

# Estimating the proportion of reasonably preventable hospital-acquired infections and associated mortality and costs

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## Background

- Hospital acquired infections (HAIs) are common, and numerous strategies to prevent them have been studied
- In Oct '08, Medicare began to encourage hospitals to adopt these strategies by instituting a policy of nonpayment for “reasonably preventable” HAIs
- Some have asserted that not all HAIs are preventable, and that this new incentive punishes hospitals that care for patients at high risk of HAIs

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## Objectives

- To inform discussions regarding the preventability of HAIs, we estimated:
  - 1) the proportion of reasonably preventable HAIs in US hospitals
  - 2) mortality and costs associated with reasonably preventable HAIs

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## Methods

$$\begin{array}{l} \text{Range of HAI preventability (\%)}^1 \\ \times \\ \text{Annual number of HAIs and HAI deaths}^2 \\ = \\ \text{Range of annual number of preventable} \\ \text{HAIs and HAI deaths} \end{array}$$

$$\begin{array}{l} \text{Range of annual number of preventable HAIs} \\ \times \\ \text{Incremental cost of HAIs}^3 \\ = \\ \text{Range of annual avoidable HAI costs} \end{array}$$

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## Methods

### 1. Range of preventability

- Use an AHRQ systematic review that examined published interventions to reduce BSI, UTI, SSI, and VAP
- We constructed ranges of preventability for each HAI by using the lowest and highest risk reductions reported in the AHRQ review for higher quality US studies published in last decade

### 2. Annual number of HAIs and HAI deaths

- Use most recently published national data

### 3. Incremental cost of an HAI

- Perform a systematic review of the published literature
- Use data from US studies reporting comprehensive cost analyses adjusted for confounders

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## Results: AHRQ Systematic Review

Infection type	BSI	VAP	UTI	SSI
Total studies included in AHRQ report	19	12	10	28
Excluded on quality grounds	10	5	1	15
Excluded: more than 10 years old	0	1	3	3
Excluded: didn't report risk reductions for infections	0	1	2	2
Excluded: non-US	2	2	2	5
Included in this analysis	7	3	2	3

15 studies included in our analysis

Ranji SR, Shetty K, Posley KA, Lewis R, Sundaram V, Galvin CM, et al. Volume 6--prevention of healthcare-associated infections. Rockville, MD: Agency for Healthcare Research and Quality; 2007 January 2007. Report No.: AHRQ Publication No. 04(07)-0051-6.

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## VAP Prevention Studies

Author Year	Study Design	Setting	Intervention	Comp	Risk before	Risk after	Risk Red.
<b>Good quality</b>							
Babcock 2004	Before-after study	ICU	Hand hygiene HOB>30° Daily interruption of sedation Clinician education	Previous care	8.75 per 1,000 vent days	4.74 per 1,000 vent days	46%
Zack 2002	Before-after study	ICU	HOB>30° Clinician education	Previous care	12.6 per 1,000 vent days	5.7 per 1,000 vent days	55%
<b>Moderate quality</b>							
Lai 2003	Before-after study	ICU	HOB>30° Clinician education Audit & feedback	Previous care	SICU: 45.1 per 1,000 vent days	SICU: 27.9 per 1,000 vent days	38%
					MICU: 22.4 per 1,000 vent days	MICU: 11.6 per 1,000 vent days	48%

Range of Risk Reductions = 38-55%

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## Range of Risk Reductions for all HAIs

HAI	Reduction in HAI risk with QI
BSI	18%–66%
VAP	38%–55%
UTI	17%–69%
SSI	26%–54%

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## Hospital-acquired infections in 2002

Type of HAI	Number of HAIs	Deaths from HAIs
BSI	248,678	30,665
VAP	250,205	35,967
UTI	561,667	13,088
SSI	290,485	8,205

Klevens RM, Edwards JR, Richards CL, Jr, Horan TC, Gaynes RP, Pollock DA, et al. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. Public Health Rep. 2007 Mar-Apr;122(2):160-6.

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## Estimating Preventable HAIs and HAI Deaths

HAI	HAIs (N)	HAI Deaths (N)	Reduction in HAI risk with QI	Preventable HAIs (N)	Preventable HAI deaths (N)
VAP	250,205	35,967	38%–55%	95,078–137,613	13,667–19,782

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## Summary estimates of preventable HAIs and HAI deaths for all HAIs

HAI	HAIs (N)	Deaths (N)	Reduction in infection risk with QI	Preventable infections (N)	Preventable deaths (N)
BSI	248,678	30,665	18%–66%	84,551–203,916	10,426–25,145
VAP	250,205	35,967	38%–55%	95,078–137,613	13,667–19,782
UTI	561,667	13,088	17%–69%	95,483–387,550	2,225–9,031
SSI	290,485	8,205	26%–54%	75,526–156,862	2,133–4,431

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## Example Search: VAP Cost Studies

Search	Syntax	Hits
1	(exp Respiration, Artificial/ or mechanically ventilated\$.ti. or intubated\$.ti. or mechanical ventilation\$.ti. or ventilator associated\$.ti.) and (exp Cross infection/ or exp bacteremia/ or nosocomial\$.ti.ab. or "healthcare associated\$.ti.ab. or "hospital acquired\$.ti.ab. or bundle\$.ti.ab.)	1,640
2	(((((Economics.mp. or exp Costs/) and Cost Analysis/) or "Value of Life".mp. or exp Economics, Medical/ or exp Economics, Hospital/ or exp Economics, Nursing/ or exp Economics, Pharmaceutical/ or exp Fees/) and Charges/) or Budgets.mp. or exp Models, Economic/ or Markov Chains.mp. or Monte Carlo Method.mp. or Decision Trees.mp. or "Quality of Life".mp. or Patient Satisfaction.mp. or Quality-Adjusted Life Years.mp. [mp=title, original title, abstract, name of substance word, subject heading word])	179,815
3	(econom\$ or cost or costly or costing or costed or costs or price or prices or pricing or priced or discount or discounts or discounted or discounting or expenditure or expenditures or budget\$ or afford\$ or pharmacoeconomic\$ or (pharmaco adj2 economic\$) or (decision adj2 (tree\$ or analy\$ or model?)) or ((value or values or valuation) adj2 (money or monetary or life or lives)) or QOL or QOLY or QOLYs or HRQOL or QALY or QALYs or (quality adj2 life) or (willingness adj2 pay) or (quality adj2 adjusted?life?year?)).mp.	525,288
4	1 and (2 or 3)	175
5	Pneumonia, Ventilator-Associated/ec	4
6	exp Respiration, Artificial/ae and exp Respiration, Artificial/ec	34
7	4 or 5 or 6	206
8	Limit to (English language and yr="1998-2008")	130
	Articles retrieved	12
	Included in analysis	4

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## Systematic Review to Estimate Incremental Cost of HAIs

Type of infection	Number of initial hits	Number of included articles
BSI	126	4
VAP	130	4
UTI	67	3
SSI	107	4

15 studies included in our analysis

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### VAP Cost Studies

Author	Lansford 2007 (13)	Cocanour 2006 (38)	Warren 2003 (14)	Rello 2002 (39)
Setting	Kansas City Trauma ICU	Houston Trauma ICU	St. Louis Med/Surg ICUs	Nationwide ICUs
N	13	70	127	816
Primary or secondary?	Secondary	Primary	Primary	Secondary
Type	Cost identification	Cost identification	Cost identification	Cost identification
Definition of infection	By infection control team using NNISS criteria	By infection control team using NNISS criteria	By infection control team using NNISS criteria	Not reported
Control group	Patients in same ICU without infection	Matched on age and Injury Severity Score.	Patients in same ICU without infection	Matched on type of admission, predicted mortality, duration of ventilation, and age.
Study design (cost component of study)	Average total costs for patients with VAP vs. patients without VAP	Average total costs for patients with VAP vs. patients without VAP	Average total costs for patients with VAP vs. patients without VAP	Average total charges for patients with VAP vs. patients without VAP
Source of cost data (baseline year)	Not reported 2003-04 dollars	Hospital cost accounting database, 2002-03 dollars	Hospital cost accounting database, 1998-99 dollars	Hospital billed charges database, 1998-99 dollars
Costs measured	Total hospital costs/charges: details and overhead costs not reported	Total ICU costs: details and overhead costs not reported	All costs in database, including overhead	All charges in database, overhead costs not reported
Perspective / Horizon	Hospital / Not reported	Hospital/ ICU stay	Hospital / Inpatient stay	Hospital / Not reported
Main economic outcome	Mean incremental charges per hospitalization attributable to VAP	Mean incremental ICU costs per stay attributable to VAP	Adjusted mean incremental costs per hospitalization attributable to VAP	Mean incremental charges per hospitalization attributable to VAP
Adjusted results (2008 dollars)	No multivariate analysis	No multivariate analysis	mean: \$21,800 95% CI: \$7,100-35,500	No multivariate analysis

## Estimated incremental cost per HAI

Infection type	Estimated cost per infection case (2008 dollars)
BSI	\$20,200-\$104,800
VAP	\$21,800
UTI	\$3,750
SSI	\$2,100

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## Summary estimates of preventable HAIs, HAI deaths, and HAI costs

HAI	HAIs (N)	Deaths (N)	Reduction in infection risk with QI	Preventable infections (N)	Preventable deaths (N)	Estimated cost per infection case (2008 dollars)	Avoidable costs (millions of 2008 dollars)
VAP	250,205	35,967	38%-55%	95,078-137,613	13,667-19,782	\$21,800	\$2,073M-\$3,000M

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## Summary estimates of preventable infections, deaths, and costs for all HAIs

HAI	HAIs (N)	Deaths (N)	Reduction in infection risk with QI	Preventable infections (N)	Preventable deaths (N)	Estimated cost per infection case (2008 dollars)	Avoidable costs (millions of 2008 dollars)
BSI	248,678	30,665	18%–66%	84,551–203,916	10,426–25,145	\$20,200–\$104,800	\$1,708M–\$21,370M
VAP	250,205	35,967	38%–55%	95,078–137,613	13,667–19,782	\$21,800	\$2,073M–\$3,000M
UTI	561,667	13,088	17%–69%	95,483–387,550	2,225–9,031	\$3,750	\$358M–\$1,453M
SSI	290,485	8,205	26%–54%	75,526–156,862	2,133–4,431	\$2,100	\$159M–\$329M

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## Limitations

- Survey data we use to calculate number of HAIs and HAI deaths is from 2002
- Difficulty in attributing a death to HAIs
- Quality of the HAI reduction and cost studies
- Lack of HAI reduction studies that have directly measured death as an outcome

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## Conclusions

- In those settings examined, reductions in HAIs have never achieved 100%, even with evidence-based infection control strategies
- Instead, an upper bound of 65 to 70% risk reduction may exist for BSI and UTI, and approximately 55% for VAP and SSI

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## Conclusions

- Even though 100% preventability may not be attainable, evidence-based infection control strategies could prevent hundreds of thousands of HAIs, and save tens of thousands of lives and billions of dollars
- One should not base policy decisions on these estimates without understanding their limitations

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## Implications

- Given the difficulty in preventing 100% of HAIs, it may be more appropriate to use strategies other than the current payment schemes to encourage HAI reduction
- Newer strategies could lessen the bias of current payment schemes against medical centers that care for the most medically complex patients

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