Hospital Acquired Infections in the Era of Antimicrobial Resistance

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Patient Story

- 23 Year old female admitted with acute heart failure related to congenital heart disease
- Cardiology SHO inserted peripheral vascular cannula to administer a bolus of frusemide and admitted the patient to CCU

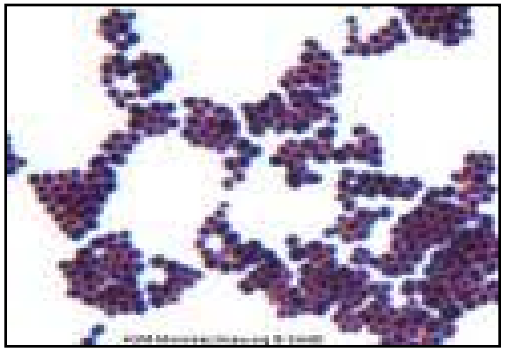
Patient Story

- 2 days later patient much improved, transferred back to the ward.
- Not in receipt of any intravenous treatments.
- Plan for home in further day or so for work up for elective heart valve replacement surgery.

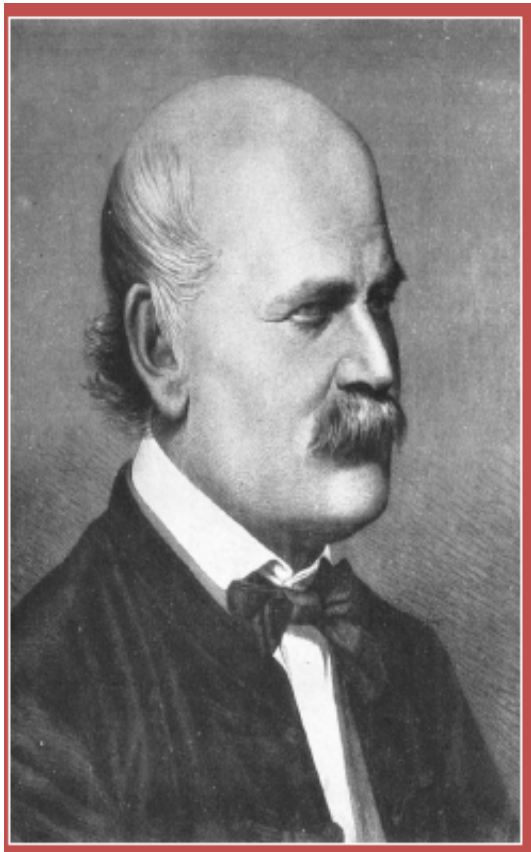
Patient Story

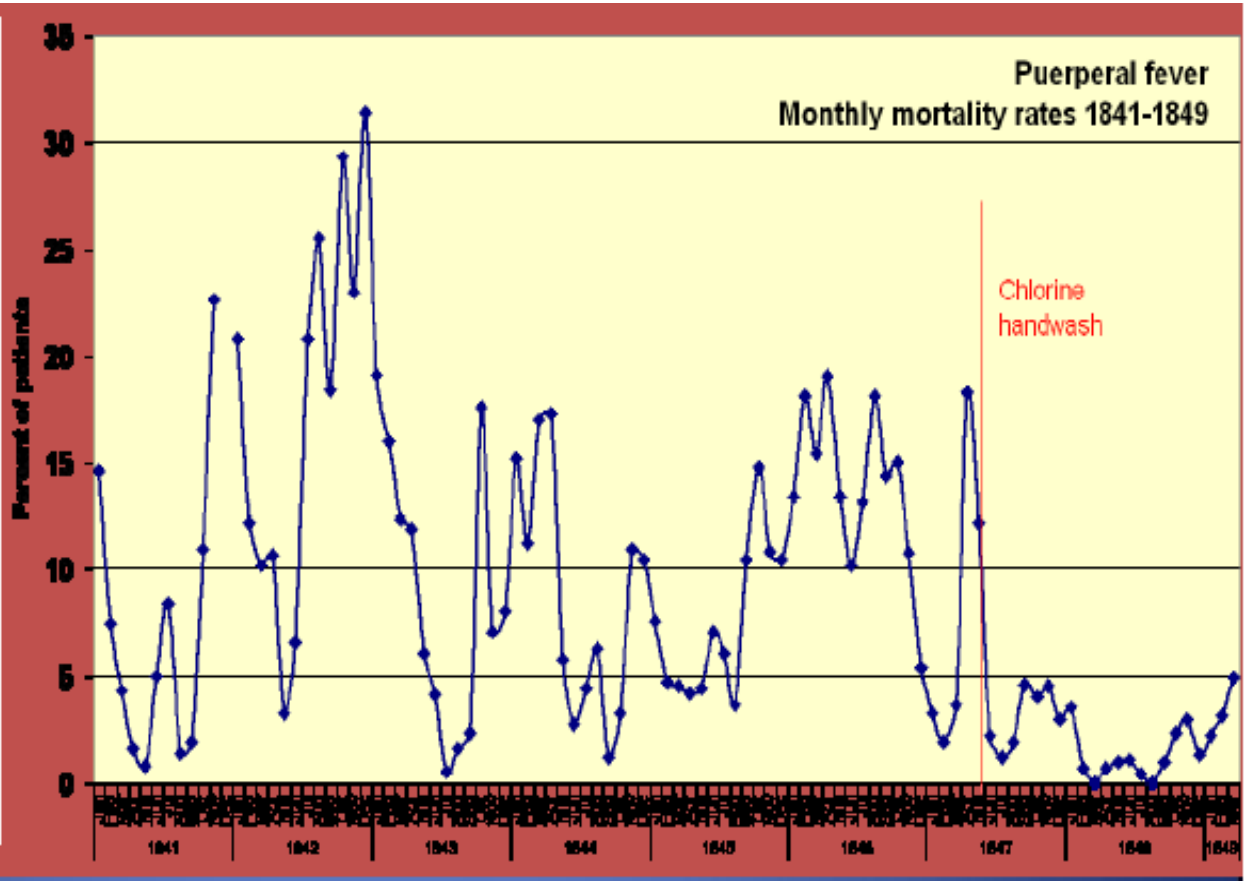
- Day 4 of admission, patient becomes acutely unwell.
  - High fever
  - Hypotensive
- Red peripheral cannula site noted.
- IV antimicrobials commenced through new peripheral cannula
- Patient transferred to Critical Care.

Patient Story



- Blood cultures yielded, *Staphylococcus aureus* (MSSA)
- Patient responded to Flucloxacillin, but infective endocarditis diagnosed affecting the congenitally abnormal heart valve.
- Acute incompetence of the valve led to emergency cardiac surgery.





Ignaz Philipp Semmelweis (July 1, 1818, to August 13, 1865)

- Assistant to the professor of the maternity clinic at Vienna General Hospital
- Introduced hand washing with chlorinated lime for interns
- Reduced puerperal fever (childbed fever) from about 10% to 1%-2%
- His hand-washing theory was ridiculed and rejected by his colleagues

Magnitude of the Problem

- Previous HAI [Healthcare-Associated Infection] estimates (based on Klevens et al., 2007)
  2002—Hospital only
  - 1.7 million HAIs.
  - 99,000 deaths.
  - ~$30 billion in excess healthcare costs.

Estimates of HAIs (US data)

CDC 2008:

- In US hospitals alone, healthcare-associated infections account for an estimated 2 million infections and 90,000 associated deaths each year.
- Of these infections:
  - 32 % of all healthcare-associated infection are urinary tract infections
  - 22 % are surgical site infections
  - 15 % are pneumonia
  - 14 % are bloodstream infections

Prevalence of HAIs

- **Urinary Tract Infections (30-40%)**
  - (indwelling catheters, Longer hosp stay)
- **Lower Respiratory Infections (10-20%)**
  - (mechanical ventilation, VAP, geriatric/pediatric)
- **Surgical Wound Infections (10-20%)**
  - (acute care, surgery)
- **Skin and Soft Tissue Infections (10%)**
  - (elderly, long term care)
- **Blood Stream Infections (5%)**
  - (intravascular devices, UTI, LRTI, SWI etc)

Marcel et al., CMI 2008 14

JCAHO 2005 Hospital National Patient Safety Goals

- Improve the accuracy of patient identification
- Improve the effectiveness of communication among caregivers
- Improve the safety of using medications
- Improve the safety of using infusion pumps
- Reduce the risk of healthcare-associated infections
  - ✓ *Comply with current CDC guidelines regarding hand hygiene*
  - ✓ *Manage as sentinel events all identified cases of unanticipated death or major permanent loss of function associated with a healthcare-associated infection*
- Accurately and completely reconcile medications across the continuum of care
- Reduce the risk of patient harm resulting from falls

HAI Risk Factors

- Invasive Procedures (Surgery and Intravascular Devices)
- Longer stay in hospitals
- Immunocompromised patients

Urinary Catheters

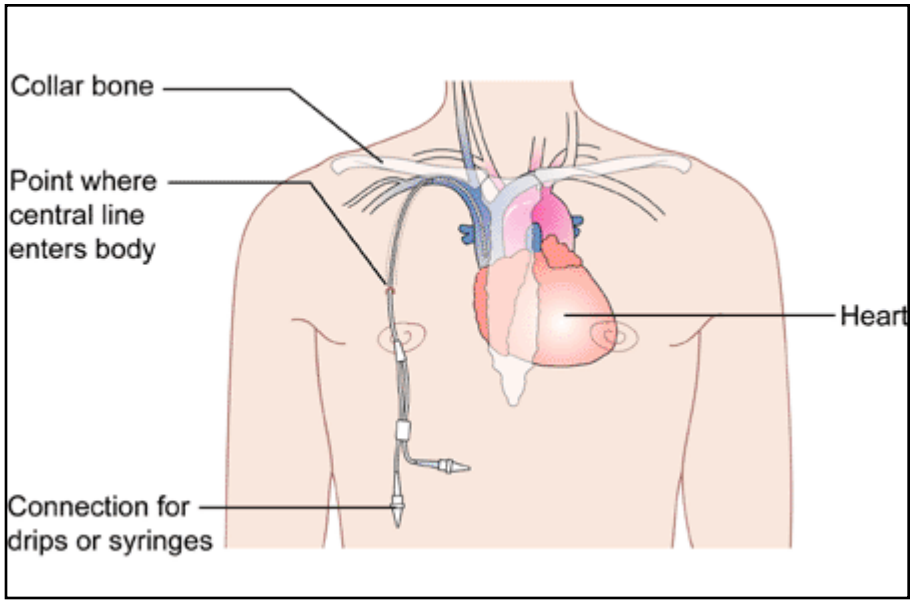
Foley introduced urinary catheterisation in 1920s to reduce bleeding post prostatectomy.

Peripheral Vascular Cannulae

Widely used since 1960s / 70s

Almost standard part of treatment on admission to hospital!!

Central Vascular Catheters



Long term venous catheters first became widely available in the 1960s

PICC lines 1975

Infection Risks of Medical Devices

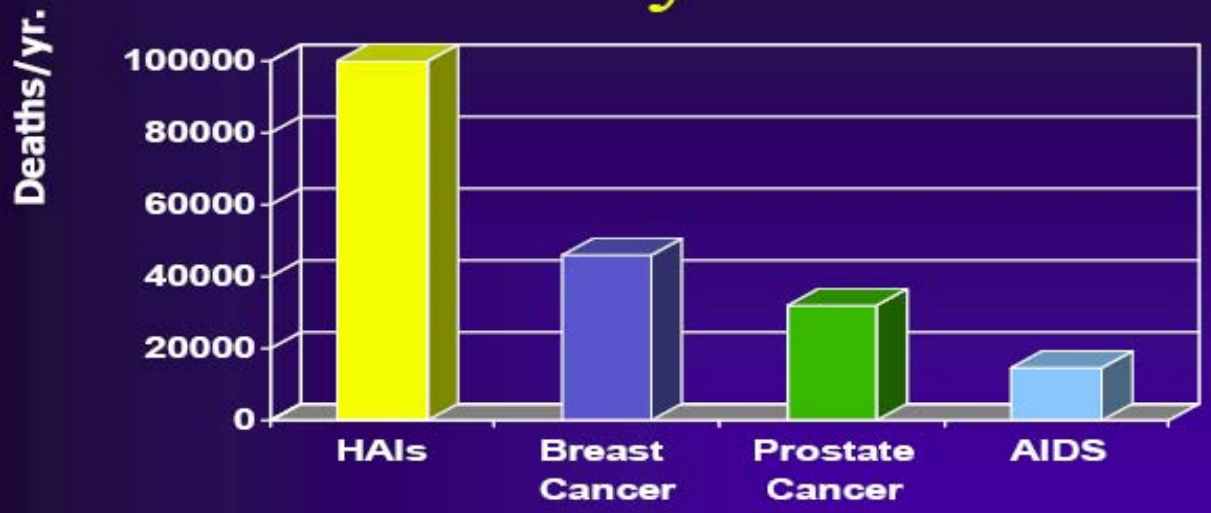
- **Breach of normal defences**
  - Skin
  - Urinary tract – urine flow
- **Device Factors**
  - Materials – plastics
  - Manipulation
    - Administration of drugs
    - Connection of giving sets
    - Sampling

- **Healthcare Factors**
  - Resistant organisms within hospital environment
  - Hand hygiene standards of care givers
  - Insertion and maintenance practices
- **Patient associated risk factors**
  - Debilitated patients
  - Chronic diseases
  - Immunosuppression

Consequences of Infection

- Worsening condition of a patient with significant other underlying disease
- Severe local infection
- Systemic infection leading to death
- Loss of use of Medical Device
- Prolonged hospitalisation
- Increased cost of care
  - UTI cost £1,122 per patient (UK NHS 2001)

HAI…Burden to the U.S. Healthcare System

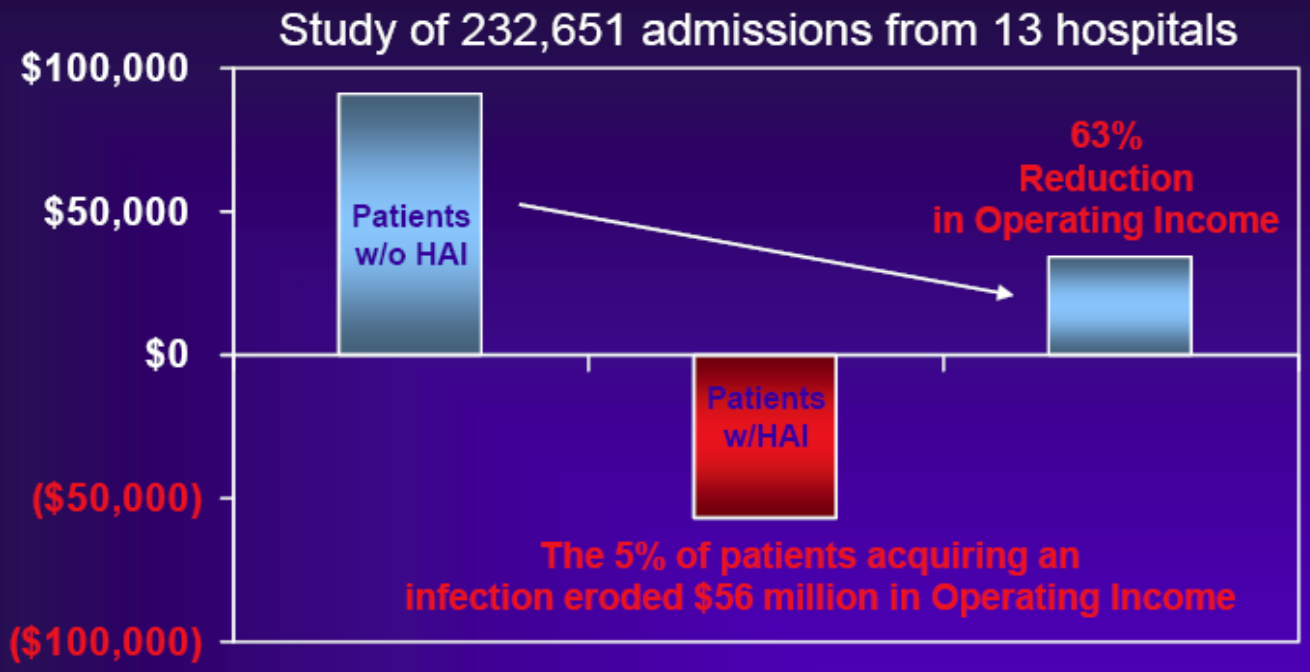


- 8 million excess hospital days
  - ✓ 16 extra hospital days per patient
- Over $5 billion in excess healthcare costs
- Mortality Rate of 12.9% (6x Greater Than Patients without HAIs)
- >70% due to MDROs—Multi Drug-Resistant Organisms
  - ✓ Microbe is Resistant to More Than 1 Commonly-Used Anti-Infective

Source: CDC

CDC™

Impact of HAIs to Healthcare Financials



Inpatient Operating Income ($000)	$91,091	($56,663)	$34,427
% Patients # Patients	95% 221,225	5% 11,426	100% 232,651

Source: MedMined, June 2005

NINSS data 1997 - 2001

- Hospital Acquired Bacteraemia (HAB)
  - 6956 cases
- Central lines was the commonest source of HAB
  - 38.3% of HAB in teaching hospitals
  - 22.3% of HAB in non-teaching hospitals

Coello et al (2003) Journal of Hospital Infection 53: 46 - 57

NINSS data 1997 - 2001

- Teaching Hospitals
  - ICU, Haematology, Special Care Baby Units, nephrology and oncology
    - Of 623 device related bacteraemias. 554 (88.9%) were from central lines.
- Central lines were the most common source of bacteraemia in general medicine and surgery.

Coello et al (2003) Journal of Hospital Infection 53: 46 - 57

Prevalence – CAUTI 2006

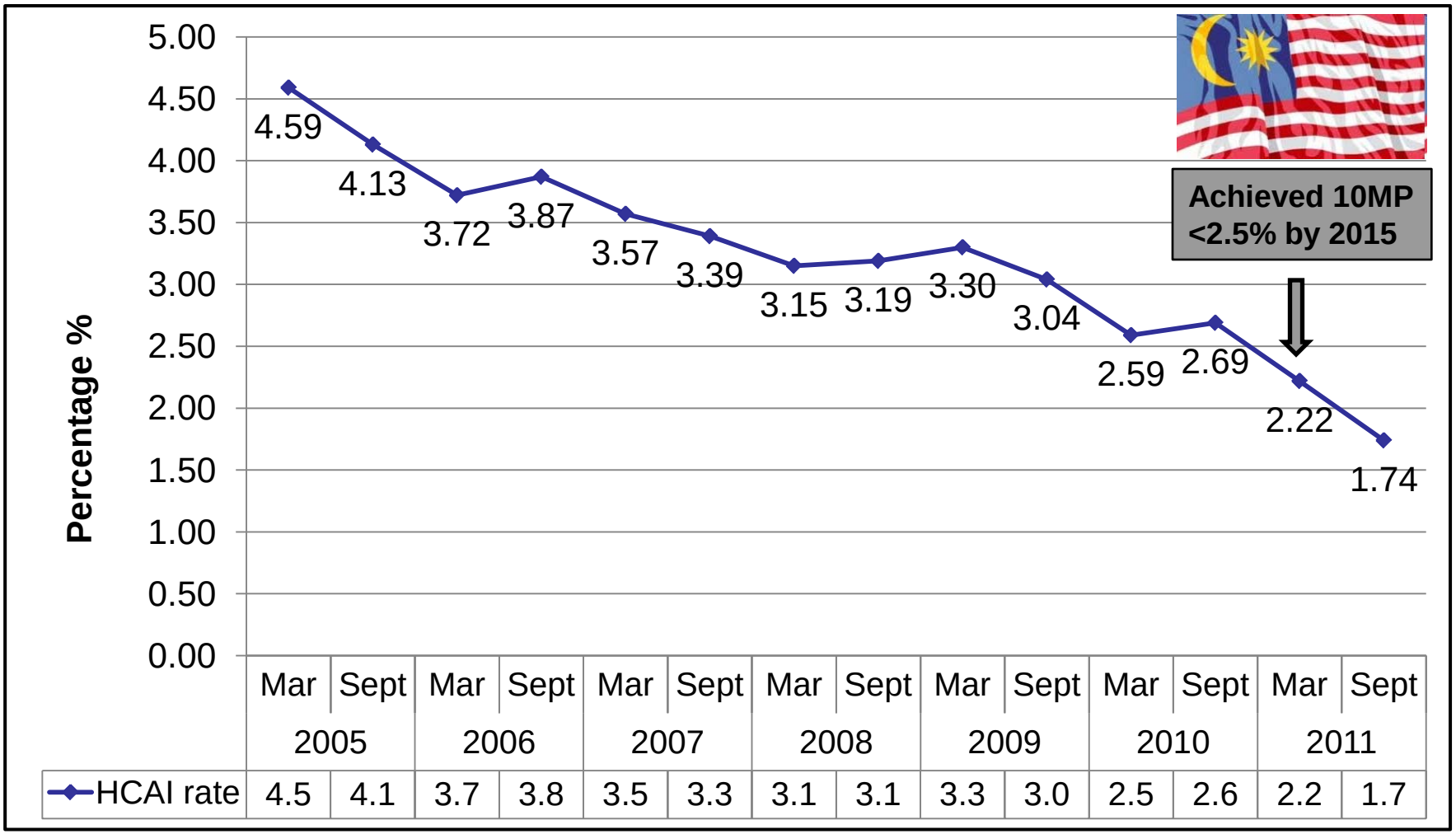
- 5734 adult in-patients surveyed
- 25% had an urinary catheter in situ or removed within the previous 7 days
- 1.7% of catheterised patients had a UTI

E.T.M. Smyth *et al* (2008) *Journal of Hospital Infection* 69:230 - 248

Prevalence – Long Term Care Facilities

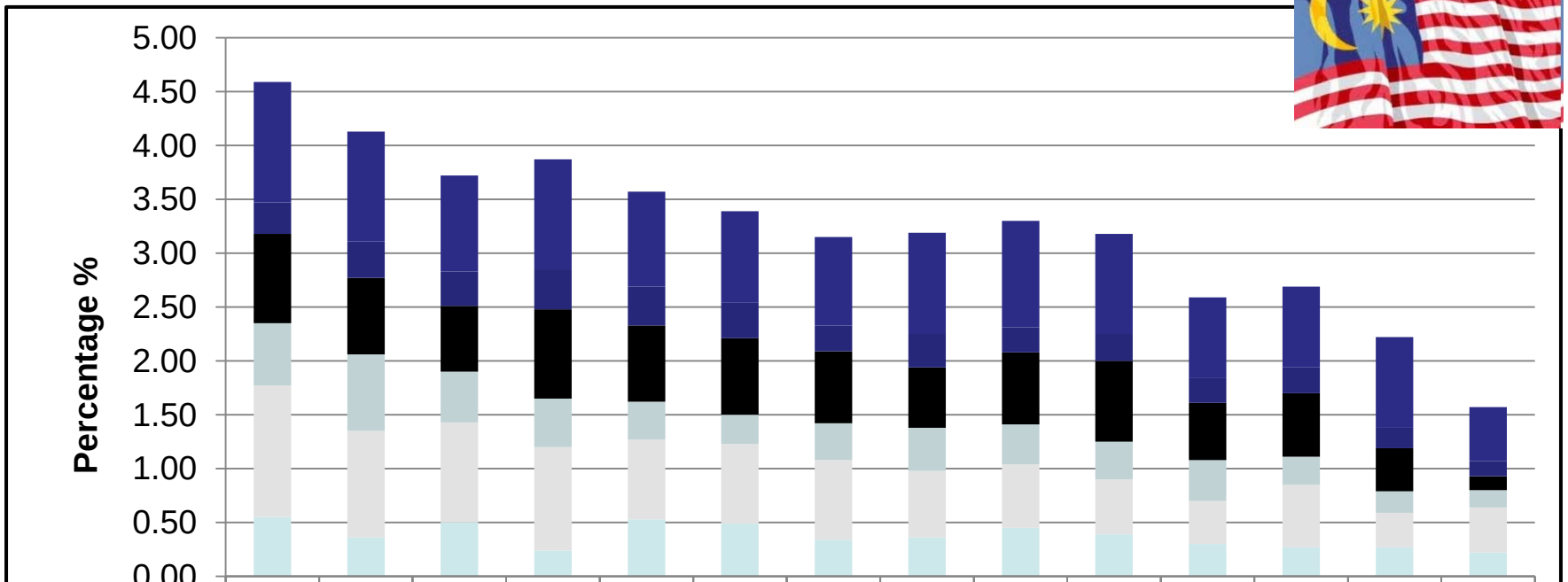
- HALT prevalence study – July – August 2010
- 895 residents surveyed across Wales
- 9% (80pts) had urinary catheters present on the day of the service
- 6% (5pts) of catheterised patients had a CAUTI

National Average and Trending of HCAI rate, 2005-2011



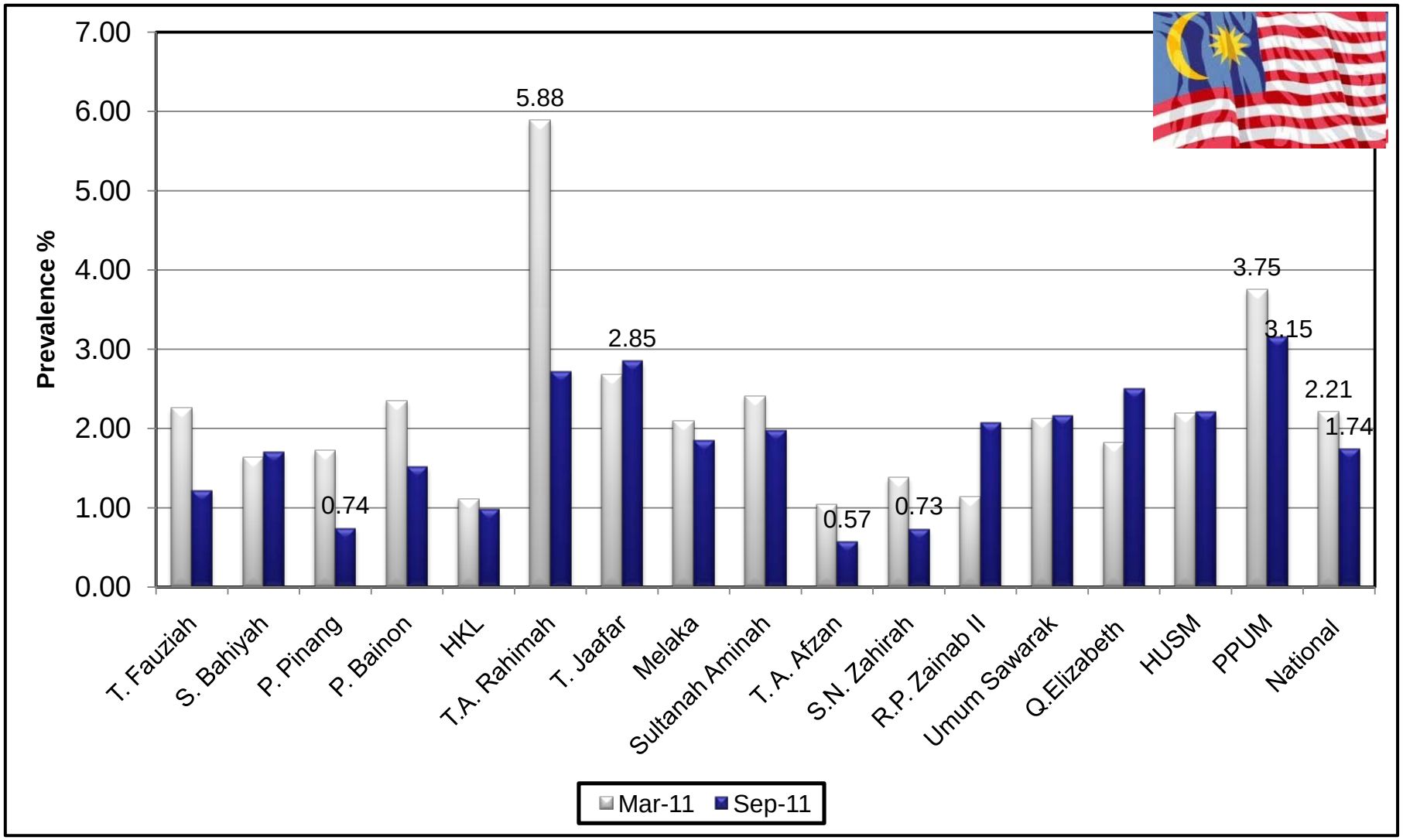
	Mar	Sept	Mar	Sept	Mar	Sept	Mar	Sept	Mar	Sept	Mar	Sept	Mar	Sept
	2005		2006		2007		2008		2009		2010		2011	
HCAI rate	4.5	4.1	3.7	3.8	3.5	3.3	3.1	3.1	3.3	3.0	2.5	2.6	2.2	1.7

National Distribution and Trending of Common Infection 2005-2011

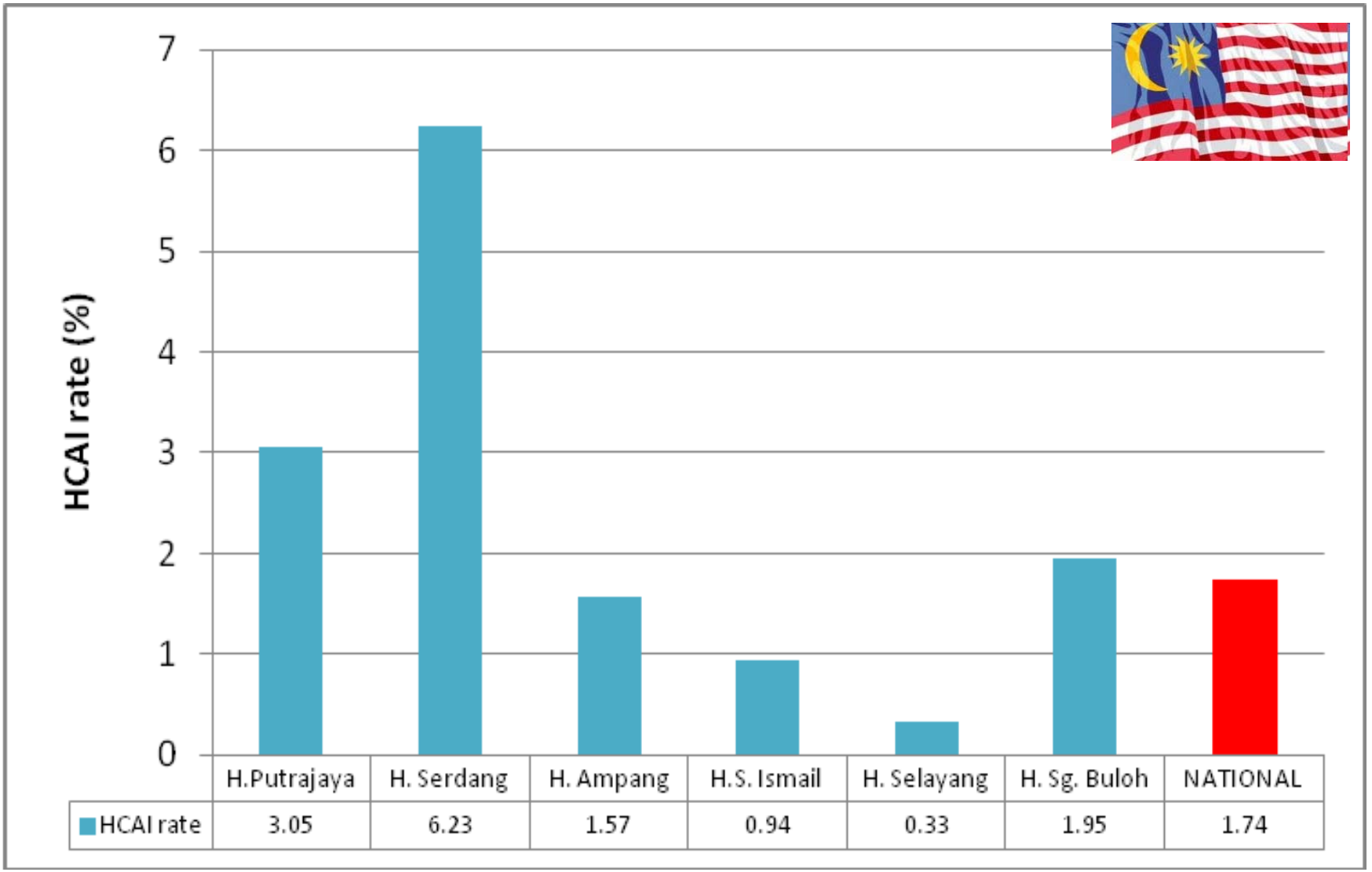


	Mar 2005	Sept 2005	Mar 2006	Sept 2006	Mar 2007	Sept 2007	Mar 2008	Sept 2008	Mar 2009	Sept 2009	Mar 2010	Sept 2010	Mar 2011	Sept 2011
Pneumonia	1.12	1.02	0.89	1.02	0.88	0.85	0.82	0.94	0.99	0.93	0.75	0.75	0.84	0.50
UTI	0.29	0.34	0.32	0.37	0.36	0.33	0.24	0.31	0.23	0.25	0.23	0.24	0.19	0.14
BSI	0.83	0.71	0.61	0.83	0.71	0.71	0.67	0.56	0.67	0.75	0.53	0.59	0.40	0.13
CS	0.58	0.71	0.47	0.45	0.35	0.27	0.34	0.40	0.37	0.35	0.38	0.26	0.20	0.16
SSI	1.22	0.99	0.93	0.96	0.74	0.74	0.74	0.62	0.59	0.51	0.40	0.58	0.32	0.42
Others	0.55	0.36	0.50	0.24	0.53	0.49	0.34	0.36	0.45	0.39	0.30	0.27	0.27	0.22

HCAI Rate in State and University Hospitals 2011

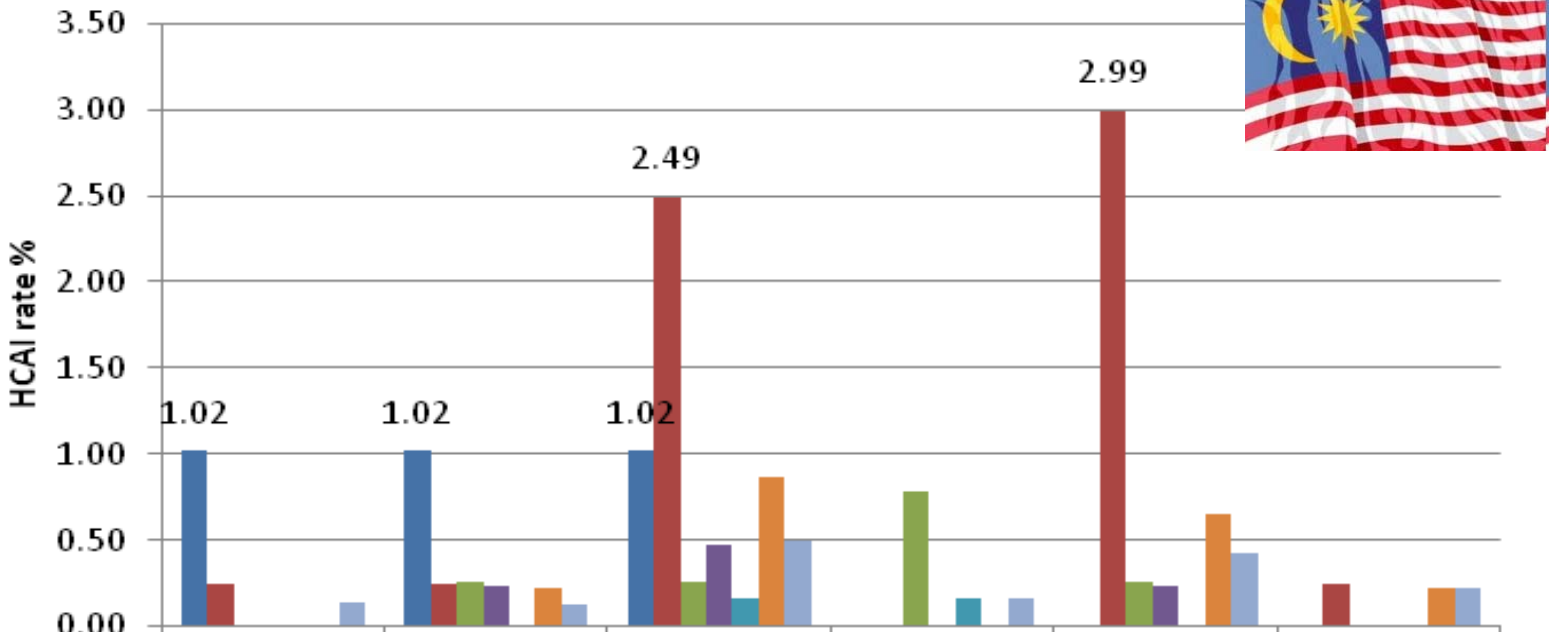


HCAI Rate in 6 Selected Specialist Hospitals



	H.Putrajaya	H. Serdang	H. Ampang	H.S. Ismail	H. Selayang	H. Sg. Buloh	NATIONAL
HCAI rate	3.05	6.23	1.57	0.94	0.33	1.95	1.74

HCAI Prevalence in 6 Selected Specialist Hospitals

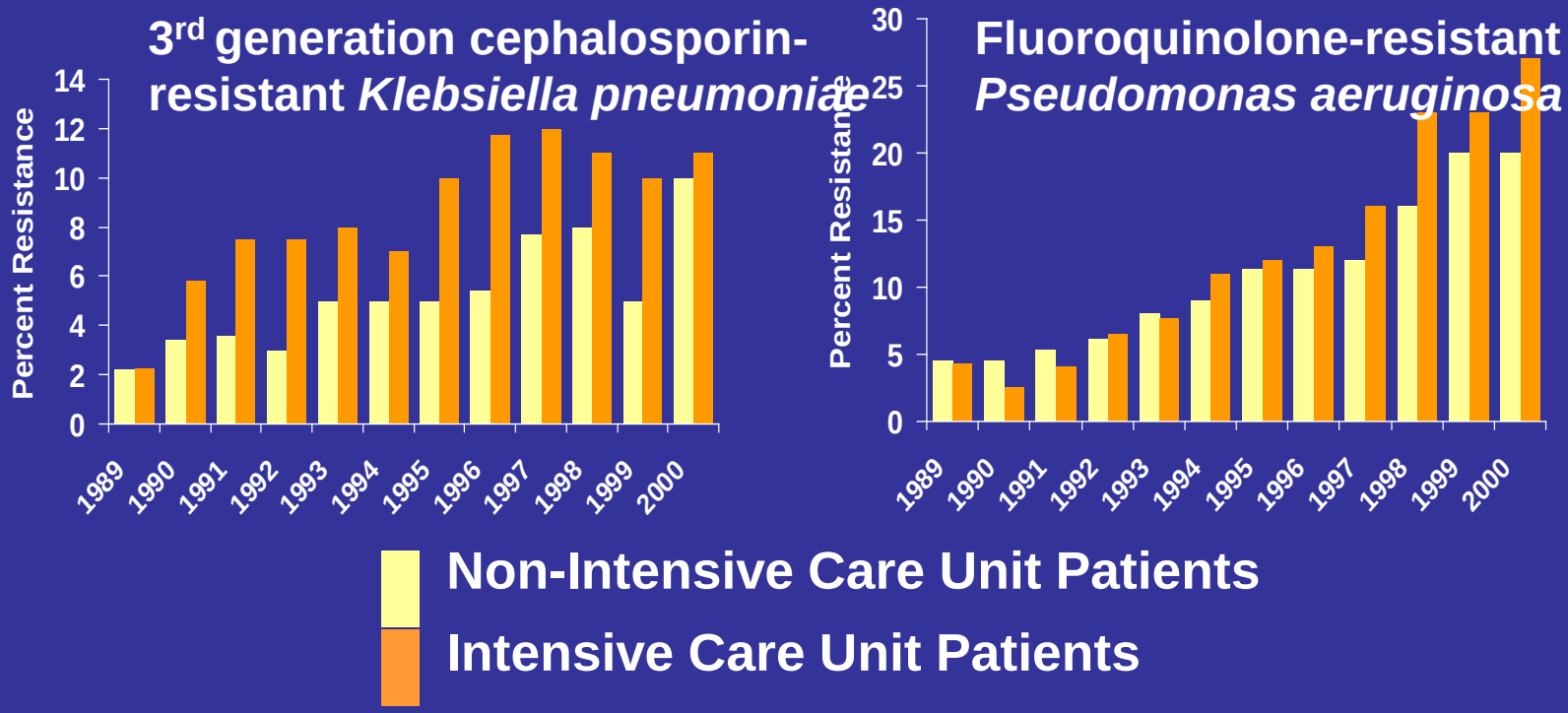


	UTI	BSI	PNEUM	CS	SSI	OTHERS
H. Putrajaya	1.02	1.02	1.02	0.00	0.00	0.00
H. Serdang	0.25	0.25	2.49	0.00	2.99	0.25
H. Ampang	0.00	0.26	0.26	0.79	0.26	0.00
H. S. Ismail	0.00	0.24	0.47	0.00	0.24	0.00
H. Selayang	0.00	0.00	0.16	0.16	0.00	0.00
H. Sg. Buloh	0.00	0.22	0.87	0.00	0.65	0.22
NATIONAL	0.14	0.13	0.5	0.16	0.42	0.22

Major HAI Pathogens

- **MRSA**
- **CA-MRSA**
- **ESBL producing *Enterobacteriaceae***
- **Vancomycin Resistant *Enterococci***
- ***Clostridium difficile***
- **MDR Acinetobacter**

Antimicrobial Resistance among Pathogens Causing Nosocomial Infections



Source: National Nosocomial Infections Surveillance (NNIS) System

Prevalence of Antimicrobial-Resistant (R) Pathogens Causing Hospital-Onset Intensive Care Unit Infections: 1999 versus 1994-98

Organism	# Isolates	% Increase*
Fluoroquinolone-R *Pseudomonas* spp.	2657	49%
3rd generation cephalosporin-R *E. coli*	1551	48%
Methicillin-R *Staphylococcus aureus*	2546	40%
Vancomycin-R enterococci	4744	40%
Imipenem-R *Pseudomonas* spp.	1839	20%

* Percent increase in proportion of pathogens resistant to indicated antimicrobial

Source: National Nosocomial Infections Surveillance (NNIS) System

The ESKAPE Pathogens: The Worst of the Worst

E	***Enterococcus faecium***
S	***Staphylococcus aureus***
K	***Klebsiella pneumoniae***
A	***Acinetobacter baumannii***
P	***Pseudomonas aeruginosa***
E	***Enterobacter* spp.**

Troublesome bacteria with the ability to "escape" the effects of current antimicrobial agents

1. Rice LB. *J Infect Dis.* 2008;197:1079-1081.
2. Rice LB. *Infect Control Hosp Epidemiol.* 2010;31(Suppl 1):S7-S10.

ESKAPE Pathogens Today

North America

VRE (*E. faecium*)	66.1%
MRSA	50.6%
ESBL-*K. pneumoniae*	9.8%
A. baumannii (Carb-R)	22.1%
P. aeruginosa (Carb-R)	8.7%
Enterobacter spp. (CFT-R)	25.3%

Europe

VRE (*E. faecium*)	14.4%
MRSA	24.8%
ESBL-*K. pneumoniae*	17.0%
A. baumannii (Carb-R)	25.1%
P. aeruginosa (Carb-R)	12.3%
Enterobacter spp. (CFT-R)	40.3%

Latin America

VRE (*E. faecium*)	38.8%
MRSA	46.6%
ESBL-*K. pneumoniae*	36.1%
A. baumannii (Carb-R)	57.5%
P. aeruginosa (Carb-R)	25.3%
Enterobacter spp. (CFT-R)	44.9%

Increasing Gm –ve resistance In Asia-Pacific

Asia Pacific

VRE (*E. faecium*)	21.7%
MRSA	45.0%
ESBL-*K. pneumoniae*	22.8%
A. baumannii (Carb-R)	41.9%
P. aeruginosa (Carb-R	15.7%
Enterobacter spp. (CFT-R)	44.3%

www.testsurveillance.com (Last accessed October 13, 2011).

Carb-R = imipenem and/or meropenem resistant; CFT-R = ceftriaxone-

Infection Control

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MMWR

Weekly

March 20, 2009 / 58(10);256-260

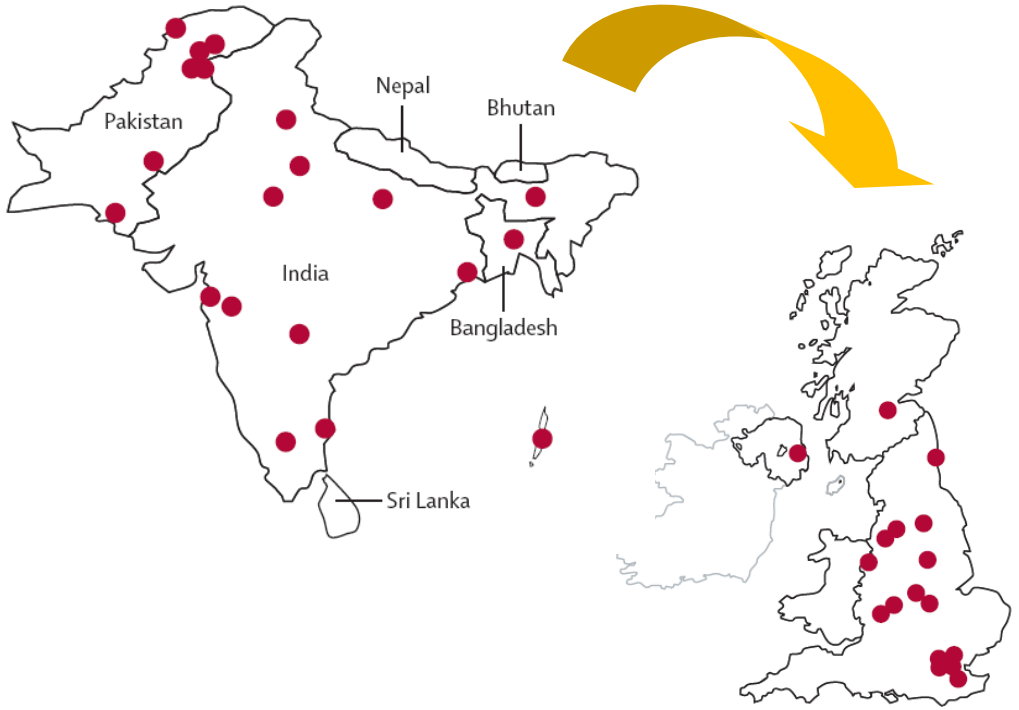
Guidance for Control of Infections with Carbapenem-Resistant or Carbapenemase-Producing *Enterobacteriaceae* in Acute Care Facilities

Infection with carbapenem-resistant *Enterobacteriaceae* (CRE) or carbapenemase-producing *Enterobacteriaceae* is emerging as an important challenge in health-care settings (*1*). Currently, carbapenem-resistant *Klebsiella pneumoniae* (CRKP) is the species of CRE most commonly encountered in the United States. CRKP is resistant to almost all available antimicrobial agents, and infections with CRKP have been associated with high rates of morbidity and mortality, particularly among persons with prolonged hospitalization and those who are critically ill and exposed to invasive devices (e.g., ventilators or central venous catheters). This report provides updated recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee

…And a New Menace

New Delhi metallo-β-lactamase 1 (NDM-1)

- Most *bla*$_{NDM-1}$ positive plasmids are readily transferable
- Multi-resistant to fluoroquinolones, β-lactams, and aminoglycosides
- Potential for worldwide endemicity



Kumarasamy KK, et al. *Lancet Infect Dis.*

Are HAIs Preventable?

CLABSI Estimates

MMWR, March 1, 2011:

- CLABSIs [central line-associated bloodstream infections] in ICUs:
  From 2001 to 2009 there was a 58% decrease in HAIs.

- Current estimates for CAUTI [catheter-associated urinary tract infection], SSI [surgical site infection], VAP [ventilator-associated pneumonia] likewise lower.
- Best current overall estimates:
  - At any one time, HAIs affect 1 out of every 20 hospital patients.
  - HAIs are costly, deadly, and largely preventable.

US CUSP Implementation for CLABSI (prelim report)

MMWR 2011:

- Recruitment:
  - 45 State hospital associations.
  - 700 hospitals.
  - 1,100 hospital teams.
- Interim results—350 hospitals:
  - Baseline: 1.8.
  - CUSP [Comprehensive Unit-based Safety Program] for CLABSI [central line-associated bloodstream infection]: 1.17—a 35% decrease.

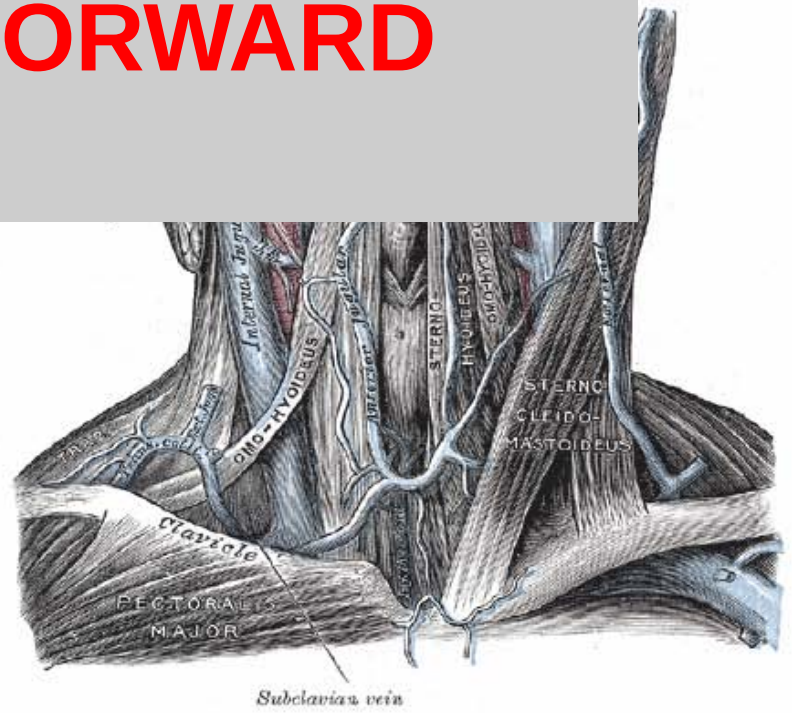
Interventions to reduce CR-BSI related HAIs

ICUs that ha
interven
bundle h

The key com
Bundle a

- Hand Hyg
- Maximal Barrier Precautions Upon Insertion
- Chlorhexidine Skin Antisepsis
- Optimal Catheter Site Selection, with Subclavian Vein as the Preferred Site for Non-Tunneled Catheters
- Daily Review of Line Necessity with Prompt Removal of Unnecessary Lines

CARE BUNBLES:
THE WAY FORWARD



HAIs are Preventable: IHI 100,000 *Lives* Campaign

- The Institute for Healthcare Improvement (IHI) is a not-for-profit organization leading the improvement of health care throughout the world. IHI was founded in 1991 and is based in Cambridge, Massachusetts.

- On December 14, 2004, at its 16th Annual National Forum on Quality Improvement in Health Care, IHI launched the "100,000 Lives Campaign"—a national initiative to engage thousands of U.S. hospitals in an effort to prevent 100,000 needless inpatient deaths by implementing improvements in care.

- Declaring that "Some is not a number; soon is not a time," Don Berwick, MD, IHI's President and CEO, challenged U.S. hospitals to commit to reaching a bold goal: saving 100,000 lives by June 14, 2006. To help hospitals reach this goal, IHI outlined six clinical interventions that hospitals could focus on to reduce mortality and morbidity.

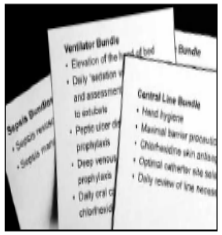
- Three of the six intervention bundles (i.e., Proven Best Practices or Standard of Care) focus on prevention of HAIs:
  - ✓ Intravascular central catheter infections
  - ✓ Surgical Site infections
  - ✓ Ventilator-associated pneumonia

HAIs are Preventable: IHI 100,000 Lives Campaign

- On June 14, 2006, the 100,000 Lives Campaign ended and IHI announced that after 18 months, the 3,100 Campaign hospitals had exceeded the goal of 100,000 lives saved by a significant margin.
  - ✓ The result: hospitals participating in the Campaign had prevented an estimated 122,300 needless deaths.

INSTITUTE FOR HEALTHCARE IMPROVEMENT

The 1st two bundles



Innovation Series 2012

Using Care Bundles to Improve Health Care Quality

IHI Ventilator Bundle*

1. Elevation of the head of the bed to between 30 and 45 degrees
2. Daily "sedation vacations" and assessment of readiness to extubate
3. Peptic ulcer disease (PUD) prophylaxis
4. Deep venous thrombosis (DVT) prophylaxis

(Note: A fifth bundle element, "Daily oral care with chlorhexidine," was added in 2010.)

IHI Central Line Bundle

1. Hand hygiene
2. Maximal barrier precautions
3. Chlorhexidine skin antisepsis
4. Optimal catheter site selection, with avoidance of using the femoral vein for central venous access in adult patients
5. Daily review of line necessity, with prompt removal of unnecessary lines

……Care Bundles for Insertion and Maintenance of Medical Devices

Starting with

- Urinary Catheter Care Bundles
- Peripheral Line Care Bundles
- Roll out of Central Line Care Bundles beyond critical care

Concept of Zero Tolerance to HAIs

- Does not mean “No infections”
- HAIs - not an inevitable outcome of care
- Requires a culture change among care providers
- Clear guidelines
- Continuing education / peers /team members

Pillars in HCAI Prevention

- Surveillance
  (Infections & Organisms)
- Guidelines :
  Structured into Care Bundles
- Organizational Commitment:
  From the very Top
- Benchmarking: Audit & Accreditation
- Legislation:
  Using the Big Stick!

Pay for Performance: the changing Reimbursement Environment

- *The Centers for Medicare & Medicaid Services is moving to a pay for performance system.*
- *As of October 1, 2008, Medicare will no longer pay hospitals for certain conditions that patient acquires while in the hospital, and hospitals also will not be allowed to bill patients for these costs.*

J of Association of Perioperative Registered Nurses

First Do No Harm …

- Increasing advances and complexity of therapies have resulted in increasing use of medical devices.
- Infection is an unwanted and often avoidable consequence of the use of medical devices.
- Ensuring evidence based practice is in routine use when medical devices are used will assist in our aim of reducing HCAI……

THANK YOU