Exploring Occupancy Through Administrative Data: A Test Case Using Operating Rooms

Health System Performance

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

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Healthier Canadians.

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Introduction

In Canadian hospitals, health care physical resources such as beds, diagnostic imaging machines and other specialized resources are tracked using information from surveys or existing local information technology systems. This may result in information that is not comparable across regions due to differing definitions and collection parameters. Comparable information is important to understanding how constrained resources are being used within regions to meet patient needs. This report outlines a new methodology using administrative data to estimate physical resources in areas such as intensive care, emergency departments, operating rooms (ORs) and possibly intravenous chemotherapy units. The concepts in this methodology are tested on the OR data to investigate 3 areas:

1. The number of ORs available for use;
2. The hours of active use during standard daytime shifts; and
3. An estimated occupancy rate for ORs across the country.

Why is it interesting to test the methodology on the OR setting?

First, while ORs account for a significant portion of hospital business in Canada, there is little comparable information. Good data is available at an individual site level, but often there is not a way to roll it up to a region or provincial level other than through surveys.

Who wants big picture data?

Big picture data is important to regional and provincial planners, specifically for managing access to care and emergency preparedness.

What is presented in this report?

An overview of the approach, benefits and limitations in answering the different questions using administrative data and how the results have been validated will be discussed.

OR Measures Typically Reported

2 types of OR measures may be currently reported at the hospital level:

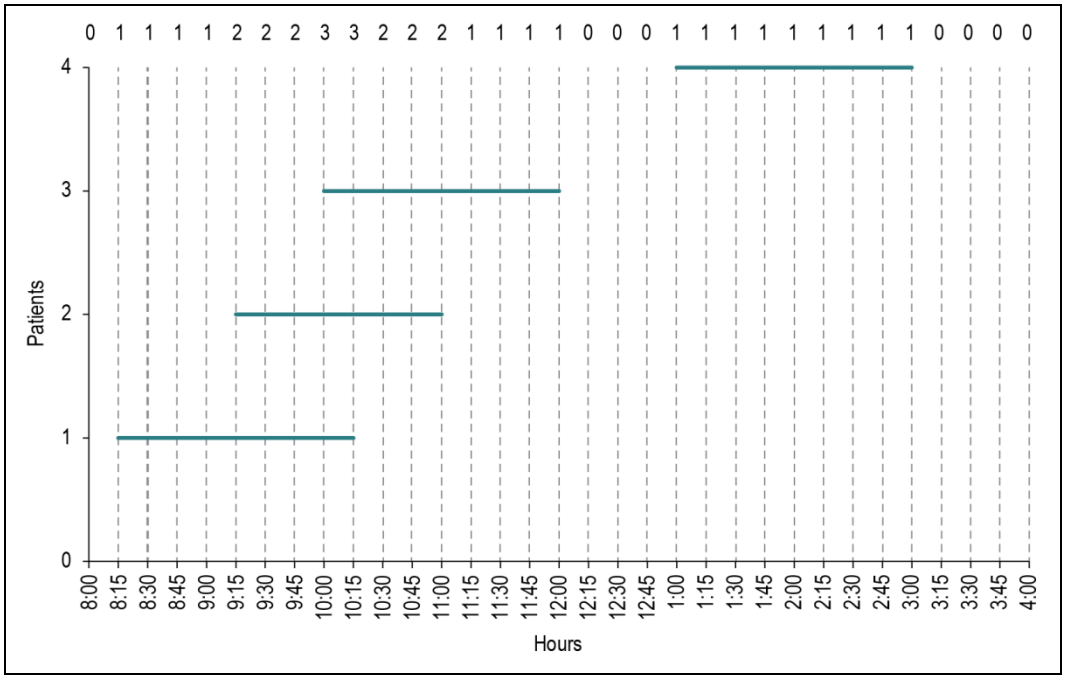
- Percentage blocked/scheduled time = total time patients were in OR ÷ total hours reserved for surgeon(s)
- Percentage staff time = total time patients were in OR ÷ total time staff available

Both of these measures address the question “How does the OR function when staff is working or intended to be working?” Much of the research on OR utilization is focused on ways to improve staff efficiencies to in turn improve wait times and patient outcomes.[1–4]

1 What Is the Number of ORs in Canada?

There is no national data source for the number of actively used ORs in Canada. The approach in this report uses 15-minute snapshots over a standard day shift (from 8 a.m. to 4 p.m., Monday to Friday, excluding statutory holidays) to obtain the maximum number of ORs concurrently in use. It is assumed that at some point during the year, all of a facility's available ORs will be simultaneously in use . Procedure start and end times (the time a patient entered and left the OR) are used to determine how many ORs are in use for each 15-minute interval (Figure 1). Understanding how many ORs are being used simultaneously allows for an estimation of how many ORs each facility has. For the estimation, the 99th percentile of OR counts, rather than absolute maximum, was used to protect against atypical, extreme values or data entry error. This method excludes non-functional or "mothballed" ORs—those that are not used at all during the year. (See appendices 2 and 3 for the technical details and SAS code used for counting.)

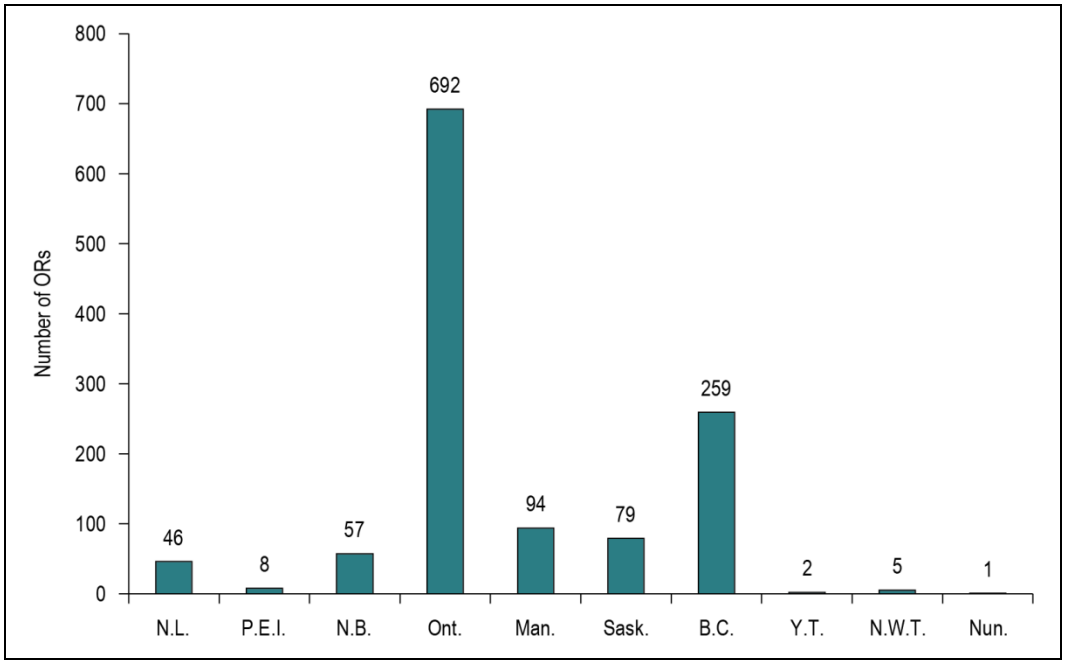
Figure 1: An Example of Counting ORs in Concurrent Use



Note
This is fictitious data.

Using this approach, a total of 1,243 ORs across 242 facilities in 7 provinces and 3 territories were identified (Figure 2), with each facility having between 1 and 33 ORs.

Figure 2: Number of ORs by Province



Sources
Discharge Abstract Database and National Ambulatory Care Reporting System, 2013–2014, Canadian Institute for Health Information.

Benefits: The benefits of using administrative data in this manner are two-fold. First, it is low cost and repeatable in short time frames compared with alternatives like surveys. Second, it provides a consistent approach with common definitions across regions for identifying ORs in use versus those that may physically exist but may not be operational.

Limitations: There are also several limitations. Using this methodology, any space identified by a facility as a "Main OR" is included. Some ORs may be reserved for specific types of procedures, such as traumas or surgical delivery of newborns; these are included as they cannot be identified. As well, when using OR counts to estimates occupancy rates, it is not possible to tell whether a facility intentionally closed or operated all or some of its ORs at a given time (e.g., rooms closed over holiday periods, rooms used only a few days each week). The methodology estimates total available ORs that are used annually.

Validation: The results were validated against a provincial survey in British Columbia, and against those of a multi-site hospital system in Ontario. In both cases, the number of ORs estimated from the administrative data matched or was lower than the actual number from the validation source (the survey and the hospital system). Other provincial ministry feedback indicated that the estimates for OR numbers calculated by administrative data were either the same as or 1 to 2 ORs lower than provincial estimates. The lower numbers occurred when a facility had an extra 1 to 2 ORs they were using as a swing OR to increase efficiency (swing

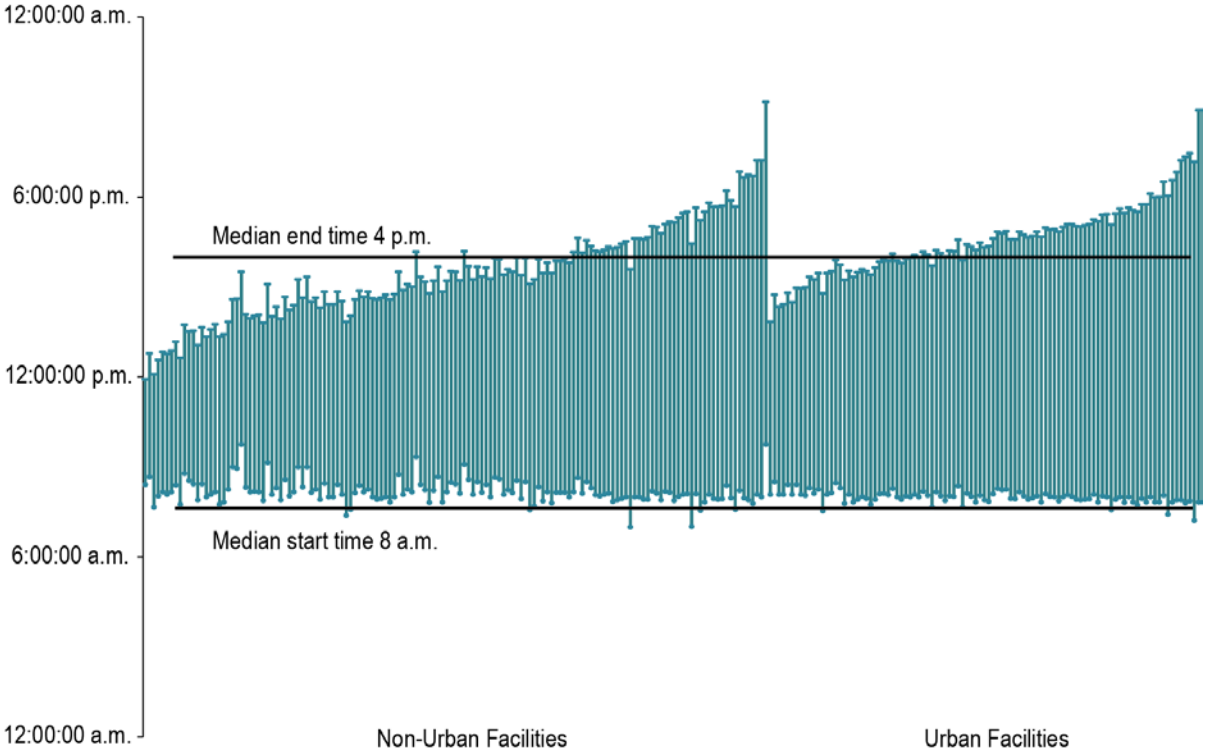
ORs do not have a regular surgical slate but the space is used to keep the flow going). As well, the proposed standard work day—the usual start and end time for the OR—was consistent with the literature and validated as reasonable by those in the field.

Understanding Typical Working Hours

This report used procedure data regularly submitted by Canadian hospitals to further explore the range of typical working hours across all facilities in all jurisdictions. Each facility's typical OR hours are defined as the 10th percentile of OR procedure start times to the 90th percentile of OR procedure end times (Monday to Friday, excluding statutory holidays, or 246 working days in 2013–2014). Using this definition, Canadian facilities have a wide range of OR hours, from 4 to 13 hours, with an average of 7.8 hours during a normal working day, but this varies by urban and non-urban location (Figure 3). Going forward, for the sake of simplicity in this report, a typical working day is defined as 8 a.m. to 4 p.m. While the estimate is restricted to these 8 hours, it's worth noting that there is wide variation in typical OR hours across facilities, with 44% in operation for 8 or more hours.

During a normal working day, the majority of OR time (in day surgery and acute combined) was spent on elective procedures (94%), but most OR activity outside of normal working hours was dedicated to urgent care. More than half (59%) of procedures done after-hours on working days (from 5 p.m. to 11 p.m.) and 69% of procedures on weekends and holidays (from 8 a.m. to 4 p.m.) were related to urgent care.

Figure 3: Typical OR Working Hours



	Non-Urban	Urban
Average Hours in Typical Day	7.3	8.6
OR Start and End Times	8:07 a.m. to 3:21 p.m.	8:00 a.m. to 4:28 p.m.

Note
Urban is defined as a census metropolitan area (CMA), as defined by Postal Code Conversion File (PCCF) issued by Statistics Canada (regions with a total population of 100,000, of which 50,000 live in the core).
Sources
Discharge Abstract Database and National Ambulatory Care Reporting System, 2013–2014, Canadian Institute for Health Information.

How Is an Urban Area Defined and Why Is the Focus on ORs in Urban Areas?

For the sake of this report, an urban area is equivalent to a census metropolitan area (CMA), which is defined by Statistics Canada as a region with a total population of at least 100,000 or more, of which 50,000 live in the core.[5] Given these characteristics, CMAs provide another way of studying comparable areas of the country. A special focus on urban areas was used to test the methodology for ORs, as it is expected that demand for surgeries would be reasonably high and supply of health care workers steady in these regions.

2 What Is OR Activity During Standard Daytime Shifts?

OR activity can also be estimated from administrative data. The calculation involves 2 measures:

- The time the patient is in the room; and
- Turnaround time.

The procedure start and end times represent the time that the patient entered and left the OR, as reported by the facility in the administrative data. Equally important is the time it takes for preparation for the surgery and clean-up afterward, as the OR is effectively occupied and unavailable for another patient. Turnaround time may vary depending on the type of surgery performed, the physical set-up of the OR, availability of surgical kits, staff resources and other human factors.

In the literature, OR turnaround time varies from 15 minutes to 45 minutes (depending on equipment used), while the Institute for Healthcare Improvement (IHI) cites an improvement case study with a turnaround time of 18 minutes for inpatients.[6–9] Ontario uses an average turnaround time calculated for each type of surgery. In this report, a fixed amount of turnaround time was added to each procedure: 15 minutes for ambulatory care and 30 minutes for inpatients. These turnaround time estimates were based on feedback from subject matter experts and on the literature, and are simple enough to apply in the model.

Estimates of OR activity are sensitive to turnaround time adjustments. Without any turnaround adjustment, the national OR occupancy rate is 55%. Table 1 shows the impact of changing the 15-/30-minute rule on the national OR occupancy rate. For example, if the turnaround time is reduced to 5 and 20 minutes, the OR occupancy rate drops from 70% to 62%. If the turnaround time is increased to 25/40 minutes, the OR occupancy rate becomes 78%.

Table 1: Impact of Turnaround Time

Turnaround Time (Ambulatory Care and Inpatients)		Occupancy Rate
	No Turnaround	55%
Less	5 and 20 minutes	62%
Project	15 and 30 minutes	70%
More	25 and 40 minutes	78%

Sources
Discharge Abstract Database and National Ambulatory Care Reporting System, 2013–2014, Canadian Institute for Health Information.

Benefits: Calculating OR activity using a combination of actual time that patients occupy an OR (from administrative data) and a standard turnaround time is a low-cost, repeatable solution to obtain data that is comparable across facilities. This approach assumes a best case scenario where there are few cancellations or delays.

Limitations: In some instances, this approach may also be a limitation when practice varies considerably from the standard turnaround time of 15 and 30 minutes for certain types of procedures and patients. For example, turnaround for bilateral hip replacements may take longer than an open resection for colon cancer. Together, over time, these differences will affect estimates of total OR activity.

Validation: While the proposed timing of 15 and 30 minutes was viewed as reasonable from those in the field, there was limited data available to understand how similar it is to actual practice.

3 What Is the Estimated OR Occupancy Rate for Canada?

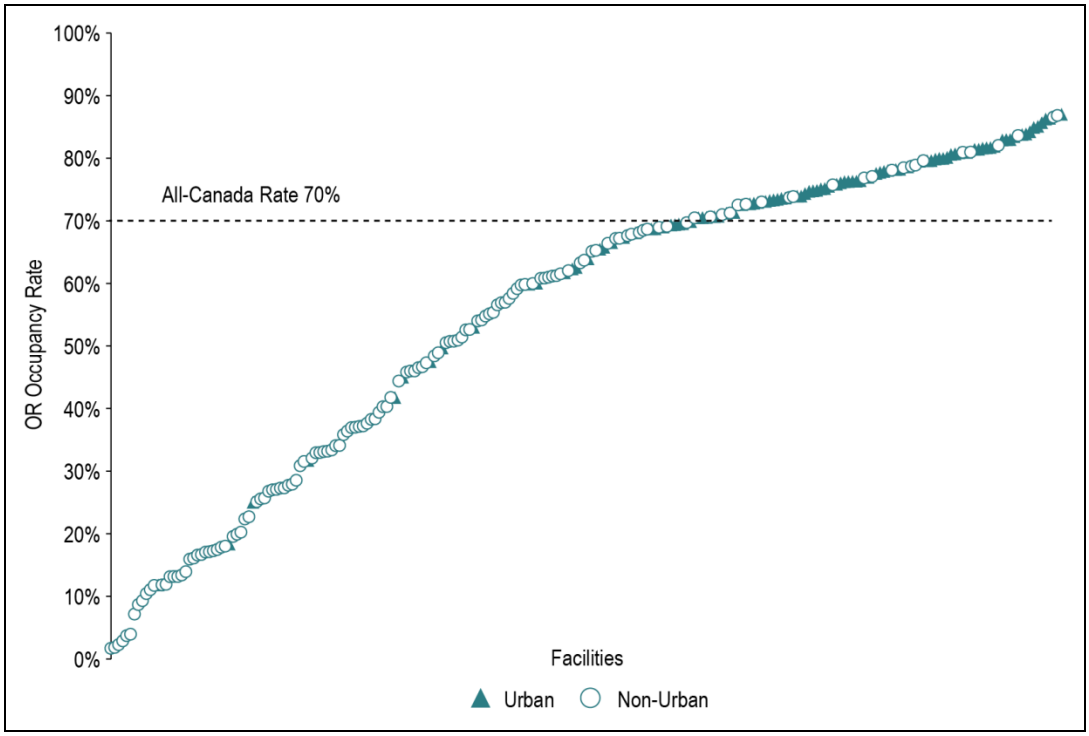
The calculation of number of ORs combines the estimated physical OR capacity with estimated activity during a standard daytime shift to arrive at a measure of how often available physical space is being used. To determine how often an OR space is in use or how frequently it is occupied, the occupancy rate was defined for Canadian ORs as follows:

$$\frac{\sum_{4pm}^{8am} i\,(patient\ entry\ into\ OR\ until\ patient\ leaves\ OR) + (15\text{- }or\text{ }30\text{-}minute\ turnaround\ time)}{\sum i\,(N\ ORs\ \times\ 246\ working\ days\ \times 8\text{-}hour\ standard\ day)}$$

$$= \frac{1{,}712{,}357}{1{,}243 \times 246 \times 8} = 70\%$$

In 2013–2014, at the national level, the OR occupancy rate was 70%, meaning that 30% of the time between the hours of 8 a.m. and 4 p.m., ORs were not occupied by patients or being prepared and cleaned. This result was stable from 2011–2012 to 2013–2014. The results of this methodology suggest that OR space is not the bottleneck for performing more surgical procedures. As calculated here, physical space is available without looking beyond normal working hours. That said, there is large variation between facilities in occupancy rates. Facility-level OR occupancy rates ranged from 2% to 87%, with a median of 64% (Figure 4). Few facilities (12%) had occupancy rates greater than 80%, and 35% of facilities had occupancy rates less than 50%. As expected, there was less variation within CMAs where the median OR occupancy rate was 75%, and only 8% of facilities had occupancy rates less than 50%.

Figure 4: Facility OR Occupancy Rates, 8 a.m. to 4 p.m.



Note

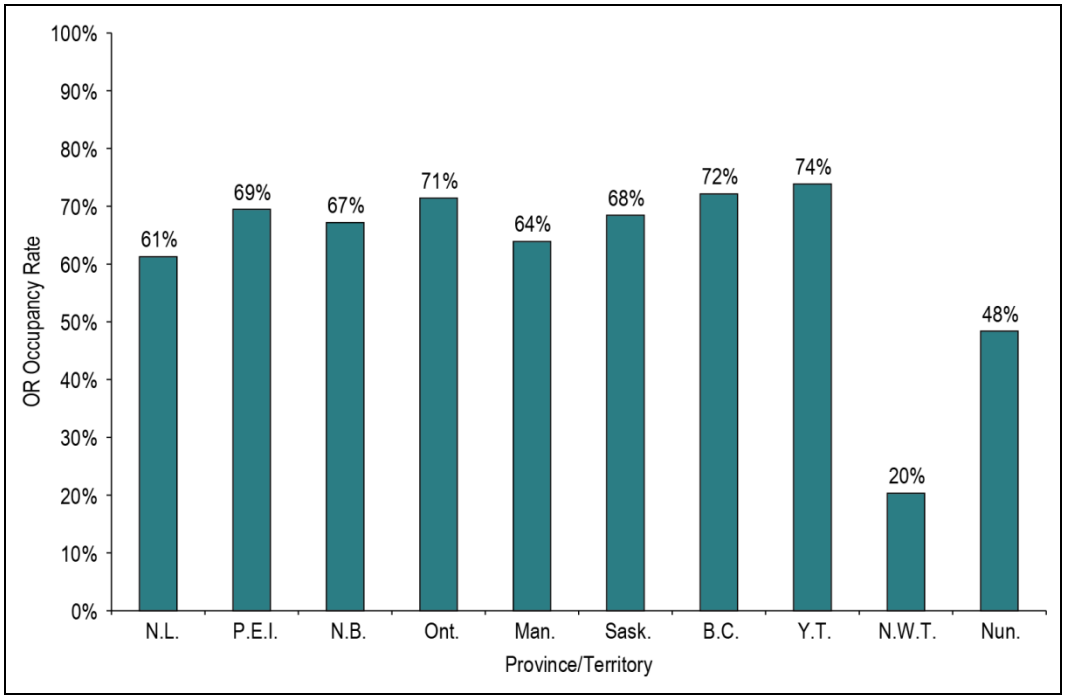
Urban is defined as a census metropolitan area (CMA), as defined by Postal Code Conversion File (PCCF) issued by Statistics Canada (regions with a total population of 100,000, of which 50,000 live in the core).

Sources

Discharge Abstract Database and National Ambulatory Care Reporting System, 2013–2014, Canadian Institute for Health Information.

OR occupancy rates also varied considerably between provinces, from 61% in Newfoundland and Labrador to 72% in British Columbia (Figure 5). The results varied considerably among the 3 territories, with OR occupancy rates of 74%, 20% and 48% in Yukon, the Northwest Territories and Nunavut, respectively.

Figure 5: Provincial OR Occupancy Rates, 8 a.m. to 4 p.m.



Sources
Discharge Abstract Database and National Ambulatory Care Reporting System, 2013–2014, Canadian Institute for Health Information.

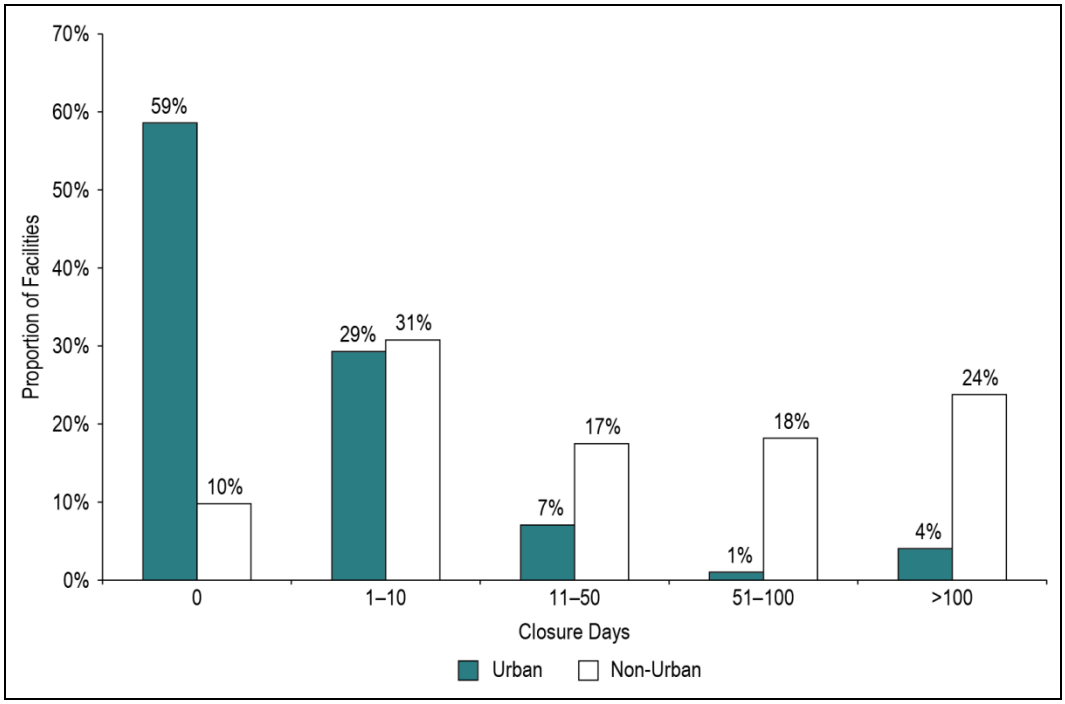
Potential reasons for lower OR occupancy include the following:

1. **Patient need:** Sparsely populated regions of the country may have less need for surgery than more densely populated areas, like urban areas, due to the much smaller numbers of people.
2. **Surgeon and anesthetist availability:** In more remote regions, surgeons and anesthetists may be travelling in to perform surgeries as needed and may not be on site all the time. Conversely, if there is only a single physician available on site, that person will also not be available 24/7 as he or she will require time off.
3. **Other health care staff availability:** Surgeries may be cancelled or not performed due to a lack of available nursing staff in general.
4. **Available funding:** The volume of surgery done in any given facility is constrained by the funding available. This is dependent on provincial health care budgets and the economy in general.
5. **Partial closures:** Partial closures may happen over summer or holiday periods when staff are not available (Figure 6).
6. **Specialized rooms:** Some rooms may be specifically designated trauma ORs or Caesarean section rooms reserved for such procedures only. Consequently, these would not be used continuously.

Benefits: Using this approach, estimates of OR occupancy rates can be derived using available data at a low cost. This methodology could also be used for at-a-glance calculations (modelling) to assess the potential to increase throughput of patients during a day shift, when staffing is most available.

Limitations: A limitation to deriving rates using available administrative data is the lack of background or granularity on low occupancy rates. Low OR occupancy rates may be related to temporary summer and holiday shutdowns or physician/staff availability (e.g., itinerant surgeons in smaller, remote communities), which cannot be accounted for in the administrative datasets. Shutdowns or closure days (non-holiday weekdays where no surgeries are performed) may be planned or unplanned and can be full days or partial days (Figure 6). Facilities ranged from 0 to 240 closure days, with facilities outside of urban areas having an average of 62 closure days in 2013–2014.

Figure 6: Closure Days



Note

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Sources

Discharge Abstract Database and National Ambulatory Care Reporting System, 2013–2014, Canadian Institute for Health Information.

Not to be overlooked is the potential for misinterpretation of this methodology with typically reported OR utilization rates or staff efficiency. Confusion with staff efficiency may have planners and OR managers questioning the validity of the data instead of recognizing that both are useful for different purposes. Other limitations that may impact low occupancy rates include variation in turnaround time by patient and procedure, population need and demand, and designated specialty OR rooms.

Conclusion

Provincial wait time representatives, particularly in smaller provinces, have expressed interest in this methodology to provide comparable information in an area where there is local data that cannot be rolled up due to differing definitions and systems or where there is no data available. Moving forward, researchers and planners with interest in investigating constrained resources may wish to further test and refine this methodology and apply it to areas beyond OR, such as emergency departments and intensive care units.

More Information

For more information about this report, please send an email to healthreports@cihi.ca.

Data Sources and Data Quality

Both the Discharge Abstract Database (DAD) and the National Ambulatory Care Reporting System (NACRS) are used to capture reported OR use from all care settings. The data sets capture information on surgical patients including location of surgery, time/date patient entered and left the OR, the nature of procedures performed and other demographic information. Ambulatory care procedure data is reported to NACRS by some facilities, however only those located in a main OR are included in this analysis. The main OR data that is reported to CIHI is defined by the *physical location within the health care facility where the intervention was performed*.[10] The definition used here may differ from facility-level reporting as it excludes other procedures performed in endoscopy rooms, cardiac catheter rooms, obstetric rooms, and OR-related resources such as pre- and post-operative rooms. This study focuses only on the *physical space* of the OR rather than on the types of procedures being performed there, so data from DAD and NACRS is merged.

As well, due to variation in organizational structures across Canada, some facilities report acute care and day surgeries via 2 or more separate sites within the same physical facility. To improve comparability between facilities, these sites are merged into a single entity using linking variables from the DAD and NACRS institution files (refer to Appendix 1).

Records of main OR procedures from DAD and NACRS were extracted for 2011–2012, 2012–2013 and 2013–2014 to create a master file for each fiscal year.

Inclusions:

Procedures done in a main OR and procedures having valid start and end date/time information

Exclusions:

- Out-of-hospital procedures on transferred patients (as these will be reported in duplicate, only the record from the facility where the procedure occurred is kept)
- Duplicate procedures based on health card number, health card province, gender, procedure start date/time
- Procedures longer than 12 hours (deemed to be a data quality concern)
- Wash period: Records as assigned to a year based on their discharge date. Procedures performed in the final 7 days of each fiscal year were excluded due to the high probability that patients with OR procedures during this time could be discharged (and filed) in the following fiscal year.

Data quality:

This methodology relies on the accurate capture of date/time information of when a patient is in the OR. Exclusion criteria were established to remove facilities with poor data quality in the procedure timing variables. For each of the 3 data years, only those facilities in which at least 75% of ambulatory care procedures and at least 75% of acute care OR procedures had valid start and end date/time values were included in the analysis. This process eliminated the Nova Scotia due to the lack of ambulatory care procedure timing data. Alberta and Quebec were also excluded due to lack of timing data, as well as difficulties in identifying main ORs within ambulatory care in Alberta (i.e., in 2013–2014, the procedure location field was blank for 99.8% of Alberta procedures in NACRS). In 2013–2014, 41 facilities outside of Alberta, Quebec and Nova Scotia were also excluded, leaving 242 facilities for analysis.

Appendix 1

Creation of the base file:

This initial step identified health records containing information about procedures that were performed in operating rooms (ORs). Records from the Discharge Abstract Database (DAD) and the National Ambulatory Care Reporting System (NACRS) were extracted for fiscal years 2011, 2012 and 2013 to create a master file of procedures for each year.

Step 1: Facility definition

For each year, facilities were defined using the Master Institution Code in the DAD. Because some provinces (Nova Scotia, Ontario and Alberta) reported their day surgeries to NACRS, the first step was to match those records using the NACRS Acute Care Number with the corresponding DAD acute care facility—as identified by Master Institution Code—so that all OR events in the facility were associated with a single entity.

Table A1: Merging NACRS and DAD Records

Database	Criteria	Variables or Codes
NACRS DAD	All day surgeries reported in NACRS (Nova Scotia, Ontario and Alberta) that were matched to DAD acute care facilities	• Acute_Care_Number (NACRS) • Master_Inst_Code (DAD)
DAD	All day surgeries reported in the DAD; some provinces submit acute care and ambulatory care to NACRS through separate institution numbers	• Inst_Code (DAD) • Master_Inst_Code (DAD)

Note
Henceforth, facilities will be identified by the Master Institution Code variable in the DAD.

Step 2: Apply inclusion and exclusion criteria for patient procedures

Table A2 lists the inclusion and exclusion criteria applied to procedures in the DAD and NACRS to create the OR base file.

Table A2: Potential Acute Care and Day Procedures

	Criteria	Variables or Codes to Look At	Database
Include	• Acute care and ambulatory care records • Valid gender • Procedure performed in main OR	• Analytical_Type_Code • Gender (M or F) • Location Code (DAD)/Interv location num (NACRS)	DAD NACRS
Exclude	• Procedures longer than 12 hours • Procedures with invalid times • Procedures that occurred outside of hospital • All duplicate procedures	• Episode start/end date/time (DAD) • Interv start date/time (NACRS) • Episode duration mins (NACRS) • Out of Hospital Indicator • Patient ID (Encrypted HCN: First 10 digits) + • Issuing Province + • Gender	DAD NACRS

Appendix 2

1. Counting functional ORs in each facility

The number of ORs in each facility is determined by considering the 99th percentile of the number of ORs in use during normal working hours (8 a.m. to 4 p.m.) throughout the year, at 15-minute intervals. The last week of the fiscal year is excluded from the analysis because patients with procedures during this time may not be discharged until the next fiscal year and are consequently not included in the data set.

Procedure inclusions: All base file procedures for a given facility with valid timing
Procedure exclusions: Procedures beginning in the last 7 days of the fiscal year (wash period)

Calculations:

i. Each working day,* the number of ORs in use is calculated at 8 a.m., repeated every 15 minutes throughout the day until 4 p.m.

ii. The 99th percentile of all of these measurements is used to represent the number of ORs in the facility. (Using the 99th percentile rather than the maximum reduces the potential impact of outliers due to data entry errors, etc.)

Note

* In fiscal year 2013, working days are Monday to Friday, excluding the following holidays: (2013) April 1, May 20, July 1, August 5, September 2, October 14 and December 25–26; (2014) January 1 and February 17. There were 246 working days between April 1, 2013, and March 24, 2014.

2. Calculation of OR occupancy rate

The OR occupancy rate is calculated first at the facility level. The numerator is adjusted to account for turnaround time (i.e., the time between procedures during which a patient is not present in the OR but the room is undergoing cleaning or other preparation).

Numerator:

The sum of a facility's OR procedure durations during normal working hours. To account for turnaround time, add 15/30 minutes for every ambulatory/acute care procedure, respectively. (The turnaround time adjustment applies only to procedures that occurred at least partly during normal working hours.)

For example, if a procedure is performed from 7 a.m. to 9 am or from 3 p.m. to 5 p.m., it would contribute 1 hour to the numerator, plus turnaround time.

Denominator:

246 × the number of ORs in a facility × 8 (where 246 represents the number of regular working days and 8 represents the length of the working day: 8 a.m. to 4 p.m.)

For example, if a facility has 3 ORs, then the occupancy rate denominator is 246 × 3 × 8 = 5,904 hours.

To obtain a provincial/national/urban area occupancy rate, the numerators and denominators of all the relevant facilities are summed separately, and the rolled-up occupancy rate is equal to the summed numerators, divided by the summed denominators.

Appendix 3

/* This program reads in the base file of OR procedures (i.e., where episodes have already been built from DAD and NACRS, and outputs the number of ORs and total adjusted daily OR hours for each facility */

/* The input variables are the facility code, the start/end of normal working hours (i.e., 0800/1600), the length (in hours) of the working day (i.e., 8), and the number of timepoints for the OR count every 15 minutes (i.e., 8 × 4 + 1 = 33).

```
%macro facility_profile(facility,peakstart,peakend,peaklength,timepoints);

/* reads in the OR procedures for a facility */

data facility;
set OR_INTERV_DAD_NACRS (where=(master_inst_code="&facility.”));
        procnum=_n_;
run;

/* Estimate OR capacity */

data findmax (keep=op_num:);
set facility (where=(peakdaynum le &peakdays.));
      e_start=.;
e_start=substr(episode_start_time,1,2)*100+substr(episode_start_time,3,2)*10/6;
 /* decimalized proc start and end times */

      e_end=.; e_end=substr(episode_end_time,1,2)*100+substr(episode_end_time,3,2)*10/6;
      array op_num{%eval(&peakdays.),&timepoints.} ;
      /* this array will hold the results of the count of ORs in use over time */

      peakstart_hours=100*floor(&peakstart./100);
      reftime_init=peakstart_hours + 10*(&peakstart.-peakstart_hours)/6;
      /* decimalized start time or normal working hours */

      peak_proc=0; /* indicator that the procedure occurs during normal working hours */

      /* one-day procs */
      if episode_start_date=episode_end_date then do;
          do j=1 to &timepoints.;
                reftime=reftime_init+(j-1)*&shift.;
                if -0.001 + e_start le reftime & 0.001 + e_end ge reftime then do;
                          op_num(peakdaynum,j)=1;
                         peak_proc=1; end;
      end;
      end;

      /* 2-day procs */
```

```
	else if episode_start_date=episode_end_date-1 & episode_end_time ge &peakstart. then
	do;
		if weekday(episode_end_date) in(1,7) or peakdaynum=&peakdays. or
		episode_end_date in ('06APR2012'd, '09APR2012'd, '21MAY2012'd,
		'02JUL2012'd, '06AUG2012'd, '03SEP2012'd, '08OCT2012'd, '25DEC2012'd,
		'26DEC2012'd, '01JAN2013'd, '18FEB2013'd, '29MAR2013'd) then; /* ignore if
		next day is not a peak day */

	else do j=1 to &timepoints.;

	reftime=reftime_init+(j-1)*&shift.;
	/*op_num(peakdaynum+1,j)=0;*/

	if 0.001 + e_end ge reftime then do; op_num(peakdaynum+1,j)=1; peak_proc=1; end;

	end;
	end;

	if peak_proc then output; run; /* erases procedures that don't occur during peak time */
run;

proc summary data=findmax nway;
	var op_num: ;
	output out=findmax2(drop=_type_ _freq_) sum=;
run;

proc transpose data=findmax2 out=findmax3A(keep=col1); run;

data findmax3; set findmax3A; if col1=. then col1=0; run; /* fix missing values */

/* this step calculates the 100th, 99th and 95th percentile of OR counts */
proc summary data=findmax3 nway;
	var col1;
	output out=OR_count(drop=_type_ _freq_) p95=orp95 max=orMAX
p&percentile.=orp&percentile.;
run;

/* calculate total OR time during normal working hours */

data daytime_OR_hoursA(keep= procnum admit_type episode: peak: dad_transaction_id );
set facility ;

	/* procedures starting and ending at the same time */
	if episode_start_date=episode_end_date then do;

	if - 0.001 + episode_start_time ge &peakend. or episode_end_time + 0.001 lt &peakstart.
	then delete; /* remove procs outside of normal working hours */
```

```
        peak_start_time=max(episode_start_time,&peakstart.); /* trim start/end times to stay
        within peak hours */
        peak_end_time=min(episode_end_time,&peakend.);
        output;
        end;

        /* procedures occurring over 2 days */
        else if episode_start_date = episode_end_date - 1 then do;
                if  - 0.001 + episode_start_time le &peakend. then do; /* start day contribution */
                    peak_start_time=max(episode_start_time,&peakstart.);
                    peak_end_time=&peakend.;
                    output;
        end;

        if  0.001 + episode_end_time ge &peakstart. then do; /* next day contribution */
                    episode_start_date + 1;
                    peak_start_time=&peakstart.;
                    peak_end_time=min(episode_end_time,&peakend.);
                    output;
        end;
        end;
run;

data daytime_OR_hoursAA;
set daytime_OR_hoursA;
        where &startdate. le  episode_start_date le &enddate.;
        peak_hours=.;
        pst_num=.; pet_num=.;

        pst_num=floor(peak_start_time/100) + (peak_start_time -
100*floor(peak_start_time/100))/60; /* decimalized version of trimmed proc time */
        pet_num=floor(peak_end_time/100) + (peak_end_time -
100*floor(peak_end_time/100))/60;; /* decimalized version of trimmed proc time */

        peak_hours=pet_num-pst_num; /* duration of the part of procedure occurring during
        normal working hours */
run;

/* This step returns us to 1 observation per procedure (may have been split into 2 records earlier
        in the program if it occurred over 2 days) */

proc summary data=daytime_OR_hoursAA nway;
        class procnum episode_start_date admit_type;
        var peak_hours;
        output out=daytime_OR_hoursAAA(drop=_type_ _Freq_) sum=peak_hours;
run;

/* Adjust for turnaround time */
```

```
data daytime_OR_hours;
set daytime_OR_hoursAAA;
        if admit_type= ‘D’ then peak_hours + 15/60; /* add 15 minutes for day surg */
        else peak_hours + 30/60; /* add 30 minutes for acute */
run;

/* Calculate total OR hours and procedure volume each day */

proc summary data=daytime_OR_hours nway;
        class episode_start_date;
        var peak_hours;
        output out=OR_hours_per_dayA(drop=_type_ rename=(_freq_=procedures))
sum=peak_hours;
run;

data or_hours_per_day;
merge OR_hours_per_dayA dates (in=p);
        by episode_start_date; if p;
        if procedures=. then do;
                procedures=0; peak_hours=0;
        end;
        dummy=1;
run;

proc transpose data=OR_hours_per_day out=temp1 (drop=_name_) prefix=test_ORU_rate;
        var peak_hours ;
        by dummy;
run;

proc transpose data=OR_hours_per_day out=temp11 (drop=_name_) prefix=test_volume;
        var procedures ;
        by dummy;
run;

/* Merge ORU hours, volumes and OR count into a single dataset */

data temp3(drop=i test: dummy);
        if _n_=1 then do;
        facility=“&facility.”;
        set OR_count;
        end;
merge temp1 temp11;
        by dummy;

        array a(*) test_oru_rate:;
        array b(*) oru_rate1-oru_rate&peakdays.;
        array c(*) test_volume:;
        array d(*) volume1-volume&peakdays.;
```

```
        do i=1 to dim(b); b(i)=0; d(i)=0;  end;
        do i=1 to dim(a); b(i)=a(i); d(i)=c(i);  end;

        peaklength=&peaklength.;
run;

PROC APPEND BASE=summary DATA=temp3; run; /* append the results for this facility to
summary file */


%mend;
```

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