number and Types of Patients	Main Finding
Canadian Studies				
2001, Bell[9]	Ontario	1988 to 1997	3,789,917 patients admitted through ED	Significant weekend effect in 23 of the top 100 highest-mortality conditions
2004, Luo[10]	Canada	1985 to 1998	3,239,972 newborns	No significant weekend effect
2007, Saposnik[11]	Canada	2003	26,676 ischemic stroke patients	Significant weekend effect OR = 1.14 (seven-day mortality)
2008, Laupland[12]	Alberta	2000 to 2006	20,466 ICU patients	No significant weekend effect
2009, Laupland[13]	Alberta	2002 to 2006	4,000 major trauma patients	No significant weekend effect
2010, Fang[1]	Ontario	2003 to 2008	20,657 stroke patients	Significant weekend effect HR = 1.12 (seven-day mortality)

Notes
ED: Emergency department.
OR: Odds ratio.
ICU: Intensive care unit.
HR: Hazard ratio.

The Canadian Institute for Health Information (CIHI) collects data on all inpatient visits to Canadian acute care hospitals, allowing this study to include data from a larger and more complete patient group than previous Canadian studies.

This study used recent CIHI data to determine whether the weekend effect exists in Canadian acute care hospitals and, if so, to what extent. The results of this study will help health system managers and health care providers determine the extent of this phenomenon in Canada and examine possible underlying patient and system risk factors. The results of the study are also important for the public, as attention given to the weekend effect in the media[4–8] influences the public's perception about hospital services on a weekend and may deter people from seeking needed medical attention outside of work days.

Methods and Results

This study used hospital discharge data collected during a three-year period (from April 2010 to March 2013), which included approximately 9 million records. Weekend admissions were defined as admissions occurring between 12 midnight on Saturday and 11:59 p.m. on Sunday, as well as on statutory holidays.

Appendix B provides detailed information on data, definitions and methodology.

Patients were divided into five groups: pediatric, obstetric, mental health, surgical and medical. The patients within each of these groups were examined separately; only the medical and surgical groups had a statistically significant weekend effect. There was no weekend effect for the obstetric, pediatric or mental health patient groups.

The patient groups that showed the weekend effect (medical and surgical) were divided based on how patients presented at the hospital: urgently (with a life-threatening condition or unexpected health problems requiring immediate assessment) or electively (scheduled to come to the hospital in advance).

Almost a quarter of medical and surgical patients were admitted to a hospital for scheduled treatments or procedures. The small number of these patients admitted on weekends (3.2% of all elective patients) and their low mortality rate (0.6%) did not allow us to draw conclusions about the difference in mortality between patients scheduled for treatments or procedures on weekends and those scheduled on weekdays. Additionally, less than 5% of hospitals had at least one scheduled admission per weekend day, so results would not be representative of Canada as a whole. Thus we excluded patients scheduled for treatments or procedures and focused on patients who came through the emergency department (ED) or arrived by ambulance, which represented more than 3.74 million patients across Canada's almost 700 acute care hospitals.

Urgent Medical and Surgical Patients Experience Weekend Effect

Overall, a small but statistically significant weekend effect was observed in this study in Canadian acute care hospitals among urgent medical and surgical patients.

The mortality rate for those admitted on the weekend was 6.1%, while the mortality rate for those admitted during the week was 6.0%. This difference in mortality rate translates to a crude odds ratio (OR) of 1.02. When patient characteristics such as age, sex, comorbidities, and clinical and resource utilization characteristics (Case Mix Group) were taken into account, the adjusted odds ratio was 1.04. Note that adjusted ORs are used for the rest of the report.

The magnitude of the weekend effect was larger for urgent surgical patients (OR = 1.07) than for urgent medical patients (OR = 1.03). Overall, the difference in weekend versus weekday mortality translated into 413 excess deaths per year across the country. This means that if death rates were the same for weekday and weekend admissions, 413 fewer deaths would be expected. This would be an approximately 0.5% drop in the number of in-hospital deaths each year, as there are about 75,000 in-hospital deaths each year. There were 363 excess deaths among medical patients, compared with 50 among surgical patients. The medical patients had the smaller odds ratio, but there were more than three times more medical patients than surgical patients.

Table 2: Weekend Effect Among Urgent Medical and Surgical Patients Admitted via ED

	Urgent Medical		Urgent Surgical	
	Weekday	Weekend	Weekday	Weekend
Admissions (Daily Average)	2,737	2,414	801	730
Mortality Rate (%)	6.51	6.64	4.33	4.39
Excess Deaths per Year	363		50	
Adjusted Odds Ratios for In-Hospital Mortality (95% Confidence Interval)	1.03 (1.02–1.04)		1.07 (1.04–1.09)	

Notes

"Excess deaths" refers to number of deaths per year that could be reduced if mortality for weekend admissions was the same as that for weekday admissions.

Odds ratios were calculated with adjustments for patient age, sex, comorbidities and Case Mix Group.

Sources

Discharge Abstract Database and Hospital Morbidity Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

How Weekend Behaviour Might Affect Mortality Rates

Changes in human behaviour on the weekends may influence people's use of health care services: people with less-severe conditions may not come to the hospital on the weekend as readily as they would during the week. A few reasons may contribute to this:

- **Mildly ill patients postpone care:** Research shows that patients with mild symptoms tend to postpone going to hospital until after the weekend or until the symptoms become more severe.[1]
- **Lower stress levels on weekends may reduce symptoms of illness:** Compared with weekday activities, those on the weekend are more often for leisure and socializing.[14] People's perceived work overload and worry predict higher levels of stress on weekdays than weekends.[15] Lower stress levels on weekends may temporarily dispel physical symptoms that are not in need of urgent care, whereas weekday activities and stress may prompt people to seek medical care for the same symptoms.

If patients with milder symptoms are not coming on the weekend to the same degree as on weekdays, the proportion of patients with more severe conditions becomes higher on the weekend. In general, a higher rate of patients with severe conditions may cause an increase in mortality.

Patient Characteristics

If patients admitted on weekends have a different demographic or clinical profile, this might in part explain the weekend effect. We found no significant difference in age groups, gender, urban/rural patient residence or the number of comorbidities between urgent *medical* patients admitted through the ED on a weekday or on a weekend. However, urgent *surgical* patients admitted through the ED on a weekend tended to be younger with fewer comorbidities than those admitted on a weekday.

The most common Case Mix Groups were similar for weekend and weekday patients, both for everyone and for those who died (Appendix C).

It is possible that other factors (e.g., disease severity) made patients hospitalized on the weekend more likely to die than those coming in during the week. However, the available data did not allow us to investigate any further differences among weekend and weekday patients.

Health Care Services on Weekends

Reduced availability of some health care services provided on a weekend may contribute to the weekend effect. Examples include reduced staffing of nurses, physicians, physiotherapists and other health care professionals[16] and lower levels of experienced staff.[2, 3] However, some studies suggest that specialists who work at the time of reduced services demonstrate more independent thinking.[17, 18]

Case Study

One large urban community hospital shared information on how some of its staffing and services differed between weekdays and weekends:

- Physician coverage is reduced on weekends: one to two physicians cover all medicine inpatients, compared with four to six specialists on a weekday (one for each of the subspecialties within medicine).
- Allied health support (when various health professionals such as respiratory therapists, physiotherapists and pharmacists are available for consultations) is decreased or unavailable on a weekend.
- Nursing coverage (the number of patients per nurse) throughout the hospital is at the same level on weekends as on weekdays. The proportion of agency nurses is the same on the weekend as during the work week. However, the weekend nurses may not have access to all nursing clinical supports, such as resource nurses, nurse practitioners, unit managers and clinical practice leaders.
- Access to some diagnostic or therapeutic interventions is less readily available on weekends. For example, not all diagnostic imaging services are available on the weekend, and other services may have reduced hours of operation. To obtain some specialized diagnostic imaging procedures, the attending physician needs to contact the radiologist on call to obtain approval. The appropriate staff are then brought in to perform the test. This results in a delay for these procedures for all patients and may lead to a decision to delay testing until Monday for some patients.
- EDs and ICUs (hospital services that provide care to the most urgent and the sickest patients) are not staffed differently on the weekend.

Weekend Effect in Specific Diseases

Urgent patients are admitted through the ED for a wide variety of reasons. During the three years of the study, the almost 4 million patients who were admitted to hospital for urgent reasons fell into 468 unique Case Mix Groups. We found a statistically significant weekend effect in 34 of them. One-third of these 34 Case Mix Groups had fewer than 10 excess deaths per year. Only four Case Mix Groups had at least 30 excess deaths per year (Table 3).

Table 3: Weekend Effect in Certain Top Conditions

Case Mix Group	Admission Volume (Daily)			Mortality (%)		Adjusted Odds Ratio (95% CI)	Excess Deaths per Year
	Weekday	Weekend	Percentage Change	Weekday	Weekend		
Myocardial Infarction/Shock/ Arrest Without Coronary Angiogram	71	66	-6	15.8	16.8	1.07 (1.02–1.11)	73
Renal Failure	40	32	-20	12.5	14.0	1.13 (1.06–1.20)	55
Malignant Neoplasm of Respiratory System	30	23	-24	26.1	28.1	1.11 (1.05–1.18)	53
Digestive Malignancy	16	13	-21	18.8	21.7	1.22 (1.12–1.33)	44

Notes

CI: Confidence interval.

Odds ratios were calculated with adjustments for patient age, sex, comorbidities and Case Mix Group.

Sources

Discharge Abstract Database and Hospital Morbidity Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

The Case Mix Group with the highest number of excess deaths was Myocardial Infarction/ Shock/Arrest Without Coronary Angiogram (e.g., a heart attack), although its odds ratio was the lowest among the four groups. The high number of excess deaths was observed because these conditions are common and the volume of these patients is high on both weekdays and weekends. Renal Failure (e.g., chronic kidney disease) had the second-highest number of excess deaths, but it also had a much higher drop in admissions compared with the myocardial infarction group. This large drop suggests that the weekend patients are different from the weekday patients in characteristics that were not captured in the data, such as disease stage, disease severity and patient prognosis.

Two cancer groups (Malignant Neoplasm of Respiratory System, e.g., lung cancer, and Digestive Malignancy, e.g., colon cancer) are also on the list. Like Renal Failure, both of these groups had a large drop in admissions on weekends. In addition, specific causes of death were more varied in the cancer groups than in other groups because cancer patients often die from various complications of cancer or cancer treatment. Therefore, the differences between the weekend and weekday groups might be more pronounced for cancer patients.

An In-Depth Look at the Weekend Effect in Heart Attack and Stroke

Examining the weekend effect for some specific diseases might help isolate factors that contribute to it. For that investigation, we chose two common conditions—heart attack and stroke—where mortality depends on timely diagnostics and treatment. Among all patients with urgent admissions across Canada, deaths from heart attack and stroke accounted for about 16% (approximately 13,500 deaths per year) of all in-hospital deaths. Almost half of these deaths happened within the first five days of admission. A delay in immediate care for these acute conditions is more likely to lead to death earlier in the hospital stay.[19] We found the weekend effect in heart attack patients but not in stroke patients. These two conditions were explored further to see if we could understand this result.

Table 4 summarizes our findings for these two diseases overall. Detailed information with data by type of disease and fiscal year can be found in Appendix D.

Table 4: Weekend Effect in Heart Attack and Stroke Patients

Heart Attack	Stroke
Weekend Effect	
Significant weekend effect: The weekend effect was observed in heart attack patients (OR = 1.08). This was driven by a specific AMI type in one year.	**No significant weekend effect:** The weekend effect was not found in stroke patients, either overall or by type of stroke.
Changes in Volume on Weekends	
Reduced volume: There was a 4% drop in admissions on weekends in about 145,000 AMI cases identified throughout the three years.	**Reduced volume:** There was a 5% drop in admissions on weekends in about 87,000 stroke cases identified throughout the three years.
Patient Characteristics	
Similar patients: Weekday and weekend admissions had a similar age, gender and comorbidity profile. Information on severity within types of the disease was not available.	**Similar patients:** Weekday and weekend admissions had a similar age, gender and comorbidity profile. Information on severity within types of the disease was not available.
Procedures	
Similar rate of procedures: The proportion of patients who received angiography and/or PCI during their hospitalization was similar in weekend and weekday admissions. **Significant delay in procedures:** A smaller proportion of patients admitted on a weekend had their procedure on the day of admission or the next day. That difference was statistically significant.	**Similar rate of procedures:** The proportion of patients who received diagnostic (MRI/CT scan, ultrasound, X-ray) and therapeutic procedures (thrombolytic intervention, mechanical ventilation, drainage surgery, implant surgery) was similar in weekday and weekend admissions. **Significant delay in diagnostic procedures only:** A smaller proportion of patients admitted on a weekend had a diagnostic procedure on the day of admission or the next day. That difference was statistically significant. This delay was not observed for therapeutic procedures.
Length of Stay	
Similar lengths of stay: There was no significant difference in the mean or median of length of stay between weekday and weekend admissions.	**Similar lengths of stay:** There was no significant difference in the mean or median of length of stay between weekday and weekend admissions.
Emergency Department Wait Times	
Similar waits: Wait time for an acute care bed in the ED for heart attack patients was similar between weekday and weekend admissions.	**Similar waits:** Wait time for an acute care bed in the ED for stroke patients was similar between weekday and weekend admissions.

Notes

OR: Odds ratio.

AMI: Acute myocardial infarction.

PCI: Percutaneous coronary intervention.

MRI: Magnetic resonance imaging.

CT: Computed tomography.

Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.

Odds ratios were calculated with adjustments for patient age, sex and comorbidities.

Sources

Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Conclusion

A better understanding of the weekend effect is of great interest to system managers, clinicians and patients. Our study found no difference in death rates between weekend and weekday admissions for obstetric and mental health patients or for children. However, we found that urgent medical and surgical patients admitted to acute care hospitals through the ED had a slightly higher likelihood of dying if they were admitted on a weekend. While the difference was small, it was statistically significant. From available data, it was difficult to pinpoint the potential reasons for this weekend effect. The 11% drop in urgent hospital admissions on the weekend suggests that those who are admitted may be among the most severely ill in ways not measureable from the data currently available. Another possible explanation is that differences in hospital staffing or delays in obtaining certain diagnostic tests or therapeutic interventions may have a negative impact on patient survival. Further investigation of these potential explanations for the weekend effect would need to be tested with additional information about patient severity, patient wait times and hospital staffing, currently available at only the hospital level.

Appendix A: Review of Literature

Table A1: Review of Literature on the Weekend Effect in Acute Care Hospitals

Year of Publication, Lead Author	Country/ Region of Study Population	Data Years	Number and Types of Patients	Main Finding
Canadian Studies				
2001, Bell[9]	Ontario	1988 to 1997	3,789,917 patients admitted through ED	Significant weekend effect in 23 of the top 100 highest-mortality conditions
2004, Luo[10]	Canada	1985 to 1998	3,239,972 newborns	No significant weekend effect
2007, Saposnik[11]	Canada	2003	26,676 ischemic stroke patients	Significant weekend effect OR = 1.14 (seven-day mortality)
2008, Laupland[12]	Alberta	2000 to 2006	20,466 ICU patients	No significant weekend effect
2009, Laupland[13]	Alberta	2002 to 2006	4,000 major trauma patients	No significant weekend effect
2010, Fang[1]	Ontario	2003 to 2008	20,657 stroke patients	Significant weekend effect HR = 1.12 (seven-day mortality)
International Studies				
2004, Cram[20]	U.S.	1998	641,860 inpatients admitted via ED for 50 common diagnoses	Significant weekend effect OR = 1.03 (in-hospital mortality)
2004, Ensminger[21]	U.S.	1994 to 2002	29,084 ICU patients	Significant weekend effect for surgical patients OR = 1.23 (in-hospital mortality) No significant weekend effect for medical or multispecialty patients

(cont'd on next page)

Table A1: Review of Literature on the Weekend Effect in Acute Care Hospitals (cont'd)

Year of Publication, Lead Author	Country/ Region of Study Population	Data Years	Number and Types of Patients	Main Finding
2005, Schmulewitz[22]	U.K.	2001	3,244 admissions for six predetermined diagnoses	No significant weekend effect for any of the selected conditions
2006, Foss[16]	Denmark	2002 to 2004	600 hip fracture patients	Significant weekend effect OR = 1.84 (30-day mortality) for holidays versus weekends and weekdays
2007, Kostis[23]	U.S.	1987 to 2002	231,164 heart attack patients	Significant weekend effect HR = 1.05 (30-day mortality) after adjustment for patient and disease characteristics; not significant after further adjustment for cardiac procedures
2010, Hong[24]	South Korea	2003 to 2007	97,466 heart attack patients	Significant weekend effect OR = 1.21 (30-day mortality) after adjustment for patient and disease characteristics; not significant after further adjustment in procedures
2010, Aylin[25]	U.K.	2005	4,317,866 inpatient admissions via ED	Significant weekend effect OR = 1.10 (in-hospital mortality)
2010, Maggs[26]	U.K.	2007	15,594 non-elective admissions	No significant weekend effect
2011, Ricciardi[27]	U.S.	2003 to 2007	29,991,621 patients with a non-elective admission	Significant weekend effect OR = 1.10 (in-hospital mortality); significant for 15 out of 26 major diagnostic categories
2012, Mohammed[28]	U.K.	2008	1,535,267 elective patients; 3,105,249 emergency patients	Significant weekend effect OR = 1.32 for elective patients (in-hospital mortality) OR = 1.09 for emergency patients (in-hospital mortality)
2012, Freemantle[29]	U.K.	2009	14,217,640 admissions	Significant weekend effect HR = 1.16 (in-hospital mortality) for Sunday versus Wednesday HR = 1.11 (in-hospital mortality) for Saturday versus Wednesday
2013, Concha[19]	Australia	2000 to 2007	3,381,962 inpatient admissions via ED	Significant weekend effect in 16 out of 430 diagnosis groups
2014, Ricciardi[30]	U.S.	2003 to 2008	48,253,968 non-elective inpatient admissions	Significant weekend effect RR = 1.15 (in-hospital mortality)

Notes
ED: Emergency department.
OR: Odds ratio.
ICU: Intensive care unit.
HR: Hazard ratio.
RR: Relative risk.

Appendix B: Methodology

Data Sources

Three databases were used in the analysis: CIHI's Discharge Abstract Database (DAD), Hospital Morbidity Database (HMDB) and National Ambulatory Care Reporting System (NACRS). Hospital records were restricted to acute care hospitalizations from all Canadian facilities that occurred between April 1, 2010, and March 31, 2013. For the in-depth analysis of patients who had heart attacks or strokes, records from Quebec were excluded because the data does not show the differences between heart attack or stroke types.

The unit of analysis was an episode of care. An episode of care links all acute care hospitalizations and same-day surgeries that occurred for the same patients within six hours. For patients who were transferred from one hospital to another, the time between hospitalizations was increased to 12 hours. Patient characteristics were derived from the first acute care admission, except for information on comorbidities, which was collected for the entire episode of care.

The discharge disposition from the end of the episode was used to identify death cases. In this report, "patients," "admissions" and "hospitalizations" all mean "episodes."

Patient Groups

Palliative care patients were excluded from our analysis.

The elective or urgent code was based on the admission category in the DAD/HMDB:

- *Elective:* Patients who are pre-registered and/or would be found on an elective booking list (we can also call them *scheduled*)
- *Urgent:* Patients who have a life-threatening condition or require immediate assessment and treatment

Patients were divided into five patient groups based on their major clinical category (MCC), which is based on their most responsible diagnosis (diagnosis most responsible for length of stay and inpatient cost) or age:

- The pediatric patient group includes patients younger than age 18.
- The mental health patient group includes patients who had MCC 17 (Mental Diseases and Disorders).
- The obstetric patient group includes patients who had MCC 13 (Pregnancy and Childbirth).
- The surgical patient group includes patients who had interventions from the Canadian Classification of Health Interventions (CCI) list (e.g., insertion of shunt/brain monitor or management of pacemaker battery/epicardial lead).
- The medical patient group includes patients with no interventions or interventions that are not on the CCI list (e.g., coronary angiogram).

Patients were defined as having been admitted through the ED if they met any of the following conditions:

- Admitted to the reporting facility through the ED
- Arriving at the reporting facility via an ambulance
- Transferred from another facility's ED

Weekdays, Weekends and Holidays

Weekday admissions occurred between 12 midnight on Monday and 11:59 p.m. on Friday. Weekend admissions occurred between 12 midnight on Saturday and 11:59 p.m. on Sunday. Statutory holidays were added to weekends. Statutory holidays included New Year's Day, Family Day (for selected provinces), Good Friday, Easter Monday, Victoria Day, Canada Day, Civic Holiday (for selected provinces), Labour Day, Thanksgiving, Remembrance Day (for selected provinces), Christmas Day and Boxing Day. When a holiday fell on a weekend, the following Monday was defined as a weekend.

Procedures, Wait Time, Length of Stay

Procedures for heart attack included angiography, cardiac angioplasty, coronary artery bypass surgery and thrombolytic intervention. Stroke diagnostic procedures included computed tomography (CT) scans, magnetic resonance imaging (MRI) scans, ultrasounds and X-ray procedures; stroke interventions included ventilation interventions, drainage surgeries and implant surgeries. We did not include thrombolytic interventions because most of these procedures happened in the ED, which is not included in the data. The number of days to procedure was calculated as the difference in days between the procedure date and the admission date.

Length of stay was calculated as the difference between the discharge date and the admission date, in days. Patients were considered to have been discharged within five days of admission if the length of stay was less than five days. Wait time in the ED was available only if the ED admission and acute care hospitalization occurred in the same facility; when available, it was captured in minutes. Patients were considered to have been admitted within two hours if the wait time was equal to or less than 120 minutes. Weekday versus weekend comparisons for length of stay and wait time were done by comparing Saturdays with Mondays. Only patients discharged alive were included in these two analyses.

Outcomes and Risk-Adjusted Model

In-hospital mortality included all patients who died while staying in a hospital (based on data in the discharge disposition field of the database).

Poisson or logistic regression models were used to measure the strength of association between mortality and weekend admissions for each specific patient group (e.g., urgent medical group). The ORs were calculated with adjustments for patient age, sex, comorbidities (Charlson Index) and top Case Mix Group accounting for 80% of deaths. The top Case Mix Groups were calculated for each patient group individually.

Significance was based on 95% confidence intervals.

Appendix C: Top Case Mix Groups

The top five Case Mix Groups among all *urgent* patients were

- Chronic Obstructive Pulmonary Disease;
- Viral/Unspecified Pneumonia;
- Heart Failure Without Coronary Angiogram;
- Arrhythmia Without Coronary Angiogram; and
- Non-Severe Enteritis.

The top five Case Mix Groups among *urgent* patients who died were

- Viral/Unspecified Pneumonia;
- Heart Failure Without Coronary Angiogram;
- Chronic Obstructive Pulmonary Disease;
- Myocardial Infarction/Shock/Arrest Without Coronary Angiogram; and
- Other/Unspecified Septicemia.

Appendix D: Data on Acute Myocardial Infarction and Stroke

Table D1: Detailed Data on Acute Myocardial Infarction

Year	Average Admissions per Day			Average In-Hospital Deaths per Day			Mortality Rate (%)		Odds Ratio (95% CI)
	Weekday	Weekend	Percentage Change	Weekday	Weekend	Percentage Change	Weekday	Weekend	
AMI (Overall)									
2010	135.0	130.4	-3	13.2	13.2	0	9.8	10.1	1.05 (0.98–1.12)
2011	131.8	125.9	-5	11.8	12.6	7	9.0	10.0	1.14 (1.06–1.22)*
2012	136.7	131.8	-4	12.3	12.5	2	9.0	9.5	1.07 (1.00–1.14)
Three-Year Average	134.5	129.3	-4	12.4	12.8	3	9.3	9.9	1.08 (1.04–1.13)*
AMI (STEMI)									
2010	37.9	38.9	3	3.4	3.5	4	8.8	8.9	1.06 (0.93–1.21)
2011	36.8	37.2	1	3.1	3.3	5	8.5	8.8	1.05 (0.92–1.21)
2012	38.1	37.6	-1	3.3	3.5	7	8.7	9.4	1.14 (1.00–1.30)
AMI (NSTEMI)									
2010	88.3	83.7	-5	7.2	7.4	2	8.2	8.8	1.06 (0.97–1.16)
2011	88.2	82.3	-7	6.8	7.3	7	7.7	8.9	1.16 (1.06–1.27)*
2012	92.3	88.3	-4	7.2	7.2	0	7.8	8.1	1.04 (0.95–1.13)
AMI (Unknown)									
2010	8.7	7.8	-11	2.6	2.4	-10	30.0	30.4	1.05 (0.88–1.25)
2011	6.7	6.5	-4	1.9	2.0	8	27.5	30.7	1.19 (0.98–1.44)
2012	6.2	5.8	-6	1.8	1.8	-1	29.4	31.0	1.11 (0.91–1.36)

Notes

* Statistically significant.

CI: Confidence interval.

AMI: Acute myocardial infarction.

STEMI: ST elevation myocardial infarction.

NSTEMI: Non-ST elevation myocardial infarction.

Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.

Odds ratios were calculated with adjustments for patient age, sex and comorbidities.

Sources

Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D2: Detailed Data on Stroke

Year	Average Admissions per Day			Average In-Hospital Deaths per Day			Mortality Rate (%)		Odds Ratio (95% CI)
	Weekday	Weekend	Percentage Change	Weekday	Weekend	Percentage Change	Weekday	Weekend	
Stroke (Overall)									
2010	81.2	77.5	-5	13.6	13.7	1	16.7	17.7	1.05 (0.99–1.13)
2011	80.4	76.2	-5	12.2	11.9	-3	15.2	15.6	1.02 (0.95–1.10)
2012	81.1	77.3	-5	12.3	11.3	-8	15.1	14.6	0.96 (0.89–1.03)
Three-Year Average	80.9	77.0	-5	12.7	12.3	-3	15.7	16.0	1.01 (0.97–1.05)
Hemorrhagic Stroke									
2010	18.2	17.5	-4	4.8	4.9	3	26.3	28.1	1.11 (0.98–1.25)
2011	18.2	17.4	-5	4.5	4.3	-4	24.4	24.5	1.00 (0.88–1.13)
2012	18.4	17.2	-7	4.4	4.2	-5	24.1	24.4	1.02 (0.90–1.15)
Ischemic Stroke									
2010	45.1	42.6	-5	5.9	6.0	2	13.1	14.2	1.07 (0.97–1.18)
2011	49.5	46.6	-6	6.0	5.8	-3	12.1	12.4	1.01 (0.92–1.12)
2012	53.2	51.2	-4	6.4	5.7	-11	12.1	11.2	0.91 (0.83–1.00)
Unknown Stroke									
2010	18.0	17.3	-4	2.9	2.7	-6	16.1	15.8	0.93 (0.80–1.08)
2011	12.7	12.2	-4	1.8	1.9	3	14.3	15.2	1.12 (0.93–1.34)
2012	9.6	9.0	-7	1.4	1.4	-2	14.6	15.3	1.04 (0.84–1.28)

Notes

CI: Confidence interval.

Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.

Odds ratios were calculated with adjustments for patient age, sex and comorbidities.

Sources

Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D3: Detailed Data on Acute Myocardial Infarction Length of Stay, 2010 to 2012

AMI Type	Mean Days		Median Days		Percentage Staying Less Than Five Days		
	Monday	Saturday	Monday	Saturday	Monday	Saturday	P-Value
AMI (Overall)	9.0	9.3	4.4	5.0	51.8	43.0	<0.0001
AMI (STEMI)	6.8	7.1	3.8	4.1	62.6	56.0	<0.0001
AMI (NSTEMI)	9.8	10.1	4.8	5.6	47.7	37.6	<0.0001
AMI (Unknown)	10.8	11.3	5.6	6.0	43.9	35.9	0.0012

Notes
AMI: Acute myocardial infarction.
STEMI: ST elevation myocardial infarction.
NSTEMI: Non-ST elevation myocardial infarction.
Patients who died were excluded.
Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.
Sources
Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D4: Detailed Data on Stroke Length of Stay, 2010 to 2012

	Mean Days		Median Days		Percentage Staying Less Than Five Days		
	Monday	Saturday	Monday	Saturday	Monday	Saturday	P-Value
Stroke Overall	20.3	20.4	8.8	9.5	32.9	26.5	<0.0001

Notes
Patients who died were excluded.
Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.
Sources
Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D5: Detailed Data on Acute Myocardial Infarction Procedures

Year	PCI						Angiography					
	Percentage Receiving			Percentage Receiving Within Same/Next Day			Percentage Receiving			Percentage Receiving Within Same/Next Day		
	Weekday	Weekend	P-Value	Weekday	Weekend	P-Value	Weekday	Weekend	Chi-Square	Weekday	Weekend	P-Value
AMI (Overall)												
2010	38.3	39.5	0.0114	58.3	51.0	<0.0001	59.4	60.4	0.0407	51.1	41.7	<0.0001
2011	39.7	40.4	0.2106	60.6	52.2	<0.0001	61.1	60.6	0.3285	53.4	43.6	<0.0001
2012	41.6	41.0	0.2477	63.4	54.8	<0.0001	63.3	63.2	0.8836	56.2	45.5	<0.0001
Three-Year Average	39.9	40.3	0.136	60.8	52.7	<0.0001	61.3	61.4	0.5808	53.6	43.6	<0.0001
AMI (STEMI)												
2010	63.8	67.0	0.0003	83.5	78.4	<0.0001	76.9	80.4	<0.0001	80.2	73.9	<0.0001
2011	65.7	67.4	0.048	85.5	81.9	<0.0001	78.6	80.0	0.0524	81.9	78.0	<0.0001
2012	68.8	69.5	0.3779	87.5	85.7	0.0128	82.0	82.8	0.2799	84.5	81.9	0.0006
AMI (NSTEMI)												
2010	29.6	28.8	0.1764	35.7	22.1	<0.0001	54.8	54.0	0.1614	34.3	20.0	<0.0001
2011	30.8	30.2	0.2784	38.9	23.1	<0.0001	56.2	54.6	0.006	37.3	21.5	<0.0001
2012	32.2	30.8	0.0109	42.6	25.5	<0.0001	57.8	57.3	0.4241	40.2	23.5	<0.0001

Notes

PCI: Percutaneous coronary intervention.

AMI: Acute myocardial infarction.

STEMI: ST elevation myocardial infarction.

NSTEMI: Non-ST elevation myocardial infarction.

Patients who died were excluded.

Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.

Sources

Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D6: Detailed Data on Stroke Procedures, 2010 to 2012

	Percentage Receiving			Percentage Receiving Within Same/Next Day		
Procedure	Weekday	Weekend	P-Value	Weekday	Weekend	P-Value
Diagnostic Procedures						
CT Scan	32.9	33.6	0.0756	56.0	53.4	<0.0001
MRI Scan	16.6	16.1	0.0367	39.6	24.9	<0.0001
Ultrasound	3.7	3.9	0.2837	35.5	20.1	<0.0001
X-Ray	3.3	3.3	0.9795	50.5	44.0	0.0013
Therapeutic Procedures						
Ventilation	8.0	8.3	0.1081	79.0	78.9	0.9151
Drainage Surgery	5.7	5.9	0.36	60.5	64.2	0.0144
Implant Surgery	8.1	8.7	0.0024	27.1	26.0	0.3192

Notes
CT: Computed tomography.
MRI: Magnetic resonance imaging.
Patients who died were excluded.
Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.
Sources
Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D7: ED Wait Times for Acute Myocardial Infarction, 2010 to 2012

	Mean Hours		Median Hours		Percentage Waiting ≤2 Hours		
AMI Type	Monday	Saturday	Monday	Saturday	Monday	Saturday	P-Value
AMI (Overall)	8.1	8.2	2.4	2.0	46.1	50.2	<0.0001
AMI (STEMI)	3.7	3.7	0.8	0.9	69.5	70.1	0.593
AMI (NSTEMI)	9.3	9.4	3.1	2.5	39.7	44.6	<0.0001
AMI (Unknown)	8.6	9.3	2.2	2.1	49.3	48.6	0.763

Notes
AMI: Acute myocardial infarction.
STEMI: ST elevation myocardial infarction.
NSTEMI: Non-ST elevation myocardial infarction.
Patients who died were excluded.
Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.
Sources
Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

Table D8: ED Wait Times for Stroke, 2010 to 2012

	Mean Hours		Median Hours		Percentage Waiting ≤2 Hours		
	Monday	Saturday	Monday	Saturday	Monday	Saturday	P-Value
Stroke Overall	10.5	10.9	4.0	3.1	33.3	38.5	<0.0001

Notes
Patients who died were excluded.
Data from Quebec was excluded from this analysis due to the use of different coding standards in Quebec.
Sources
Discharge Abstract Database, 2010–2011 to 2012–2013, Canadian Institute for Health Information.

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Production of this document is made possible by financial contributions from Health Canada and provincial and territorial governments. The views expressed herein do not necessarily represent the views of Health Canada or any provincial or territorial government.

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ISBN 978-1-77109-286-9 (PDF)

How to cite this document:
Canadian Institute for Health Information. *Weekend Admissions and In-Hospital Mortality*. Ottawa, ON: CIHI; 2014.

Cette publication est aussi disponible en français sous le titre *Admissions la fin de semaine et mortalité hospitalière*.
ISBN 978-1-77109-287-6 (PDF)

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