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How many ICU beds does a province need?



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The Epidemiology and Outcomes of Critical Illness in Manitoba

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Introduction

- Critical illness is important in people and to society
 - associated with much human suffering
 - common -- and increasing
 - very expensive -- and increasingly so
- Most data about critical illness is from ICU databases covering one or a few ICUs/hospitals, over limited time period
- Some studies have used larger ICU databases, but these are few, and aren't population-based

Population-Based ICU Data

- In Manitoba we now possess a powerful tool for studying the population-based epidemiology of critical illness
 - combines comprehensiveness of admin data with the clinical detail of a dedicated clinical database (age 17+)
- Manitoba: no Canadian cities >15,000, nor any hospital with a trained ICU physician within 300 km of borders
 - except for those travelling when they get sick, Manitobans needing ICU care receive it in Manitoba

Adult ICUs in Manitoba (2007)

- Urban = Winnipeg & Brandon
 - Winnipeg: 6 hospitals, 11 ICUs -- 82 beds
 - Brandon: 1 hospital, 1 medical-surgical ICU -- 9 beds
 - staffed by Intensivists and specially trained ICU nurses
 - available 24-7-365; able to care for the full spectrum of critical illnesses
- Rural = all others
 - 9 hospitals, 9 general ICUs -- 27 total beds (2-4 each)
 - no Intensivists or specially trained ICU nurses
 - able to *temporarily* care for relatively sick patients
- Total: 118 beds, or 9.8 per 100k population (Can: 13.5)

“Right” Number of ICU Beds?

It’s complicated, depends on:

- Large fluctuations in demand (short-term)
- How often you are willing to be ‘full’
- Inefficiencies/consequences of being *almost* full
- Willingness to pay for additional supply
- Potential sharing of ICU beds across areas
 - practical geographic considerations

Measuring “Need” using “Use”

- True ‘demand’ for ICU care impossible to know precisely
- Next best thing: data on past usage
 - Solid, given combined clinical + admin databases
- Limitations:
 - Does not include unmet need – those who truly needed ICU care, but didn’t get it because units were already full (or almost)
 - Includes those in ICU but didn’t really need it - either never did, or stayed in ICU longer because no regular ward bed was available

Traditional approach

- Hill-Burton formula (US Dept of Health):
 - # beds = Ann bed use \div optimal occupancy
 - Ann bed use = one year's bed-days \div 365 = # beds
 - Optimal occupancy usually 80%, based on research showing that management is difficult above that level
- Bigger problem in Numerator: averaging over a year masks large daily fluctuations in demand
 - Includes all days of care in the year, but assumes they're spread evenly over all 365 days
 - Eg: Winnipeg: Ann avg was 62 beds, but max was 95

Our approach

- Imagine a simple daily ‘counting’ device for each ICU
 - Start from # patients in ICU on day 1
 - Every time a patient is admitted, add 1 to the counter
 - Every time a patient is discharged, subtract 1
 - Note the maximum value for each day (not # at midnight)
 - This provides the actual maximum at any moment that day
 - Do this for the entire year (8 years)
- This provides the ‘actual’ maximum number of ICU beds simultaneously used at any time, each day

Our approach (cont)

- Also examined impact of aggregation across hospitals / RHAs
 - Consider ability to share ICU beds within / across RHAs
 - BUT: sharing must be practical – account for geographic and transportation issues

Example with two ICUs

ICU	Day 1	Day 2	Day 3	
Hosp A	3	2	4	

Example with two ICUs

ICU	Day 1	Day 2	Day 3	
Hosp A	3	2	4	
Hosp B	1	4	1	

Example with two ICUs

ICU	Day 1	Day 2	Day 3	Max (Independent)
Hosp A	3	2	4	4
Hosp B	1	4	1	4

Example with two ICUs

ICU	Day 1	Day 2	Day 3	Max (Independent)
Hosp A	3	2	4	4
Hosp B	1	4	1	4
				8

Example with two ICUs

ICU	Day 1	Day 2	Day 3	Max (Independent)
Hosp A	3	2	4	4
Hosp B	1	4	1	4
Sum (shared)	4	6	5	8

Example with two ICUs

ICU	Day 1	Day 2	Day 3	Max (Independent)
Hosp A	3	2	4	4
Hosp B	1	4	1	4
Sum (shared)	4	6	5	8

- We counted ICU bed use for 8 years (2922 days), and looked at the distribution: on how many days did you have N patients, to see the Max, 99%, 95%, etc

Analysis of Actual Bed Usage (2007)

Location	# Actual Beds	Percentiles of Maximum Daily ICU bed occupancy		
		95th (18 days)	99th (4 days)	100th (0 days)
Winnipeg	82	81	86	95
Brandon	9	7	8	8
Rural North	8	3	4	6
Rural Mid	6	6	7	9
Rural South	13	8	10	11

Conclusion

- Manitoba did okay with 118 beds:
 - ‘Over census’ less than 5% of time in Wpg; less outside Wpg
 - Resource sharing within Winnipeg hospitals is key
 - Facilitated by ‘program’ organization
 - 9.8 beds per 100k pop – well below national avg of 13.5
- Then along came H1N1, which stretched the system dramatically (respirators)
- 10 new ICU beds added (10.7 / 100k)

Thank You / Questions



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ICU Utilization - 1

- 6,300 episodes/year
- 26,000 ICU patient-days/year
- Average ICU length of stay = 4.1 days
- 5% of usage for non-Manitobans (½ from Ontario)
- Changes over the 9 years:
 - # episodes/year fell slightly from 6,600 → 6,200
 - average ICU length of stay rose from 3.7 → 4.3
 - 9.7% more ICU bed-days in 2007/08 in than 1999/2000 -- average yearly increase of 1.2%

ICU Utilization - 2

- Changes over the 9 years:
 - # episodes/year fell slightly (6,600 → 6,200)
 - average ICU length of stay rose (3.7 → 4.3 days)
 - 9.7% more ICU bed-days in 2007/08 in than 1999/2000 -- average yearly increase of 1.2%
- ICU bed supply per 100,000 population (in 2007):
 - 9.8 for the whole province -- 13.4 in Winnipeg
 - Canada=13.5, Ontario=14.8, US=20.0
 - selected European countries=3.5-24.6
 - Problem or not?

Population-Based Rates of ICU Care, by Age

(Average over all 9 years)

