The evolving role of epidemiology in infection prevention and control: past present and future

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EM Cotterall Lecture
IPS 2010

Health Protection Scotland

GCU Glasgow Caledonian University

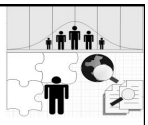
Broadcast live from the 2010 conference of the Infection Prevention Society
www.ips.uk.net

Overview

- Past: The historical contribution of epidemiology to infection prevention
- Present: The role of epidemiology in our current understanding of HAI
- Future: How the role of epidemiology will continue to evolve and contribute to infection prevention

The past

Epidemiology



- Epidemiology is the study of disease in human populations.
- This branch of science has been essential in saving the lives of millions of people by discovering the risk factors of many diseases.
- Epidemiology has prompted advances in medicine and better ways of controlling and preventing disease.

What defines epidemiologists?

- 'It may seem a strange principle to enunciate as the very first requirement in a Hospital that it should do the sick no harm'. [Florence Nightingale, 1859]

A brief history of the contribution of epidemiology to IP&C

- 18th century
- 100 years later…
- Bacteriological era
- End of 19th century
- ID hospitals in the early 20th century
- 1960s onward

Elements of successful HAI reduction

Intensive surveillance (led by an ICN)

+

Intensive control

+

Programme of regular feedback to staff

=20% reduction over 5 years

+

Interested/ involved physician

=38% over 5 years

- Haley RW et al (1985) **The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals.** Am J Epidemiol. 1985 Feb;121(2):182-205.
- Reilly J, McIntosh J and Currie K (2002) The effect of feedback of performance data on surgical practice *Journal of Advanced Nursing* (38) 6: 1-8

'We must measure and feedback the infection rates of all HAI problems to be reduced'
Haley RW, IPS 2009

The present

Prevalence of HAI

- Europe:
  - Approximately 4 100 000 patients are estimated to acquire a healthcare-associated infection in the EU every year.
  - The number of deaths occurring as the direct consequence of these infections is estimated to be at least 37 000

ECDC (2009) Annual Epidemiological Report on Communicable Diseases in the European Union, ECDC Stockholm

Comparisons with the epidemiology of public health issues

- There are **307432** new cases of colorectal cancer in the EU each year
- There are **85000** new cases of TB in EU each year
- With over **4 million** new cases of HAI in the EU each year, patient safety is a serious concern

HAI prevalence across Europe

Table 2.2.1. Overview of recent prevalence surveys of nosocomial infections in industrialised countries

	NI Prevalence	Reference	Hospitals (N)	Patients (N)
UK, 1996	9.0 %	8,9	157	37 111
Germany, 1997	3.5 %	10	72	14 926
France, 2001 (1996)	6.6 %	11,12	1 533	162 220
Switzerland, 2002	8.1 %	13,14	60	7 540
Greece, 2000	9.3 %	15	14	3 925
Italy, Lombardy, 2000	4.9 %	16	88	18 667
Slovenia, 2001	4.6 %	17	19	6 695
Canada, 2002	10.4 %	18	71	5 250
Italy, INF-NOS, 2002	7.5 %	19	15	2 165
Portugal, 2003	8.4 %	20	67	16 373
Denmark, 2003	8.7 %	21	18	4 226
Latvia, 2003	3.9 %	22	7	1 150
Finland, 2005	8.5 %	23	30	8 234
Sweden, 2004–2006(b)	9.5 %	24	56	13 999
UK and Ireland, 2006	7.6 %	25	273	75 763
France, 2006(b)	5.0 %	26,27	2 337	358 353
Norway, 2002–2007(?)(c)	6.8 %	28,29,30	53	11 359
Scotland, 2007	9.5 %	31	45	11 608
Spain, (990–) 2004–2007(?)	6.8 %	32,33,34	259	58 892
Lithuania, 2003,2005,2007(?)	3.7 %	35,36	35	8 000
Netherlands, 2007	6.9 %	37	30	8 424
Mean	7.1 %			

(a) Average numbers from repeated point prevalence surveys in several years.
(b) Figure for acute care facilities only.
(c) Corrected for non-included infection types (i.e. those other than UTI, LRTI, SSI and BSI).

ECDC (2010) Annual report of communicable diseases ECDC Stockholm

Epidemiology of HAI in acute hospitals

HAI Type	Infections	
	N	%
Bone and Joint Infection	6	0.5
Blood Stream Infection	55	4.4
Central Nervous System Infection	2	0.2
Cardiovascular System Infections	11	0.9
Eye, Ear, Nose, Throat or Mouth Infection	155	12.5
Gastrointestinal Infection	191	15.4
Lower Respiratory Tract Infection other than Pneumonia	139	11.2
Pneumonia	109	8.8
Reproductive System Infections	17	1.4
Systemic Infection	2	0.2
Surgical Site Infection	197	15.9
Skin and Soft Tissue Infection	137	11.0
Urinary Tract Infection	222	17.9
Total	1243	100.0

•Reilly J, Stewart S, Allardice GA, Noone A, Robertson C, Walker A, S Coubrough S (2008) Results from the Scottish National HAI Prevalence Survey. *Journal of Hospital Infection*. 69(1):62-8

Epidemiology of HAI in acute specialties

Specialty	Inpatients with HAI	HAI Prevalence within specialty	95% CI	
	N	%	Lower	Upper
Care of the Elderly	199	11.9	10.0	13.7
Dentistry	2	12.5	4.1	20.9
Gynaecology	10	4.8	1.2	8.4
Haematology	8	6.7	2.0	11.3
Medicine	491	9.6	8.5	10.7
Obstetrics	4	0.9	0.0	1.9
Oncology	12	8.8	2.0	15.7
Orthopaedics	105	9.2	7.3	11.1
Other	0	0.0	-	-
Psychiatry	9	3.5	0.3	6.7
Surgery	247	11.2	9.5	12.9
Urology	16	6.3	3.0	9.5
Total	1103	9.5	8.8	10.2

•Reilly J, Stewart S, Allardice GA, Noone A, Robertson C, Walker A, S Coubrough S (2008) Results from the Scottish National HAI Prevalence Survey. *Journal of Hospital Infection*. 69(1):62-8

What is the impact of HAI in terms of length of stay on NHS activity?

- Those patients with HAI stay in hospital 70% longer than those without
- Normal LOS varies by specialty:
  - 3.2 additional days in obstetrics
  - 13.7 days in care of the elderly

- Reilly J, Stewart S, Allardice GA, Noone A, Robertson C, Walker A, S Coubrough S (2008) Results from the Scottish National HAI Prevalence Survey. *Journal of Hospital Infection*. 69(1): 62-8

What are the costs associated with HAI?

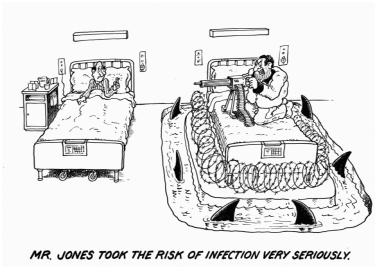
- Almost £200 million per year in Scotland in acute hospitals in Scotland (Reilly et al 2007)
- Close to £1 billion in the rest of the UK (Plowman et al 2001)
- €billions in Europe

- Reilly J, Stewart S, Allardice GA, Noone A, Robertson C, Walker A, S Coubrough S (2008) Results from the Scottish National HAI Prevalence Survey. *Journal of Hospital Infection*. 69(1):62-8

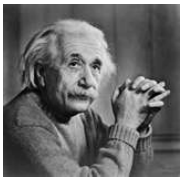
Towards zero HAI

- What is the irreducible minimum?
- How will we know we are there?
- New technologies and infection prevention interventions may mean that zero infections is achievable in the future?
- Need to better understand effectiveness of existing practice: Absence of evidence is not absence of effect

Beginning to happen…



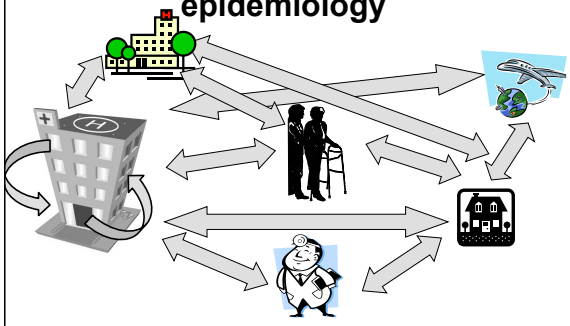
Cepeda J et al (2005) Isolation of patients in single rooms or cohorts to reduce spread of MRSA in intensive-care units: prospective two-centre study *Lancet; 365: 295–304*



'Insanity: doing the same thing over and over again and expecting different results.'

(***Albert Einstein)***

New challenges for HAI epidemiology

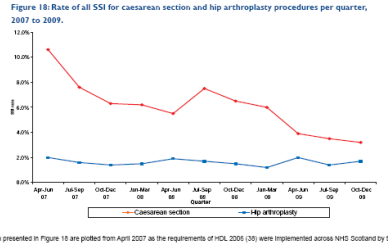


IPC efforts need to address all of the healthcare collectives

The epidemiology of HAI in the community

- Advancing technologies in surgery
- Changes in demography of hospital patients having surgery
- Average length of stay post op has reduced
- Many infections present after discharge from hospital

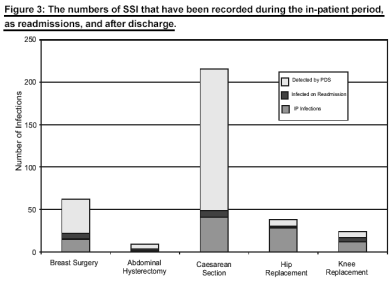
SSI: reducing incidence or length of stay?



*The data presented in Figure 18 are plotted from April 2007 as the requirements of HDL 2006 (38) were implemented across NHS Scotland by this date.

HPS (2010) Annual report on HAI surveillance HPS, Scotland

Post discharge surveillance



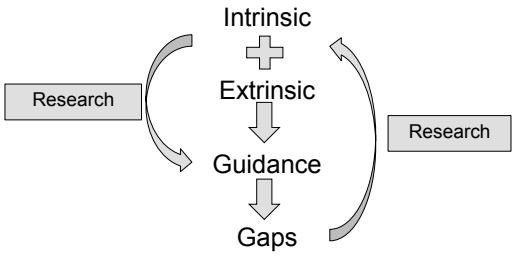
Reilly J, Hill R, Bruce J (2005) The impact of post discharge surveillance on SSI rates: results from the Scottish Surveillance of HAI programme *Infection Control and Hospital Epidemiology* 27: 1318-1323

Innovative approaches

McNeish J, Lyle D, McCowan M, Emmerson S, McAuley S, Reilly J (2007) Post discharge surgical site infection surveillance by automated telephony *Journal of Hospital Infection* 66: 232-236

Reilly J, Rowley D, Sullivan F et al (2005) Orthopaedic surgical site infection: post discharge surveillance *British Journal of Bone and Joint Surgery* 87-B (7):997-999

Identifying risk factors



Johnson A. Young D. Reilly J.(2006) Caesarean section surgical site infection surveillance *Journal of Hospital Infection* 64 (1): 30-35
Timmins, J McCoubrey, F McKirdy, MG Booth and J Reilly (2007) Antibiotic use in Scottish intensive care units. *The Journal of the Intensive Care Society* 8 (3) 38-40.

Using epidemiology to improve care

- **An increasing incidence of deep sternal surgical site infections (DSSI)**
  - A bundle of interdisciplinary infection control measures was initiated in order to prevent further cases of DSSI (8 interventions from screening to antimicrobial stewardship
  - Identified potential risk factors in a case-control study (120 patients each) by multivariate analysis.
- **A significant decrease of DSSI from 3.61% (CI 95: 2.98-4.35) down to 1.83% (CI 95: 1.08-2.90) occurred.**
  - Independent significant risk factors for DSSI were age >68 years (OR=2.47; CI 95: 1.33-4.60), diabetes mellitus (OR=4.84; CI 95: 2.25-10.4), and intra-operative blood glucose level >8 mmol/l (OR=2.27; CI 95: 1.17-4.42).
  - Protective factors were preoperative antibiotic prophylaxis (OR=0.31; CI 95: 0.13-0.70) and extubation on the day of surgery (OR=0.25; CI 95: 0.11-0.55).
- Concluded clinicians needed epidemiology to improve care

Graf K, Sohr D, Haverich A, Kühn C, Gastmeier P, Chaberny IF, (2009) **Decrease of deep sternal surgical site infection rates after cardiac surgery by a comprehensive infection control program.** Interact Cardiovasc Thorac Surg. 9(2):282-6.

New approaches for new(ish) issues

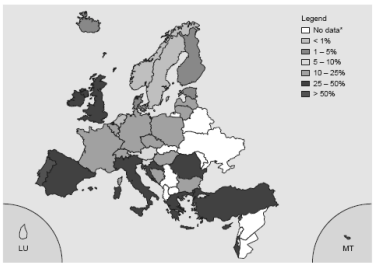


Figure 5.8. *Staphylococcus aureus*: proportion of invasive isolates resistant to oxacillin (MRSA) in 2008.
* These countries did not report any data or reported less than 10 isolates.

•European Antimicrobial Resistance Surveillance System. EARSS Annual Report 2008. Bilthoven: European Centre for Disease Prevention and Control (ECDC); 2009.
•J. Reilly, S. Stewart, P. Christie et al (2010) Universal screening for meticillin-resistant Staphylococcus aureus: Interim results from the NHS Scotland pathfinder project *Journal of Hospital Infection*, Volume 74, Issue 1, Pages 35-41

New approaches for new issues

- MRSA screening
  - Healthcare delivery system
  - Emerging technologies (TAT)
  - Effective interventions (LOS)
  - Innovative approaches (CRA)
  - Best bang for your buck?

Reilly JS, Stewart S, Christie P, Allardice G, Smith A, Masterton R, Gould I, Williams C (2010) Universal screening for meticillin-resistant Staphylococcus aureus: interim results from the NHS Scotland pathfinder study *J Hosp Infect* Volume 74, Issue 1, Pages 35-41

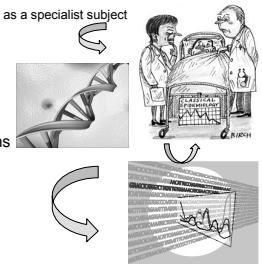
The future

'Let all men know how empty and worthless is the power of kings, for there is none worthy of the name, but He whom heaven, earth, and sea obey by eternal laws' King Canute

?NDM 1

Where will epidemiology go in the 21st century and beyond?

- A rapidly changing discipline
  - Healthcare epidemiology recognised as a specialist subject
- Molecular epidemiology
  - Refine our measurement techniques
  - Biomarkers of disease
- Genetic epidemiology
  - Post genome mapping era
  - Gene environment interactions
- Statistical models
  - Multi-factorial nature of IPC
- Implementation of the findings
  - Policy and practice



Already beginning to happen….

- Transmission of multidrug-resistant *Acinetobacter baumannii* (MDR-Aci) from military casualties to civilians due to shared care.
- In a recent hospital outbreak in Birmingham, six patients were colonised with MDR-Aci isolates indistinguishable using standard techniques. Used whole-genome sequencing to identify single nucleotide polymorphisms in these isolates, allowing discrimination between alternative epidemiological hypotheses in this setting

- Lewis T et al (2010) **High-throughput whole-genome sequencing to dissect the epidemiology of *Acinetobacter baumannii* isolates from a hospital outbreak JHI** Vol 75, Issue 1, Pages 37-41

Hyping health risks?


NEWS
Patients enter superbug lottery
500,000 DAYS LOST TO SUPERBUGS
NEW KILLER SUPERBUG INFECTS 47 PATIENTS

- 'one death is a tragedy, 1000 are a statistic'

Reilly, J (2008) The epidemiology of health-care associated infection *Journal Of Wound Care* (17)4: 145-156

"It could be said for epidemiology, with respect to disease etiology and prevention, what is frequently said about democracy as a system of government: they both have many problems and weaknesses, but they still represent the best available approach for the achievement of their respective objectives."

(Trichopoulos D, Professor of epidemiology, Harvard 1996)

A word of warning

- ***'When you have two data points, it is very likely that one will be different from the other.' Deming, 1992.***
- Bad epidemiology results in inappropriate IP&C activities
  - Change the HAI definition to count fewer events. VAP rates vary from 20% to 80% with different definitions.
  - Don't count infections if colonised on admission (universal MRSA screening is coming!)
  - Change from clinical surveillance to entirely microbiologically based computer surveillance (Rates of SSI, VAP & post op pneumonia will drop to < half)

Maintaining and developing the role of epidemiology in IPC

- New roles: clinical epidemiology, surveillance coordinator, nurse epidemiologist, molecular epidemiologist
- Epidemiology competencies (ECDC 2009)
- Healthcare epidemiology competencies (HPA 2010)
- IPS competencies (epidemiology)
- Educating society, policy makers, the media and the public

Summary of the contribution of epidemiology to the past, present and future of infection prevention and control

- **Epidemiology has informed the development of infection prevention and control to date**
- **Current epidemiology informs us that the burden of HAI in the UK and wider Europe is a patient safety concern and there is a burden of avoidable infection in healthcare**
- **There is a on going need for more epidemiology in order that we might reach the irreducible minimum of HAI**
- **Understanding and using epidemiology to enable management and improvement is a critical component of IP&C- locally, nationally and internationally.**
- **Epidemiology can be expected to play a major role in the future of IPC.**

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