

# A Cost-Benefit Analysis of Private Versus Semi-Private Inpatient Rooms in a New Hospital

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# Background

- Many existing hospital facilities are outdated and occupy valuable land in central urban areas.
- Developers are eager to obtain the land for building houses or offices
- Hospital administrators would like to reduce costs and provide new facilities.
- Population increases, the baby boomer demographic shift, and increasing wealth and expectations raise the demand for hospital services.
- These pressures will lead to a significant increase in the number of new hospitals built during the next decade in Canada, Britain, the United States and elsewhere.

# Background

- In Canada and most other countries except the U.S., hospital construction is publicly funded, directly or indirectly.
- Typically, new urban hospitals cost more than \$1 billion to complete and last 50 years or more.
- Changing the layout is expensive, so it is usually avoided.
- Consequently, it is important to ensure that hospitals are initially designed as well as possible.

# Focus of this Paper

- Although many Canadian hospitals have inpatient rooms with four patient beds, this is no longer considered to be an option for a new Canadian hospital.
- Several new hospital projects in North America and Europe provide only private rooms, although Britain requires only 50 per cent private rooms in new constructions (Dowdeswell et al., 2004; Jones et al., 2004).
- How many occupants in each inpatient hospital room?
- Should they be private rooms or semi-private rooms?

# The Specific Question

- Obviously, there are trade-offs.
- Private rooms are generally preferred by patients, may minimize the spread of disease and aid recovery times
- But they take up more space and they are more expensive to build and to staff than semi-private rooms.
- Are they worth it from a social CBA perspective?

# Outline of This Paper-1

1. Previous literature about the effect of different occupancy rates
2. Itemise the cost and benefit impacts of a private room relative to a semi-private room
3. Estimate the incremental costs and benefits of a private room for a new hospital to replace St. Pauls—requires valuation and discounting Benefits are based on Canadian WTP data

# Outline of This Paper-2

4. Alternative estimates of benefits based on:
  - U.S. data
  - Adding up the component parts
5. Sensitivity Analysis:
  - Construction costs
  - Physician costs
  - Discount rate

# 1. Previous Literature

- Surprisingly, there has been little economic analysis of alternative hospital room designs, and none focuses on the issue of (single versus double) occupancy.
- The existing literature on hospital design concerns construction costs, identifies some design impacts on patients and contains qualitative information about benefits and costs; see, for example, the literature review by Chaudhury et al. (2005).
- However, the estimates consist mainly of “expert opinion” and rarely contain quantitative data.
- The limited empirical research that does exist applies to specific clinical situations rather than to full institutions.
- No previous quantitative estimates of the social costs and benefits of building new hospital rooms with different occupancy.

## 2. Incremental Costs of a Private Room

Impact	Cost	Benefit	Description
<b>COSTS</b>			
Land cost	X		Larger room requires more land
Construction cost	X		Single-occupancy room is larger
Maintenance	X		Interior refinishing and updating of interior fixtures and furniture every 10 years
Housekeeping and operating costs	X		Based on ward area
Health provision	X		Longer distances traveled by nurses, doctors

# Patient Impacts and Other Impacts of a Private Room

Impact	Cost	Benefit	Description
<b>PATIENT IMPACTS</b>			
Patient Health and Satisfaction		X	
- Privacy and ability to sleep		X	Preference for privacy. Also, improved ability to rest increases recovery times
- Patient care, reduced infection and fewer adverse events		X	Patients are more open and honest, reduced infection, nurses make fewer errors
- No help or companionship from roommate	X		Could help with surveillance, falls, reassurance
<b>OTHER IMPACTS</b>			
Patient transfers (orderlies)		X	Fewer transfers, but slightly longer distances Reduced patient waiting time; slight increase in
Patient turnover	X	X	administrative costs

# 3. Quantitative Estimates-- Assumptions

- We assume the new hospital will last 50 years after which it will be demolished.
  - Architects often consider a hospital's useful life is 40 years although hospitals are frequently in use for longer.
  - Fraumeni (1997) reviews the practices of the BEA for measuring the depreciation of assets, and finds that government hospitals typically have a service life of 50 years (private hospitals of 48 years).
- Discount rate of 3.5 percent (Moore et al., 2004).
- All figures are expressed in 2005 dollars.

# The Rooms and Wards

Designed according to “best practices”:

- Have as much natural light as the building codes allow
- Airflow at the recommended circulation levels
- Non-handed (i.e. standardized headboards) rooms adaptable to changing acuity (i.e. illness) levels of patients
- Ward unit floor plan that minimizes staff walking and maximizes the ability of nurses to monitor patients from central nursing stations (e.g. triangular or hub and spoke layout)

# Private Rooms

- Private rooms require about 265 sq. ft. per patient
- Semi-private rooms require about 165 sq. ft. per patient.
- Difference is is approximately 100 sq. ft. (61 per cent) per bed unit

# And More Corridor Space

- Assuming each ward was triangular, with 120 ft sides
- The total ward floor space would be 10,464 sq. ft. (436 sq. ft. per bed) on a ward with private rooms and 12,060 sq. ft. (287 sq. ft. per bed) on a ward – 52% more (Similar to Davis Langdon Adamson, 2003, who suggested 49 percent more space).
- The overall gross mark-up of total space per patient to room space per patient is 1.74 (i.e.  $287/165$ ) for semi-private patient beds and 1.65 (i.e.  $436/265$ ) for private patient beds.

# Cost of Incremental Space

- Developers pay between \$100 to \$110 per buildable sq. ft. on the west side of Vancouver and from \$30 to \$35 per buildable sq. ft. on the east side in Vancouver.
- Assume \$80 per buildable sq. ft.
- The land cost for each semi-private bed would be \$22,960, and for a private bed it would be \$34,880, a difference of \$11,920 per patient bed.

# But Only Rent it for 50 Years

- Need to subtract the present value of possessing this additional land in 50 years time
- Assuming no change in the relative price of land over 50 years, the PV of owning the land in 50 years is \$4,111 per semi-private room, \$6,245 per private room, a difference of \$2,134.
- Thus, the net incremental land cost of a private patient bed over 50 years is \$9,786.

# Construction Costs

- Davis Langdon Adamson (2004) estimated US construction cost components for ten new hospital ward designs.
- Excluding costs that would not vary with room types, they estimate the cost of construction is \$410 per sq. ft.
- Construction cost of a patient bed:
  - in a semi-private room is  $\$410 \times 287 = \$117,670$ ,
  - in a private room is  $\$410 \times 436 = \$178,760$ ,
  - a difference of \$61,090 per patient bed.

# Maintenance

- Not much major refurbishing due to the significant pipefitting (gas and plumbing) costs required
- However, rooms receive new fixtures, flooring, wall coverings and furniture every 10 years or so
- Typically, such updates cost approximately 10 percent of construction costs
- \$1,177 per annum for a semi-private patient bed, \$1,788 per annum for a private patient bed
- Difference of \$611 per year, PV = \$14,329.

# Housekeeping and Operations

- Housekeeping costs at St. Paul's are \$7.26 per sq. ft. per annum and plant operations cost \$9.62 per sq. ft. per annum (Anis, 2005).
- A new hospital design with a "Green Building" whole systems approach for responding to changing heating and cooling loads would reduce plant operations costs by \$1.56 per sq. ft. (Harvard Green Campus Initiative, 2005).
- The annual housekeeping and costs would be \$4,397 for a semi-private room, \$6,680 for a private room, a difference of \$2,283 per annum, PV = \$53,542.

# Patient Care Costs-Nurses Time

- Patient carers have to walk an extra half an hour per shift
- Assuming 5 hours of nursing support per patient per day and a 7.5 hr work shift, each patient bed would require 0.66 nurses per day.
- Thus, each private patient would require about 20 minutes more nursing time per day ( $0.66 \times 30$  minutes), which is equivalent to 122 additional nursing hours per year per patient bed.

# Incremental Nursing Costs

- Registered nurses perform approximately 75 per cent of nursing duties; licensed practical nurses perform the remainder.
- Nurses earn roughly \$60,000 and \$41,000 per annum
- Each hour of patient care costs \$28.34 in nursing time. Consequently, the additional nursing cost from having private patients would be \$3,457 per bed per year (122 hours per patient bed x \$28.34 per hour), PV = \$81,086.

# Shortage of Nurses

- Will lead to rising real nursing costs
- Assuming that the real relative wages of nurses increase at 2 percent per annum for the next ten years and then remain unchanged, the PV of the increased nursing time for a private room would equal \$85,522.

# Patient Care Costs-Doctors Time

- Nurses spend 1.3 % of their time on rounds with doctors
- Assuming doctors spend the same amount of time on their rounds
- Implies that doctors spend  $1.3\% \times 122 = 1.5$  hours more time per patient per year in a private room
- Given the average Canadian physician's salary is \$187,951 per year, or \$96.39 per hour, this amounts to \$153 per patient bed per year, PV equal to \$3,589.

# Patient Benefits

- Based on willingness to pay
- Sum of the components method (later)

# Prices of Alternative Rooms

	<b>Semi-Private</b>	<b>Private</b>	<b>Difference</b>	<b>Wards</b>	<b>Semi-Private</b>	<b>Private</b>
	<b>(\$)</b>	<b>(\$)</b>	<b>(\$)</b>	<b>(%)</b>	<b>(%)</b>	<b>(%)</b>
Burnaby General	100	130	30			
Surrey Memorial	90	120	30	54	36	9
Lions Gate Hospital	90	110	20	46	39	16
Richmond General	60	100	40	82	9	9
Vancouver Hospital and Health Science Centre	110	150	40			
University of British Columbia Hospital	75	115	40	33	33	33
St. Pauls Hospital	85	120	34	48	32	20
Average Canadian Sample	87	121	33	53	30	17

# Price Differences May Reflect Value

- Combination of wards (4+), semi-private and private rooms
- Excess demand for both private and semi-private rooms
- Average price difference = \$33 per day
- Higher prices reflect higher quality
- Given a new facility, we assume patients are willing to pay \$40 per day

# Occupancy Rate

- Patient beds cannot be and should not be occupied 100 percent of the time.
- Target occupancy rates tend to be higher in units with predictable utilisation, such as medical/surgical units, than in units with less predictable utilisation, such as maternity or an intensive care unit (ICU).
- Beds may be “closed” due to renovations, seasonal short staffing, and budgetary restrictions. Such beds are typically excluded from consideration when calculating occupancy rates.

# Patient Benefits

- While the proposed new hospital will probably set an overall occupancy rate goal of 85 per cent *for all open beds*, this would be approximately equivalent to a goal of about 80 per cent *of the total beds*.
- Incremental patient benefit of a private room is \$32 ( $\$40 \times 0.80$ ) per night or \$12,439 per year, which has a PV of \$291,769.

# Fewer Patient Transfers

- In existing hospitals with 30 patients per ward, there are approximately 5 transfers per week on average
- Take just less than 30 minutes in time and cost about \$28.76
- Private rooms reduce requests for privacy
- Suppose they reduce the number of within-ward transfers from 0.167 (5 out of 30) per week per bed to zero but will have no effect on moves to ICU wards
- Private rooms would save \$249.75 per bed per year, PV = \$5,858.

# Shorter Waiting Times

- Private rooms may reduce length of stay due better diagnosis, better treatment, better sleep, fewer adverse events.
- Later, we estimate that private rooms reduce the number of preventable adverse events by about one event per bed year.
- Baker et al. (2004) estimated that an adverse event increases the length of hospitalization by about 16 days.
- Thus, each private room could reduce the usage of each patient bed by 0.16 days per year.
- Given that the incremental cost of a day in an acute care room is about \$250 per bed per day, the estimated benefit of reduced waiting times would equal approximately \$40 per bed per year (PV= \$938).

# Costs and Benefits of a Private Room

Impact	Semi-Private Room	Private Room	Difference	PV of difference
<b>Up-Front Costs</b>				
Land Cost (per patient bed)	18,849	28,635	9,786	9,786
Construction Cost (per patient bed)	117,670	178,760	61,090	61,090
<b>On-going Annual Costs</b>				
Maintenance	1,177	1,788	611	14,329
Housekeeping and Operating	4,397	6,680	2,283	53,542
Cost of nurses care			3,457	85,522
Cost of doctors			153	3,589
<b>Total costs</b>				<b>227,857</b>
<b>Annual Benefits</b>				
Patients' Willingness to Pay	22,864	35,303	12,439	291,769
Reduced Transfers			250	5,858
<b>Total benefits</b>				<b>297,627</b>
<b>Net Social Benefits</b>				69,770

## 4. Benefits Based on U.S. Data

	<b>Semi- Private (\$)</b>	<b>Private (\$)</b>	<b>Difference (\$)</b>
Bronson Medical Center	n/a	2020	n/a
Hackensack Medical Center	7246	7497	251
Southwest Medical Center	916	960	44
Swedish Medical Center	1615	1615	0
Sacred Heart Hospital	847	847	0
University of Washington Medical Center	1096	1506	410
Average US sample	2344	2408	141

# Benefits Based on Components

Patients are willing to pay for:

- Privacy and quiet
- Reduced sickness

# Quiet

- Wibe (1997) studied the cost of noise in Sweden and found that persons were willing to pay roughly 6.5 per cent of mean monthly rental charge per household to decrease noise to a “quiet” or non-disruptive level.
- The average rent for a two-bedroom apartment in Vancouver is \$984 per month, implying the cost of noise reduction would be \$63.96 per month or \$2.12 per day.
- Saelendminde (1999) found the willingness to pay for road traffic noise reduction by an “annoyed” person is between \$645 and \$1291 per year in Norway, i.e. approximately \$2.65 per day.
- Using the average of these amounts suggests that for quieter rooms people are willing to pay \$2.38 per day, \$695 per year (PV of \$16,300)

# Privacy

- A survey of eight advertised singles cruises of 3-night to 12-night durations that originated in different parts of the world
- We found that the average cost differential for private accommodation for an inside cabin is \$121.75 per day.
- People may be willing to pay more for privacy on a singles holiday than in hospital due to higher disposable income and personal preferences. And there is some evidence that privacy is less valued with increasing illness (Spork, 1990).
- Nonetheless, the results do suggest that our earlier \$40 per day estimate for a private hospital room is likely to be on the low side.

# Patient Treatment, Patient Health

- Strong belief that private rooms result in better treatment, fewer medical errors, reduced chance of hospital-acquired infection or other adverse events.
  - better suited to the maintenance of patient confidentiality
  - Roughly 5 per cent of patients in multi-bed rooms withhold portions of their medical history and/or refuse components of their physical examinations (Barlas et al., 2001)
  - Nurses overwhelmingly consider patient consultation/examination is improved in single patient rooms (Chaudhury et al., 2003).

# Infections and Disease

- Patients may worry about hospital-acquired infections from antibiotic resistant pathogens (MRSA, VRE), the presence of airborne pathogens (tuberculosis, varicella-zoster) and potentially highly virulent and transmissible pathogens (SARS).
- On average, nosocomial infection rates range between 7 and 10 per cent of all inpatients, with rates in the ICU approaching 50 per cent (Filetoth, 2003).

# However, the evidence is weak

- Some evidence of improvement as go from 5-person to 4-person wards, little benefit after that

# But ANY impact has a big effect

- Good work environments that lessen staff fatigue and unhappiness can reduce medical errors leading to mortality by about 5 per cent (Lundstrom et al., 2002).
- Suppose, therefore, that private rooms reduce the incidence of preventable adverse events by 1 percent.
- Equivalent to one preventable adverse event per bed year, of which 20% die and 80% suffer serious illness

# Monetization of Health Benefits

- Using a VSL of \$4.48 million (Zhang et al., 2004)
- Recognising that Blincoe et al. (2000) estimate the cost of a serious crash injury requiring hospitalization is \$325,480 (AIS 3), while the cost of a severe crash injury is \$757,837 (AIS 4). Subtracting the cost of medical and emergency services, insurance administrative costs, legal costs, property damage and travel delay costs yields an estimated value of \$228,554 for a serious injury avoided and \$536,482 for a severe injury avoided.
- Helliwell (2005) proposes an alternative approach and estimates the income equivalent to a change in happiness associated with enduring a serious illness is \$320,000.
- These estimates imply a saving of \$8,960 for deaths avoided per bed year and a saving of \$2,560 for serious illness avoided per bed year for a total of \$11,520 per bed per year, which has an NPV of \$270,209.

# 5. Sensitivity Analysis

- Construction costs may not be so high. If only \$250 per sq. ft., this would increase net social benefits (NSB) by \$23,840 per patient bed to \$94,818.
- Discount rate of 2% increases the NPV by \$53,721 to \$124,429 per patient bed. If we use a higher discount rate of 5 percent, the PV of the net social benefits decreases by \$27,727 to \$42,981 per patient bed.

# Conclusion

- It is clear to us that for the average patient the incremental benefits of a private room exceed the incremental costs
- NPV of approximately \$71,000 per patient bed