

Healthcare Associated Infections (HAI): Rates

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Your taxes at work

HAI Rates Objectives

- Describe methods used to calculate HAI rates and select the most appropriate method for each type of HAI
- Understand the importance of producing data taking into account the severity of patient's condition and the complexity of the intervention to allow meaningful comparisons
- Collect appropriate numerators and denominators for rate calculation

Rates: Numerators

- Number of infections
- Number of patients infected
- Note:
 - Infections caused by multiple organisms of similar origin at the same site = single infection
 - In a patient with a previously established nosocomial infection, a second nosocomial infection should be recorded in two situations:
 1. the appearance of clinical infection at a new and different site
 2. the appearance in culture of new and different organisms if deterioration in patient's condition

Rates: Denominators

- Number of patients admitted (or discharged)
- Number of hospital days
- Number of device days

Hospital Wide Rates

- Hospital wide nosocomial infection rate /100 Admissions for a given period: month, quarter, year.

$$= \frac{\text{Number of nosocomial infections}}{\text{Number of patients admitted}} * 100$$

In this rate a patient with 2 infections is counted twice

- Hospital wide patient infected rate /100 Admissions for a given period: month, quarter, year

$$= \frac{\text{Number of patients infected}}{\text{Number of patients admitted}} * 100$$

In this rate a patient with 2 infections is counted only once

Ward Specific Rates



- Rate of infection /1,000 HD

$$= \frac{\text{Number of infections}}{\text{Number of hospital days}} * 1000$$

- Rate of Patients infected /1,000 HD

$$= \frac{\text{Number of patients infected}}{\text{Number of hospital days}} * 1,000$$

Device Specific Rates, Procedure Specific Rates

- Surgical Site Infection rate:

$$= \frac{\text{Number of surgical site infections}}{\text{Number of patients operated on}} * 100$$

- Ventilator Associated Pneumonia rate:

$$= \frac{\text{Number of ventilator associated pneumonia}}{\text{Number of patients on ventilator-days}} * 1,000$$

- Catheter Related Blood Stream Infection rate:

$$= \frac{\text{Number of Catheter related BSI}}{\text{Number of patients on IV line-days}} * 100$$

How To Calculate A Device-Associated Infection Rate

- Step 1: Decide on the time period for analysis: month, quarter, 6 months, year
- Step 2: Select patient population for analysis (stratum), example: type of ICU or birthweight category
- Step 3: Select infections to be used in numerator
 - must be site-specific
 - must have occurred in selected patient population
 - date of onset must be during the selected time period

How To Calculate A Device-Associated Infection Rate cont.

- Step 4: Determine number of device-days used as denominator
 Device-days = total number of days of exposure to device (central line, ventilator, or urinary catheter) by all patients in selected population during selected time period
- Step 5: Calculate device-associated infection rate (per 1000 device-days) using the formula:

$$\text{Device-associated infection rate} = \frac{\text{Number of device-associated infections for specific site}}{\text{Number of device-days}} * 1000$$

Utilization Rate

- The Device Utilization Rate (DUR) is the proportion of patient days for which a certain device is used
 - DUR are specific to a certain device: catheter, IV line, ventilator
 - DUR reflects the amount of devices used and is a reflection of the patient severity
- $$= \frac{\text{Number of Device Days}}{\text{Number of Patient Days}} * 100$$

How to Calculate a Device Utilization Ratio

- Step 1: Decide on the time period for analysis: month, quarter, 6 months, year
- Step 2: Select patient population for analysis, ie, type of ICU or a birthweight category
- Step 3: Determine the number of device-days used as a numerator
 Device-days = total number of days of exposure to the device (central line, ventilator, or urinary catheter) by all patients in the selected population during the selected time period

 Note: Step 3 is the same as Step 4 in the device-day but here it is used as a numerator

Device Utilization Ratio cont.

- Step 4: Determine the number of patient-days which is used as denominator of DU ratio
 Patient-days = total number of days that patients are in the ICU during selected time period
- Step 5: Calculate the DU ratio with the following formula:

$$\text{DU ratio} = \frac{\text{Number of device-days}}{\text{Number of patient-days}}$$

 Example DU = $28/72 = 0.39$ or 39% of patient-days were also central line-days for the first week of the month

Risk Adjustment: Assessing Severity of Illness

- APACHE (Acute Physiology & Chronic Health Evaluation)
- Discharge diagnosis systems
- Made for predicting mortality, not NI
- Require individual evaluation of each member of denominator

APACHE II

THE APACHE II SEVERITY OF DISEASE CLASSIFICATION SYSTEM

PHYSIOLOGIC VARIABLE	HIGH ABNORMAL RANGE					LOW ABNORMAL RANGE				
	+4	+3	+2	+1	0	-1	-2	-3	-4	
TEMPERATURE — rectal (°C)	≥ 41.1	39.4–40.9		38.5–38.9	36.7–38.4		32.2–35.9	30.2–31.9	≤ 28.9	
MEAN ARTERIAL PRESSURE — mm Hg	≥ 160	130–159	110–129		70–109		50–69		≤ 39	
HEART RATE (ventricular response)	≥ 180	140–179	110–139		70–109		50–69	40–54	≤ 39	
RESPIRATORY RATE — (not-ventilated or ventilated)	≥ 30	25–29		20–24	12–24	15–11	6–9		≤ 5	
OXYGENATION: A-ADO ₂ or P _{AO₂} (mm Hg): a. P _{AO₂} ≥ 0.5 record A-ADO ₂ , b. P _{AO₂} ≥ 0.5 record only P _{AO₂}	≥ 500	350–499	200–499	≤ 200	PO ₂ ≥ 70	PO ₂ 61–70	PO ₂ 55–60	PO ₂ ≤ 55		
ARTERIAL pH	≥ 7.7	7.67–7.69		7.57–7.59	7.37–7.49		7.27–7.32	7.15–7.24	≤ 7.15	
SERUM SODIUM (mmol/L)	≥ 160	150–159	130–159		120–149		110–129	111–119	≤ 110	
SERUM POTASSIUM (mmol/L)	≥ 7	6.5–6.9		6.5–6.9	3.5–4	3.4	2.5–2.9		≤ 2.5	
SERUM CREATININE (mg/100 ml) (Double point score for acute renal failure)	≥ 3.5	2.5–3.4		1.5–1.9	1.5–1.4		≤ 0.8		≤ 0.8	
HEMATOCRIT (%)	≥ 50	40–49	30–39	20–29	10–19	5–9	≤ 5		≤ 5	
WHITE BLOOD COUNT (cells/mm ³) (≥ 1,000)	≥ 40	20–39	15–19	5–9	3–4		≤ 1		≤ 1	
GLASGOW COMA SCORE (GCS): Score = 15 minus actual GCS										
A) Total ACUTE PHYSIOLOGY SCORE (APS): Sum of the 12 individual variable points										
B) Serum HCO ₃ (venous-mmol/L) (Not preferred, use if no ABGs)	≥ 25	20–24	15–19	10–14	5–9		≤ 5		≤ 5	
AGE POINTS: Assign points to age as follows: AGE (yr) Points ≤ 44 0 45–54 1 55–64 2 65–74 3 ≥ 75 4										
CHRONIC HEALTH POINTS: If the patient has a history of severe organ system insufficiency or is immuno-compromised assign points as follows: a. for nonoperative or emergency postoperative patients — 5 points b. for elective postoperative patients — 2 points DEFINITIONS: Organ insufficiency or immuno-compromised state must have been evident prior to the hospital admission and conform to the following criteria: LIVER: biopsy proven cirrhosis and documented portal hypertension; episodes of past upper GI bleeding attributed to portal hypertension; or prior episodes of hepatic failure/encephalopathy/coagulopathy. CARDIOVASCULAR: New York Heart Association Class IV. RESPIRATORY: Chronic restrictive, obstructive, or vascular disease resulting in severe exercise restriction, i.e., unable to climb stairs or perform household duties; or documented chronic hypoxia, hypercapnia, secondary polycythemia, severe pulmonary hypertension (>40mmHg), or respirator dependency. RENAL: Requiring chronic dialysis. IMMUNO-COMPROMISED: The patient has received therapy that suppresses resistance to infection, e.g., immunosuppression, chemotherapy, radiation, long-term or recent high-dose steroids, or has a disease that is sufficiently advanced to suppress resistance to infection, e.g., leukemia, lymphoma, AIDS.										
APACHE II SCORE: Sum of A + B + C + D + E + F + G + H + I + J + K + L + M + N + O + P + Q + R + S + T + U + V + W + X + Y + Z + AA + AB + AC + AD + AE + AF + AG + AH + AI + AJ + AK + AL + AM + AN + AO + AP + AQ + AR + AS + AT + AU + AV + AW + AX + AY + AZ + BA + BB + BC + BD + BE + BF + BG + BH + BI + BJ + BK + BL + BM + BN + BO + BP + BQ + BR + BS + BT + BU + BV + BW + BX + BY + BZ + CA + CB + CC + CD + CE + CF + CG + CH + CI + CJ + CK + CL + CM + CN + CO + CP + CQ + CR + CS + CT + CU + CV + CW + CX + CY + CZ + DA + DB + DC + DD + DE + DF + DG + DH + DI + DJ + DK + DL + DM + DN + DO + DP + DQ + DR + DS + DT + DU + DV + DW + DX + DY + DZ + EA + EB + EC + ED + EE + EF + EG + EH + EI + EJ + EK + EL + EM + EN + EO + EP + EQ + ER + ES + ET + EU + EV + EW + EX + EY + EZ + FA + FB + FC + FD + FE + FF + FG + FH + FI + FJ + FK + FL + FM + FN + FO + FP + FQ + FR + FS + FT + FU + FV + FW + FX + FY + FZ + GA + GB + GC + GD + GE + GF + GG + GH + GI + GJ + GK + GL + GM + GN + GO + GP + GQ + GR + GS + GT + GU + GV + GW + GX + GY + GZ + HA + HB + HC + HD + HE + HF + HG + HH + HI + HJ + HK + HL + HM + HN + HO + HP + HQ + HR + HS + HT + HU + HV + HW + HX + HY + HZ + IA + IB + IC + ID + IE + IF + IG + IH + II + IJ + IK + IL + IM + IN + IO + IP + IQ + IR + IS + IT + IU + IV + IW + IX + IY + IZ + JA + JB + JC + JD + JE + JF + JG + JH + JI + JJ + JK + JL + JM + JN + JO + JP + JQ + JR + JS + JT + JU + JV + JW + JX + JY + JZ + KA + KB + KC + KD + KE + KF + KG + KH + KI + KJ + KK + KL + KM + KN + KO + KP + KQ + KR + KS + KT + KU + KV + KW + KX + KY + KZ + LA + LB + LC + LD + LE + LF + LG + LH + LI + LJ + LK + LL + LM + LN + LO + LP + LQ + LR + LS + LT + LU + LV + LW + LX + LY + LZ + MA + MB + MC + MD + ME + MF + MG + MH + MI + MJ + MK + ML + MM + MN + MO + MP + MQ + MR + MS + MT + MU + MV + MW + MX + MY + MZ + NA + NB + NC + ND + NE + NF + NG + NH + NI + NJ + NK + NL + NM + NN + NO + NP + NQ + NR + NS + NT + NU + NV + NW + NX + NY + NZ + OA + OB + OC + OD + OE + OF + OG + OH + OI + OJ + OK + OL + OM + ON + OO + OP + OQ + OR + OS + OT + OU + OV + OW + OX + OY + OZ + PA + PB + PC + PD + PE + PF + PG + PH + PI + PJ + PK + PL + PM + PN + PO + PP + PQ + PR + PS + PT + PU + PV + PW + PX + PY + PZ + QA + QB + QC + QD + QE + QF + QG + QH + QI + QJ + QK + QL + QM + QN + QO + QP + QQ + QR + QS + QT + QU + QV + QW + QX + QY + QZ + RA + RB + RC + RD + RE + RF + RG + RH + RI + RJ + RK + RL + RM + RN + RO + RP + RQ + RR + RS + RT + RU + RV + RW + RX + RY + RZ + SA + SB + SC + SD + SE + SF + SG + SH + SI + SJ + SK + SL + SM + SN + SO + SP + SQ + SR + SS + ST + SU + SV + SW + SX + SY + SZ + TA + TB + TC + TD + TE + TF + TG + TH + TI + TJ + TK + TL + TM + TN + TO + TP + TQ + TR + TS + TT + TU + TV + TW + TX + TY + TZ + UA + UB + UC + UD + UE + UF + UG + UH + UI + UJ + UK + UL + UM + UN + UO + UP + UQ + UR + US + UT + UU + UV + UW + UX + UY + UZ + VA + VB + VC + VD + VE + VF + VG + VH + VI + VJ + VK + VL + VM + VN + VO + VP + VQ + VR + VS + VT + VU + VV + VW + VX + VY + VZ + WA + WB + WC 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Risk Adjustment

- For comparison: rates should be adjusted for risk factors
- Risk adjustment is labor intensive because data must be collected on the entire population at risk (denominator) rather than only the fraction with infections (numerator)
- Risk adjustment cannot correct for variability among data collectors in accuracy of finding and reporting events
- Current risk-adjustment methods improve but do not guarantee the validity of inter-hospital comparisons, especially comparisons involving facilities with diverse patient populations (e.g., community versus tertiary-care hospitals)

Risk Adjustment By Stratification

- Stratification = calculation of rates separately in multiple categories for risk adjustment
- NHSN Example: device-associated infections are risk adjusted by
 - rates/1,000 device-days (SSI/1,000 central line-days)
 - stratifying by unit type
 - SSI risk adjustment of SSIs done by calculating of operation-specific rates stratified by a standardized risk index
 - do not incorporate all potential confounding variables
 - but acceptable level of risk adjustment
 - avoids data collection burden required to adjust for all variables
- Drawback:
 - small numbers of infections in any one category
 - unstable rates (small hospital with low surgical volume)

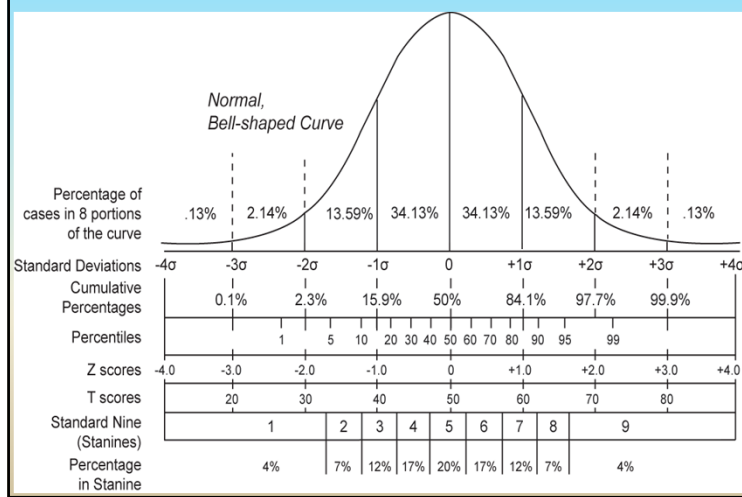
Percentiles

- Step 1: Evaluate the rate (ratio) calculated for the hospital and confirm that variables in the rate (both numerator and denominator) are identical to the rates (ratios) in the Table.
- Step 2: Examine the percentiles in each of the Tables and look for the 50th percentile (or median).
 - At the 50th percentile, 50% of the hospitals have lower rates (ratios) than the median, and 50% have higher rates (ratios).
- Step 3: Determine whether the hospital's rate (ratio) is above or below this median.

Percentiles

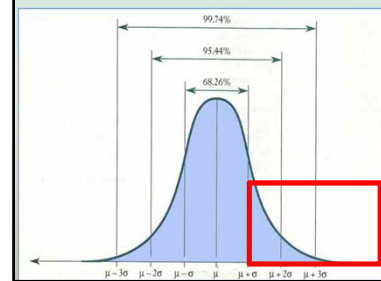
- Step 4: If the hospital's rate or ratio is $>$ median, determine where rate the (ratio) falls: between 50th and 75th, 75th and 90th or $>90^{\text{th}}$.
- Step 5: Do the same if the hospital rate (ratio) is $<$ median.

Percentiles



Percentiles

- If the ratio is above the 90th percentile, it is a **high outlier**
- It may be due to:
 - True excess of HAI
 - Excess infections due to misclassification: including colonization for example
 - Underestimation of denominators: low device days

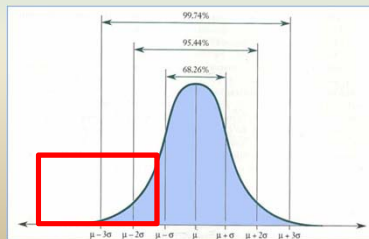


Prevent miscalculations:

- 1-Follow definitions
- 2-Check risk factors and strata
- 3-Check device-days

Percentiles

- If the ratio is below the 10th percentile, it is a **low outlier**
- It may be due to:
 - underreporting of infections
 - infrequent and/or short duration of device use.



National Healthcare Safety Network

- NHSN will replace
 - NNIS: National Nosocomial Infections Surveillance
 - NaSH: National Surveillance System for Health Care Workers (NaSH)
 - DSN: Dialysis Surveillance Network
- Integrates healthcare personnel safety surveillance systems managed by the Division of Healthcare Quality Promotion (DHQP) at CDC.

National Healthcare Safety Network

- Secure web-based reporting and knowledge system for patient and healthcare worker safety information
 - Provide comparative data
 - Access to guidelines, prevention tools
- Integrated data repository at CDC

National Healthcare Safety Network

- NHSN comprises data on
 - Healthcare Associated Infections
 - Health Care Worker Health
 - Dialysis surveillance
 - Blood & Blood products associated adverse reactions and incidents
- Open to all US HCF: acute care hospitals, long term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centers, ambulatory surgery centers, and long term care facilities.
- Voluntary, secure, internet-based surveillance system

Surgical Patients, NHSN

- Record on every patient undergoing selected procedure generated with risk factors information for SSI
 - Wound class
(Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Am J Infect Control 1999;27:97-134.)
 - Duration of operation
 - American Society of Anesthesiology (ASA) score
(Owens WD, Felts JA, Spitznagel EL Jr. ASA physical status classification: a study of consistency of ratings. Anesthesiology 1978;49:239-43)
- Using a composite index for predicting SSI risk after operation calculate rates by the number of risk factors present
(Culver DH, Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG, et al. Surgical wound infection rates by wound class, operative procedure, and patient risk index. Am J Med 1991;91(Suppl 3B):152S-7S.)

SSI Rates

By Operative Procedure & Risk Index, 2007/08

Table 22. SSI rates* by operative procedure and risk index category, PA module, 2006 through 2007

SSI rate-inpatient procedures						
Procedure code	Operative procedure description	Duration cut point (min)	Risk index category	No. of procedures	No. of SSI	Pooled mean
AAA	Abdominal aortic aneurysm repair	225	0,1	881	16	1.82
AAA	Abdominal aortic aneurysm repair	225	2,3	288	15	5.21
APPY	Appendix surgery	81	0,1	2691	40	1.49
APPY	Appendix surgery	81	2,3	372	13	3.49
AVSD	Arteriovenostomy for renal dialysis	111	0,1,2,3	606	6	0.99
BILI	Bile duct, liver or pancreatic surgery	330	0,1	422	37	8.77
BILI	Bile duct, liver or pancreatic surgery	330	2,3	202	33	16.34
BRST	Breast surgery	202	0	997	8	0.80
BRST	Breast surgery	202	1	914	25	2.74
CARD	Cardiac surgery	300	0,1	10,382	121	1.17
CARD	Cardiac surgery	300	2,3	3396	58	1.71
CBGB	Coronary bypass w/chest and donor incision	300	0	1003	3	0.30
CBGB	Coronary bypass w/chest and donor incision	300	1	47,296	1399	2.96
CBGB	Coronary bypass w/chest and donor incision	300	2,3	15,706	767	4.88
CBGC	Coronary bypass graft with chest incision	285	0,1	3495	57	1.63
CBGC	Coronary bypass graft with chest incision	285	2,3	1147	33	2.88
CEA	Carotid endarterectomy	133	0,1,2,3	2615	11	0.42
CHOL	Gallbladder surgery	121	0,1,2,3	3337	23	0.69
COLO	Colon surgery	188	0	9539	399	4.18
COLO	Colon surgery	188	1	16,537	1004	6.07
COLO	Colon surgery	188	2	7270	582	8.01
COLO	Colon surgery	188	3	810	88	10.86
CRAN	Craniotomy	219	0,1	4596	99	2.15
CRAN	Craniotomy	219	2,3	1048	49	4.68

SSI Rates By Operative Procedure & Risk Index, 2007/08 Percentiles

Table 23. Percentiles of the distribution of SSI rates,* PA module, 2006 through 2007

SSI percentiles-inpatient procedures					Percentile				
Procedure code	Operative procedure description	Risk index category	No. of hospitals	Pooled mean	10%	25%	50% (median)	75%	90%
CARD	Cardiac surgery	0,1	64	1.17	0.00	0.00	0.66	1.58	2.91
CARD	Cardiac surgery	2,3	46	1.71	0.00	0.00	1.10	2.79	3.65
CBGB	Coronary bypass w/chest and donor incision	1	160	2.96	0.00	1.18	2.48	4.09	5.34
CBGB	Coronary bypass w/chest and donor incision	2,3	134	4.88	0.00	2.00	3.80	6.52	10.08
CBGC	Coronary bypass graft with chest incision	0,1	55	1.63	0.00	0.00	0.00	3.30	5.08
CEA	Carotid endarterectomy	0,1,2,3	21	0.42	0.00	0.00	0.00	0.94	1.48
COLO	Colon surgery	0	121	4.18	0.00	0.95	3.70	6.02	9.44
COLO	Colon surgery	1	184	6.07	0.00	2.22	4.76	8.33	12.50
COLO	Colon surgery	2	123	8.01	0.00	2.11	6.06	9.56	15.83
CRAN	Craniotomy	0,1	27	2.15	0.00	0.00	1.61	2.10	4.27
CSEC	Cesarean section	0	32	1.50	0.00	0.29	1.33	3.05	3.44
CSEC	Cesarean section	1,2,3	33	2.64	0.00	0.19	1.99	4.00	8.41
RUSN	Spinal fusion	0	59	0.72	0.00	0.00	0.37	0.99	1.78
RUSN	Spinal fusion	1	59	1.95	0.00	0.71	1.54	2.70	3.81
RUSN	Spinal fusion	2,3	38	4.13	0.00	1.94	4.00	5.52	9.21
RK	Open reduction of fracture	1	23	1.69	0.00	0.69	1.52	2.43	4.08
GAST	Gastric surgery	0,1	23	1.84	0.00	0.70	1.48	2.90	3.80
HPRO	Hip prosthesis	0	110	0.75	0.00	0.00	0.28	1.04	2.04
HPRO	Hip prosthesis	1	127	1.68	0.00	0.00	1.35	2.13	3.01
HPRO	Hip prosthesis	2,3	69	2.97	0.00	0.00	2.21	4.00	6.89
HYST	Abdominal hysterectomy	0	84	1.12	0.00	0.00	0.70	1.95	2.67
HYST	Abdominal hysterectomy	1	67	2.41	0.00	0.00	1.88	3.60	7.78
HYST	Abdominal hysterectomy	2,3	24	4.37	0.00	0.00	3.13	5.66	8.63
KPRO	Knee prosthesis	0	126	0.68	0.00	0.00	0.32	0.90	1.46
KPRO	Knee prosthesis	1	138	1.12	0.00	0.00	0.77	1.49	2.63
KPRO	Knee prosthesis	2,3	89	1.82	0.00	0.00	1.63	2.81	5.00

SSI

- Risk Index Category
- ASA
- Duration

CLABSI Rates Percentiles

Table 3. Pooled means and key percentiles of the distribution of central line-associated BSI rates and central line utilization ratios, by type of location, DA module, 2006 through 2007

Type of location	Central line-associated BSI rate*				Percentile				
	No. of locations	No. of CLABSI	Central line-days	Pooled mean	10%	25%	50% (median)	75%	90%
Critical care units									
Burn	22	239	42,452	5.6	0.0	1.5	3.8	8.2	13.5
Coronary	121	373	181,079	2.1	0.0	0.0	1.3	2.8	5.3
Surgical cardiothoracic	97	397	275,194	1.4	0.0	0.0	1.2	1.9	3.4
Medical	144	1073	454,839	2.4	0.0	0.6	1.9	3.6	5.3
Medical/surgical, major teaching	104	692	342,214	2.0	0.0	0.5	1.5	3.0	4.2
Medical/surgical, all others	343	972	662,489	1.5	0.0	0.0	0.6	2.0	3.6
Pediatric medical/surgical	71	404	140,848	2.9	0.0	0.0	2.1	3.8	6.0
Pediatric medical	10	6	6256	1.0					
Neurologic	15	31	25,440	1.2					
Neurosurgical	39	173	68,550	2.5	0.0	0.0	1.9	3.8	6.2
Surgical	128	881	383,126	2.3	0.0	0.5	1.7	3.1	5.1
Trauma	32	435	107,620	4.0	0.3	1.5	4.0	5.7	7.7
Inpatient wards									
Adult step down unit (postcritical care)	24	61	24,981	2.4	0.0	0.0	0.7	2.7	3.5
Medical	40	111	60,257	1.8	0.0	0.0	0.0	2.2	3.4
Medical/surgical	82	169	132,133	1.3	0.0	0.0	0.0	1.6	4.0
Rehabilitation	11	2	3705	0.5					
Surgical	18	40	24,254	1.6					

Central Line Utilization Ratios Percentiles

Type of location	No. of locations	Central line-days	Patient-days	Pooled mean	Percentile				
					10%	25%	50% (median)	75%	90%
Critical care units									
Burn	24	42,452	72,329	0.59	0.24	0.34	0.52	0.71	0.82
Coronary	122	181,079	453,850	0.40	0.17	0.26	0.37	0.50	0.61
Surgical cardiothoracic	99	275,194	382,960	0.72	0.48	0.60	0.75	0.88	0.93
Medical	149	454,839	785,602	0.58	0.27	0.42	0.56	0.68	0.77
Medical/surgical, major teaching	104	342,214	581,286	0.59	0.37	0.46	0.58	0.71	0.75
Medical/surgical, all others	362	662,489	1,428,609	0.46	0.14	0.27	0.42	0.56	0.67
Pediatric medical/surgical	75	140,848	303,879	0.46	0.21	0.30	0.40	0.52	0.61
Pediatric medical	10	6256	16,569	0.38					
Neurologic	15	25,440	59,027	0.43					
Neurosurgical	39	68,550	154,242	0.44	0.26	0.36	0.46	0.60	0.70
Surgical	128	383,126	624,986	0.61	0.39	0.50	0.62	0.69	0.76
Trauma	32	107,620	166,487	0.65	0.51	0.56	0.64	0.71	0.80
Inpatient wards									
Adult step down unit (postcritical care)	27	24,981	97,615	0.26	0.03	0.09	0.21	0.33	0.46
Medical	40	60,257	256,098	0.24	0.07	0.14	0.18	0.27	0.57
Medical/surgical	92	132,133	638,229	0.21	0.03	0.07	0.11	0.22	0.35
Rehabilitation	11	3705	42,061	0.09					
Surgical	18	24,254	97,235	0.25					

NOTE: See Horan et al⁴ for criteria.

* $\frac{\text{Number of CLABSI}}{\text{Number of central line-days}} \times 100$

† $\frac{\text{Number of central line-days}}{\text{Number of patient-days}}$

BSI, bloodstream infection including criteria 1 and 2a only; CLABSI, central line-associated BSI.

Permanent Central Lines No Percentiles

Table 4. Pooled means and key percentiles of the distribution of permanent central line-associated BSI rates and central line utilization ratios, by type of location, DA module, 2006 through 2007

Type of location	Permanent central line-associated BSI rate*				Percentile				
	No. of locations	No. of PCLAB	Permanent central line-days	Pooled mean	10%	25%	50% (median)	75%	90%
Specialty care area									
Bone marrow transplant	11	110	28,251	3.9					
Hematology/oncology	10	44	25,740	1.7					
Type of location	Permanent central line utilization ratio [†]				Percentile				
	No. of locations	Permanent central line-days	Patient-days	Pooled Mean	10%	25%	50% (median)	75%	90%
Specialty care area									
Bone marrow transplant	11	28,251	42,459	0.67					
Hematology/oncology	10	25,740	69,487	0.37					

NOTE: See Horan et al⁴ for criteria.

* $\frac{\text{Number of PCLAB}}{\text{Number of permanent central line-days}} \times 100$

† $\frac{\text{Number of permanent central line-days}}{\text{Number of patient-days}}$

BSI, bloodstream infection including criteria 1 and 2a only; PCLAB, permanent central line-associated BSI.

Urinary Tract Infections Percentiles

Table 5. Pooled means and key percentiles of the distribution of urinary catheter-associated UTI rates and urinary catheter utilization ratios, by type of location, DA module, 2006 through 2007

Type of location	Urinary catheter-associated UTI rate*				Percentile				
	No. of locations	No. of CAUTI	Urinary catheter-days	Pooled mean	10%	25%	50% (median)	75%	90%
Critical care units									
Burn	16	217	28,326	7.7					
Coronary	56	636	143,926	4.4	0.6	2.7	3.8	6.1	8.5
Surgical cardiothoracic	48	506	156,199	3.2	0.0	1.6	2.6	4.1	6.1
Medical	68	1419	347,465	4.1	0.6	1.9	3.7	5.5	7.9
Medical/surgical, major teaching	59	981	299,628	3.3	0.7	1.7	2.9	4.3	6.2
Medical/surgical, all others	130	1603	514,552	3.1	0.0	1.0	2.6	4.3	6.5
Pediatric medical/surgical	37	222	44,542	5.0	0.0	0.0	3.0	6.6	9.8
Neurosurgical	20	485	71,658	6.8	0.4	3.3	6.5	8.1	10.5
Surgical	65	1145	282,600	4.1	0.4	1.5	3.1	4.9	9.2
Trauma	21	624	109,849	5.7	1.8	3.5	5.7	7.1	7.5
Inpatient wards									
Adult step down unit (postcritical care)	20	109	23,430	4.7					
Medical	20	220	38,316	5.7	0.0	1.6	4.2	7.7	8.5
Medical/surgical	63	341	68,758	5.0	0.0	0.6	3.4	7.2	9.2
Rehabilitation	13	98	5821	16.8					
Surgical	11	97	18,573	5.2					

Urinary Catheter Utilization Ratios Percentiles

Type of location	Urinary catheter utilization ¹				Percentile				
	No. of locations	Urinary catheter-days	Patient days	Pooled mean	10%	25%	50% (median)	75%	90%
Critical care units									
Burn	16	28,326	43,317	0.65					
Coronary	56	143,926	242,052	0.59	0.31	0.48	0.62	0.70	0.78
Surgical cardiothoracic	49	156,199	196,708	0.79	0.49	0.71	0.83	0.88	0.95
Medical	68	347,465	458,606	0.76	0.63	0.71	0.76	0.83	0.87
Medical/surgical, major teaching	59	299,628	379,416	0.79	0.63	0.76	0.80	0.85	0.91
Medical/surgical, all others	132	514,552	715,845	0.72	0.54	0.67	0.79	0.84	0.89
Pediatric medical/surgical	39	44,542	158,304	0.28	0.13	0.18	0.26	0.33	0.41
Neurosurgical	20	71,658	88,576	0.81	0.69	0.77	0.82	0.88	0.91
Surgical	65	282,600	349,008	0.81	0.64	0.77	0.83	0.88	0.94
Trauma	21	109,849	121,015	0.91	0.82	0.88	0.90	0.94	0.96
Inpatient wards									
Adult step down unit (postcritical care)	20	23,430	68,283	0.34					
Medical	20	38,316	148,890	0.26	0.12	0.17	0.24	0.28	0.43
Medical/surgical	69	68,758	309,870	0.22	0.11	0.16	0.22	0.27	0.30
Rehabilitation	13	5821	48,151	0.12					
Surgical	11	18,573	59,977	0.31					

¹Ratio of CAUTI/Number of urinary catheter-days × 1000
²Number of urinary catheter-days
³Number of patient-days
 UTI, urinary tract infection; CAUTI, urinary catheter-associated UTI.

Ventilator Associated Pneumonia Rates Percentiles

Table 6. Pooled means and key percentiles of the distribution of ventilator-associated PNEU rates and ventilator utilization ratios, by type of location, DA module, 2006 through 2007

Type of location	Ventilator-associated PNEU rate ^a				Percentile				
	No. of locations	No. of VAP	Ventilator-days	Pooled mean	10%	25%	50% (median)	75%	90%
Burn	19	243	22,765	10.7					
Coronary	72	211	83,446	2.5	0.0	0.0	1.2	3.3	4.9
Surgical cardiothoracic	70	523	112,400	4.7	0.0	1.4	3.4	7.1	13.1
Medical	93	656	257,631	2.5	0.0	1.0	1.9	4.0	6.1
Medical/surgical, major teaching	79	692	209,617	3.3	0.5	1.3	2.3	4.1	7.7
Medical/surgical, all others	187	808	344,085	2.3	0.0	0.0	1.5	3.4	5.7
Pediatric medical/surgical	50	176	85,809	2.1	0.0	0.0	0.7	3.2	4.1
Neurologic	11	101	14,180	7.1					
Neurosurgical	26	263	40,748	6.5	0.0	3.2	4.5	6.5	11.7
Surgical	87	954	178,405	5.3	0.7	2.1	4.5	7.1	10.5
Trauma	25	719	76,926	9.3	0.5	2.7	8.3	11.1	16.7
Inpatient wards									
Adult step down unit (postcritical care)	15	23	5021	4.6					

Ventilator Utilization Ratios Percentiles

Type of location	Ventilator utilization ratio ¹				Percentile				
	No. of locations	Ventilator-days	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
Critical care units									
Burn	19	22,765	55,285	0.41					
Coronary	74	83,446	304,885	0.27	0.09	0.14	0.26	0.32	0.43
Surgical cardiothoracic	73	112,400	290,898	0.39	0.18	0.24	0.35	0.45	0.53
Medical	94	257,631	573,167	0.45	0.23	0.32	0.45	0.56	0.63
Medical/surgical, major teaching	81	209,617	471,619	0.44	0.22	0.31	0.44	0.58	0.65
Medical/surgical, all others	207	344,085	990,010	0.35	0.11	0.22	0.33	0.43	0.53
Pediatric medical/surgical	54	85,809	206,380	0.42	0.14	0.25	0.37	0.49	0.55
Neurologic	11	14,180	36,669	0.39					
Neurosurgical	26	40,748	107,095	0.38	0.25	0.29	0.36	0.44	0.48
Surgical	87	178,405	437,594	0.41	0.21	0.29	0.40	0.50	0.59
Trauma	25	76,926	131,941	0.58	0.41	0.49	0.56	0.65	0.76
Inpatient wards									
Adult step down unit (postcritical care)	15	5021	68,430	0.07					

¹Ratio of VAP/Number of ventilator-days × 1000
²Number of ventilator-days
³Number of patient-days
 PNEU, pneumonia infection; VAP, ventilator-associated PNEU.

Central Line Rates and Line Utilization Ratios in NICU Percentiles

Table 7. Pooled means and key percentiles of the distribution of central line-associated BSI rates and central line utilization ratios for level III NICUs, DA module, 2006 through 2007

Birth-weight category	Central line-associated BSI rate ^a				Percentile				
	No. of locations	No. of CLABSI	Central line-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤750 g	82	225	60,850	3.7	0.0	0.0	2.3	4.9	9.0
751-1000 g	84	185	55,445	3.3	0.0	0.0	2.4	4.5	7.3
1001-1500 g	83	144	55,874	2.6	0.0	0.0	1.6	3.6	6.1
1501-2500 g	71	105	44,402	2.4	0.0	0.0	1.1	3.3	6.0
>2500 g	61	87	42,611	2.0	0.0	0.0	0.0	3.1	5.4
Birth-weight category	Central line utilization ratio ¹				Percentile				
	No. of locations	Central line-days	Patient-days	Pooled Mean	10%	25%	50% (median)	75%	90%
≤750 g	88	60,850	177,542	0.34	0.19	0.29	0.35	0.44	0.53
751-1000 g	91	55,445	175,397	0.32	0.18	0.22	0.31	0.40	0.51
1001-1500 g	94	55,874	238,102	0.23	0.09	0.16	0.22	0.31	0.38
1501-2500 g	93	44,402	273,739	0.16	0.03	0.07	0.12	0.20	0.33
>2500 g	87	42,611	213,322	0.20	0.05	0.07	0.13	0.19	0.30

NOTE: See Horan et al⁴ for criteria.
 BSI, bloodstream infection including criteria 1, 2a, and 3a only; CLABSI, central line-associated BSI.
^aNumber of CLABSI/Number of central line-days × 1000
¹Number of central line-days/Number of patient-days

Umbilical Catheter Rates and Line Utilization Ratios in NICU Percentiles

Table 8. Pooled means and key percentiles of the distribution of umbilical catheter-associated BSI rates and umbilical catheter utilization ratios for level III NICUs, DA module, 2006 through 2007

Umbilical catheter-associated BSI rate ^a					Percentile				
Birth-weight category	No. of locations	No. of UCAB	Umbilical catheter-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤750 g	71	79	16,762	4.7	0.0	0.0	0.0	7.7	14.7
751-1000 g	70	39	15,034	2.6	0.0	0.0	0.0	4.1	8.8
1001-1500 g	67	32	16,681	1.9	0.0	0.0	0.0	2.8	7.8
1501-2500 g	62	15	16,321	0.9	0.0	0.0	0.0	0.0	3.0
>2500 g	68	22	22,978	1.0	0.0	0.0	0.0	0.0	3.7

Umbilical catheter utilization ratio ^b					Percentile				
Birth-weight category	No. of locations	Umbilical catheter-days	Patient-days	Pooled mean	10%	25%	50% (median)	75%	90%
≤750 g	85	16,762	155,133	0.11	0.05	0.08	0.12	0.20	0.28
751-1000 g	87	15,034	151,822	0.10	0.05	0.06	0.11	0.18	0.24
1001-1500 g	90	16,681	207,079	0.08	0.03	0.05	0.08	0.14	0.19
1501-2500 g	92	16,321	250,858	0.07	0.02	0.03	0.06	0.10	0.14
>2500 g	89	22,978	219,705	0.10	0.05	0.06	0.09	0.15	0.20

NOTE: See Horan et al⁴ for criteria.

BSI, bloodstream infection including criteria 1, 2a and 3a only; UCAB, umbilical catheter-associated BSI.

^a $\frac{\text{Number of UCAB}}{\text{Number of umbilical catheter-days}} \times 1000$

^b $\frac{\text{Number of umbilical catheter-days}}{\text{Number of patient-days}}$

Aggregate Comparisons

- To get the high-level view, it would be ideal to find a way to aggregate data from all unit types to yield a single number.
- The Standardized Infection Ratio is a way to do just that

Standardized Infection Ratio

- SIR, is a summary measure used to compare the HAI experience among one or more groups of patients to that of a standard population's
- Indirect standardization method
- Accounts for differences in risk of HAI among the groups

$$\text{SIR} = \frac{\text{Observed (O) HAIs}}{\text{Expected (E) HAIs}}$$

- To calculate O, sum the number of HAIs rates among a group
- To calculate E, requires the use of the appropriate aggregate data (risk-adjusted rates)

Potential Applications for the SIR

- Can provide public health policy makers with (and others) with an overview of HAI rates across several units or facilities.
- Is a measure with "built-in" risk adjustment.
- Might be useful in helping direct us to facilities with particular problems.

