When do you start sampling in an outbreak?

Associate Professor Caroline Marshall
Royal Melbourne Hospital
Peter Doherty Institute for Infection and Immunity
Department of Medicine, University of Melbourne

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VIDS
Victorian Infectious Diseases Service

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Doherty Institute

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Outline

* Why sample?
* Epidemic curves
* Outbreak sources
* Outbreak investigation
* Specific organisms
* Caveats

Why sample during an outbreak?

1. To determine the source and eliminate reservoir
2. Identify cases to implement infection prevention measures

* How to identify the source or reservoir – need to know organism, person, place, time
  * Identify the organism - can use knowledge from previous outbreaks to develop a hypothesis
  * Derive an epidemic curve
  * May use case-control study
* Source may be
  * Animate – Patients/Healthcare personnel/Visitors
  * Inanimate – Environment/Equipment/Devices

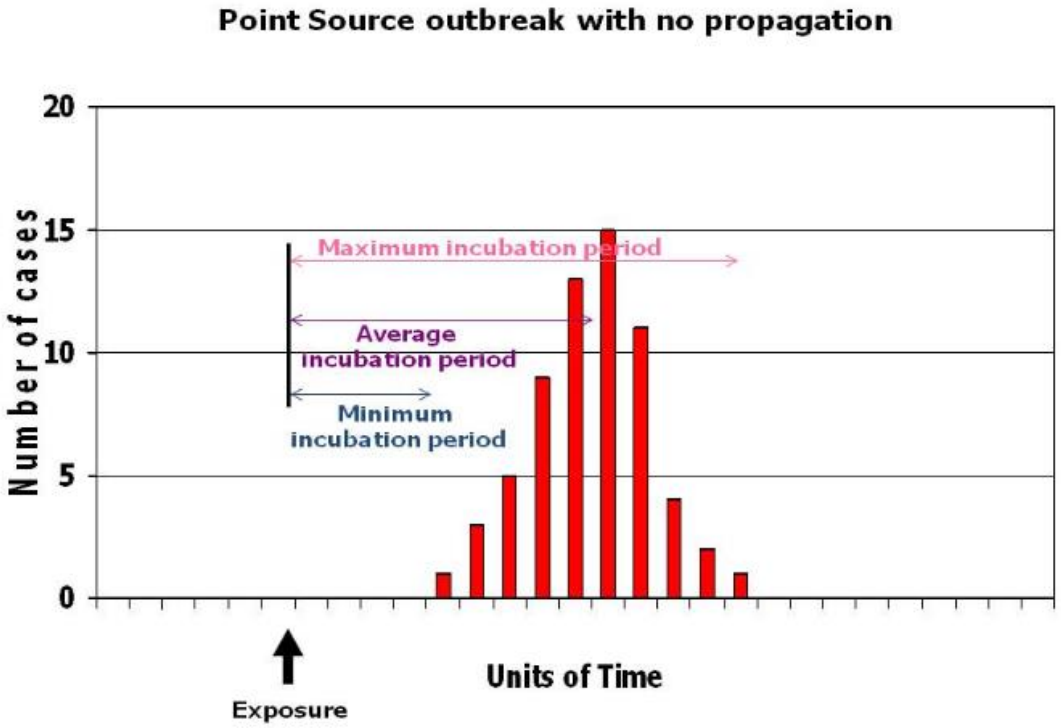
Epidemic curves

* Epidemic curve may indicate type of outbreak and putative transmission dynamics and source
* HAIs may not follow the “typical” curve
* **A. Common Source Outbreaks**
  * Cases arise from a single, shared or 'common' source, such as a batch of bad food, contaminated water supply, contaminated instrument, introduction of colonised patient
  * Controlling the source stops the outbreak
* **B. Person-to-Person Spread**
  * Spreads via person-to-person contact –classic infectious disease pattern
  * Controlling the source is no longer sufficient to control the outbreak

Epidemic curves: Common Source Outbreaks

Point source outbreak

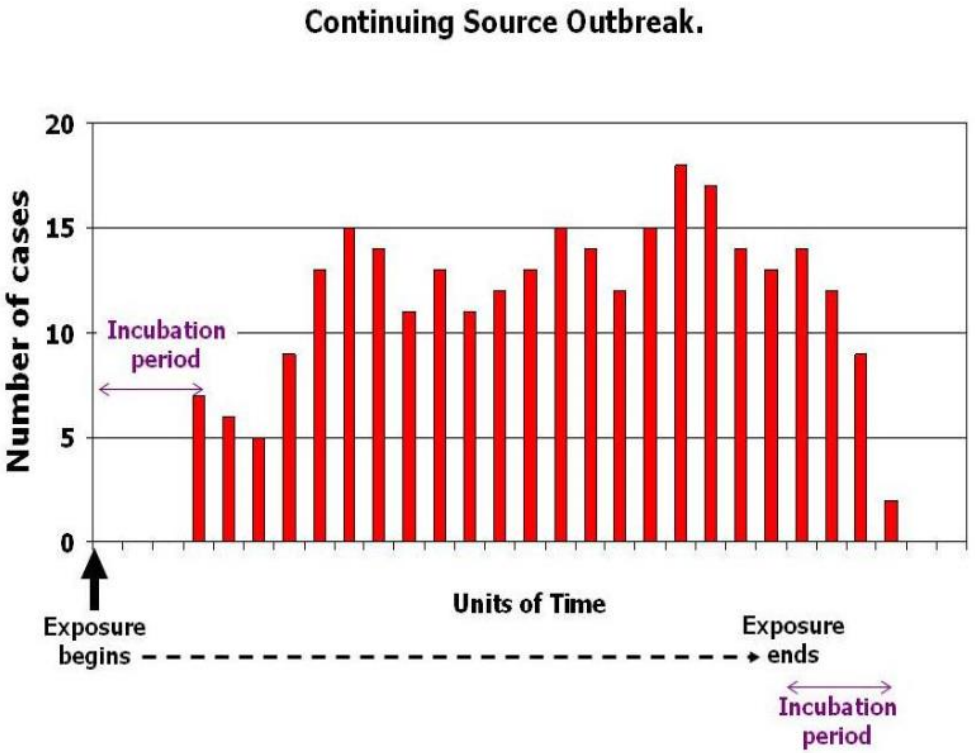
* Exposure occurs on one occasion
* All cases occur within one incubation period
* Eg sterilisation failure, contaminated instrument removed from service



Epidemic curves: Common Source Outbreaks

Continuing source outbreak

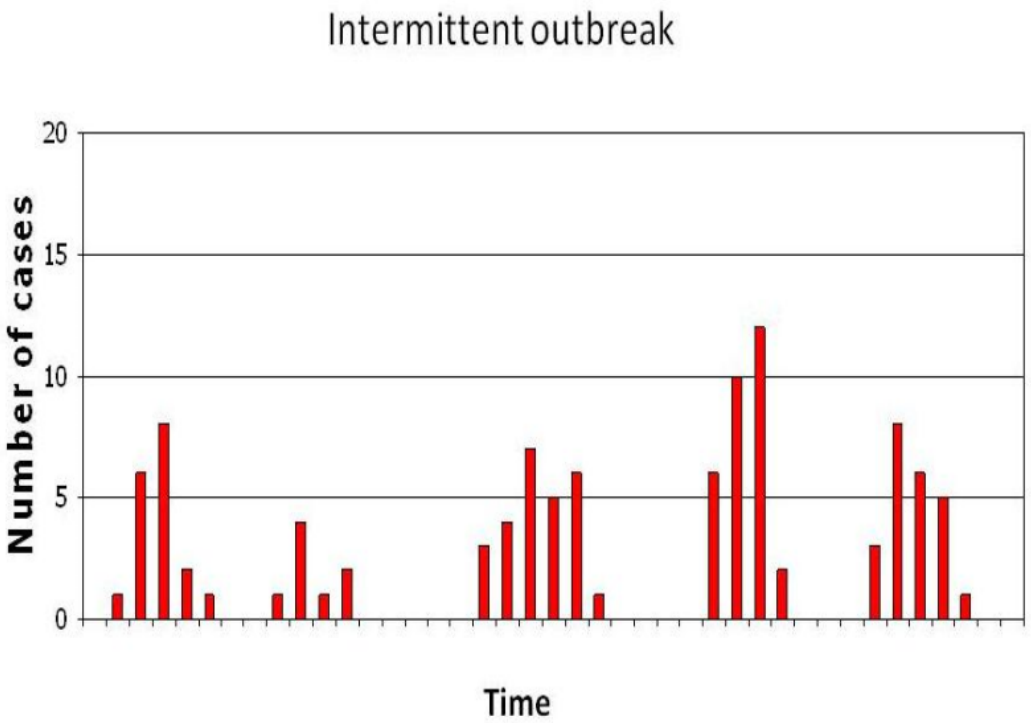
* Exposure continues over a longer time
* Eg contaminated water, contaminated HCUs



Epidemic curves: Common Source Outbreaks

Intermittent outbreak

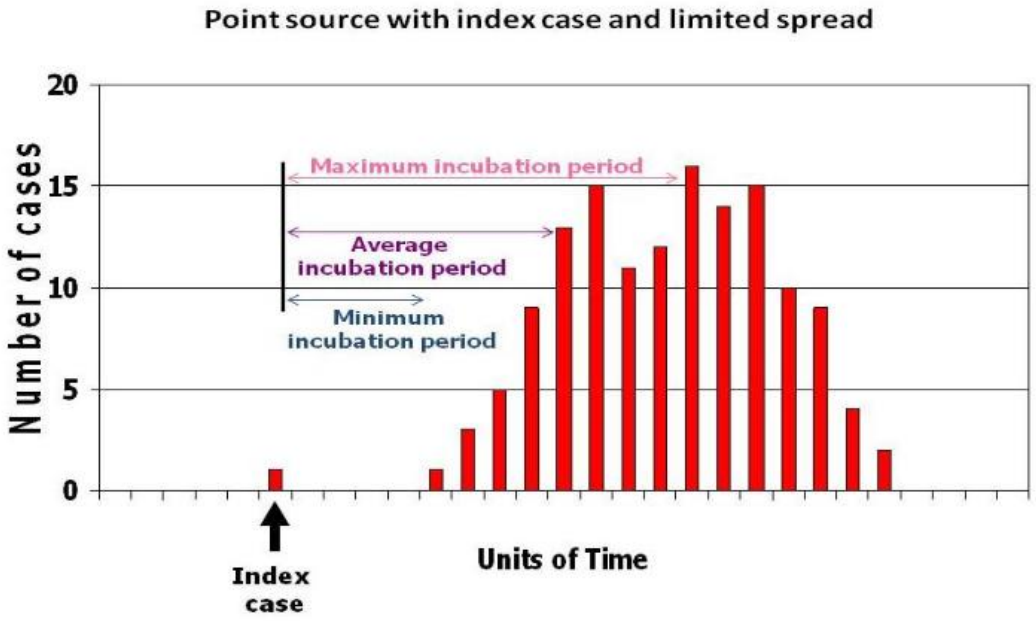
* Source not well controlled and recurs intermittently
* Eg contaminated instrument used intermittently, readmission of colonised patient, shift work of colonised HCW



Epidemic curves: Person-to-person spread

Index case with limited spread

* A single 'index' case infects other people and cases arise after an incubation period
* Eg multidrug resistant organism introduced into a hospital infecting local contacts and then being controlled

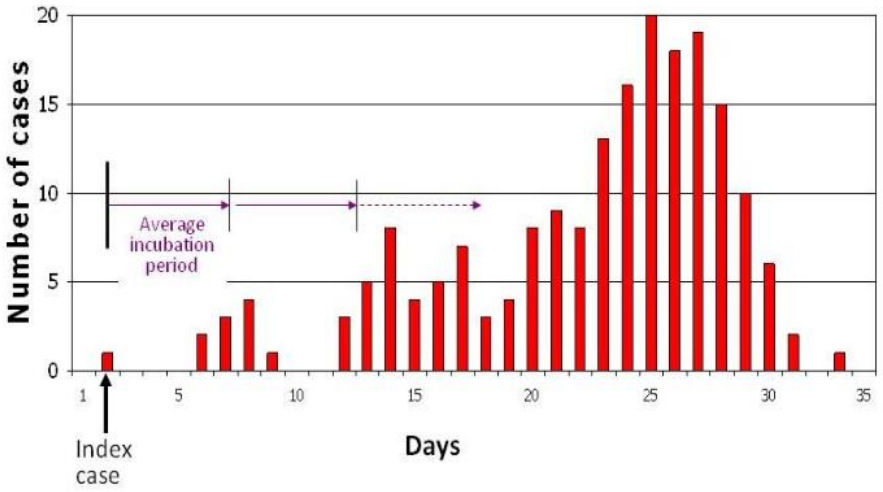


Epidemic curves: Person-to-person spread

Propagated spread

* This begins like an infection from an index case but then develops into a full-blown epidemic with secondary cases infecting new people who, in turn, serve as sources for yet other cases
* Eg MDR organism causing transmission with multiple ongoing cases

Disseminated outbreak originating from an index case with propagated spread



NH&MRC Outbreak Investigation

1. Recognise outbreak and prepare to investigate
2. Verify the diagnosis and confirm outbreak exists
3. Establish case definition and find cases
4. Characterise outbreak by person, place and time
5. Determine who is at risk
6. Develop hypothesis – the 'how' and 'why'
7. Test hypothesis with established facts
8. Carry out further studies if necessary
9. Implement ongoing control/prevention measures
10. Communicate findings

Step 8 – Further studies

* To support the hypothesis or if epidemiological studies do not confirm the hypothesis
  * May involve testing of environmental samples or food samples in some situations (eg Legionella, Pseudomonas, other GNBs) or screening HCWs or patients eg SA

Outbreak Database

* Searchable online database of published outbreaks in the health care setting
* Started in 2001
* Contains 3517 outbreak reports from 1936 to 2016
* 304 different pathogens
* Provides a standardised report on each outbreak
* http://www.outbreak-database.com/

Source of outbreak

* 1561 reported outbreaks studied to 2006
* 37.1% - no information about the sources given
  * Significantly higher for Klebsiella, enterococci, streptococci and staphylococci
  * Significantly lower for hepatitis B virus and Legionella
* Most frequent sources
  * Index patients (40.3%)
  * Contaminated equipment or devices (21.1%)
  * Environment (19.8%)
  * Personnel (15.8%)

Where should one search when confronted with outbreaks of nosocomial infection? *Gastmeier et al* AJIC 2006

Most common sources

Organism	Most common sources
Enterococci, streptococci, hepatitis C	Other patients
Staphylococci, hepatitis B	Personnel
Serratia, Pseudomonas	Equipment/ devices
Acinetobacter, Pseudomonas, Enterobacter, Legionella	Environment
Enterobacter	Contaminated drugs or food
Enteric Salmonella	Food
Klebsiella	Not significantly associated with any special outbreak source category

Common sources

Table 1. Number of nosocomial outbreaks in the outbreak database for the 12 most frequent pathogens grouped by source

	Staphylococci	Pseudomonas	Klebsiella	Acinetobacter	Serratia	Hepatitis B virus
Total	223	129	115	105	94	70
Source unknown, n (%)	97 (43.5)*	48 (37.2)	67 (58.3)*	38 (36.2)	30 (31.9)	8 (11.4)†
Source confirmed, n	126	81	48	67	64	62
Other patients, n (%)	61 (48.4)	12 (14.8)†	22 (45.8)	15 (22.4)†	17 (26.6)	31 (50.0)
Personnel, n (%)	49 (38.9)*	9 (11.1)	6 (12.5)	6 (8.9)	5 (7.8)	21 (33.9)*
Equipment/devices, n (%)	18 (14.3)†	37 (45.6)*	20 (41.7)	25 (37.3)	39 (60.9)*	7 (11.3)
Environment, n (%)	9 (7.1)†	29 (35.8)*	9 (18.8)	26 (38.8)*	7 (10.9)	0 (0.0)†
Drugs, n (%)	4 (3.2)	9 (11.1)	2 (4.2)	4 (6.0)	3 (4.7)	3 (4.8)
Food, n (%)	0 (0.0)†	2 (2.5)	1 (2.1)	0 (0.0)†	1 (1.6)	0 (0.0)

*Significantly higher.
†Significantly lower ($P < .05$).

	Enterococci	Enterobacter	Streptococci	Hepatitis C virus	Salmonella	Legionnella	Total
Total	67	66	63	56	56	48	1561
Source unknown, n (%)	37 (55.2)*	28 (42.4)	31 (49.2)*	16 (28.6)	17 (30.3)	6 (12.5)†	579 (37.1)
Source confirmed, n	30	38	32	40	39	42	982
Other patients, n (%)	20 (66.7)*	7 (18.4)†	21 (65.6)*	23 (57.5)*	11 (28.2)	0 (0.0)†	396 (40.3)
Personnel, n (%)	3 (10.0)	3 (7.9)	5 (15.6)	6 (15.0)	6 (15.4)	0 (0.0)†	155 (15.8)
Equipment/devices, n (%)	4 (13.3)	12 (31.6)	0 (0.0)†	5 (12.5)	2 (5.1)†	0 (0.0)†	207 (21.1)
Environment, n (%)	6 (20.0)	13 (34.2)*	3 (9.4)	0 (0.0)†	2 (5.1)†	42 (100.0)*	194 (19.8)
Drugs, n (%)	0 (0.0)	7 (18.4)*	3 (9.4)	6 (15.0)	0 (0.0)	0 (0.0)	73 (7.4)
Food, n (%)	0 (0.0)	5 (13.2)*	1 (3.1)	0 (0.0)	24 (61.5)*	0 (0.0)	50 (5.1)

Specific organisms

* Pseudomonas
  * Likes moist environments
  * Able to form biofilms
  * Outbreaks associated with sinks, drains, water, faucets, showers, contaminated equipment
  * MBL-PA in sinks
* *Acinetobacter baumannii*
  * Can survive on wet and dry surfaces
  * Outbreaks associated with environmental contamination including respiratory equipment (spirometers, ventilation equipment, peak flow meter, temp/O_2 monitors, suction catheters), others (pillows, mattresses, humidifiers, taps, bedpans, warming bath water)

Specific organisms

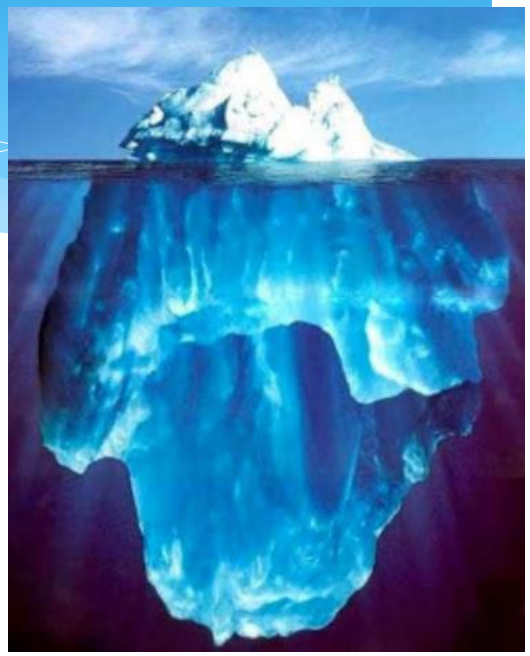
* Serratia
  * Ubiquitous in the environment
  * Can survive for long periods in solutions and disinfectants
  * Outbreaks related to contaminated thermometers, ventilation equipment, disinfectants, colonised staff and patients
* Enterobacteriaceae
  * Able to survive in biofilm, multiply in moist conditions
  * Found in sinks, *Klebsiella oxytoca* in disinfectants, multi-dose vials, IV fluid bags, humidifiers, ventilators, sinks, also person-to-person transmission
  * ESBL KP in sinks, MBL-KP in wastewater, KPC-KP in sinks, MR-KP in sinks/pipes

More specific organisms

* Burkholderia
  * Widely distributed in the environment
  * Often found in liquid reservoirs or moist environments
    * Able to survive and grow in water sources with minimal nutritional sources
  * Outbreaks and pseudo-outbreaks associated with water, chlorhexidine, topical cocaine, iodine, QACS, respiratory therapy equipment
* Rhizopus
  * Outbreaks associated with contaminated adhesive bandages, ostomy supplies, wooden tongue depressors, linen, contaminated hospital laundry carts

Active surveillance of patients in a bacterial outbreak

* Using clinical isolates only detects the tip of the iceberg
* Used as a tool to detect colonised patients, not an intervention in itself
* Detection of colonised patients in order to:
  * Institute infection control precautions
  * Decolonisation (MRSA)
  * Changes in empirical treatment/prophylaxis
* Decisions:
  * Which sites to screen (nose, throat, rectal, wounds, urine etc)
    * Depends on organism
  * How often to screen
    * Admission/discharge/weekly/twice weekly??
  * Different issues for screening in the endemic situation



HCW and nosocomial outbreaks

* Systematic review of 152 outbreaks 1958-2006
* 5% outbreaks in the Outbreak Database included
* Surgery, neonatology, gynaecology, paediatrics, internal medicine most common
* Transmission most common in theatre than wards
* Most frequent organisms: SA, HBV, GAS
* Contact transmission most common, then droplet and airborne
* Physicians and surgeons (41.5%) most common sources, then nurses (39.4%)
* Outbreaks rarely caused by HCWs
  * Screening of HCWs should not routinely be performed
  * Consider screening for particular organisms eg SA, *S. pyogenes*

Health care workers causing large nosocomial outbreaks: a systematic review

Lisa Danzmann[1], Petra Gastmeier[2], Frank Schwab[2] and Ralf-Peter Vonberg[1*]

BMC Infectious Diseases 2013, **13**:98

MRSA and healthcare workers

* Literature review 1980-2006, 127 papers
* 1545/33 318 (4.6%) of HCWs carried MRSA (range 0-59%)
  * 48/942 (5.1%) had symptomatic infection
  * Risk factors: chronic skin diseases, poor infection control practices, having worked in countries with endemic MRSA
* 68 studies that genotyped
  * Transmission from HCWs to patient likely in 63 (93%)
  * 18 studies with proven and 26 with likely transmission to patients from MRSA colonised health-care workers (vs. infected)
* Authors recommend MRSA screening in HCWs
  * All HCWs epidemiologically associated with MRSA outbreak or with any MRSA case if sporadic MRSA occurrence
  * Pre-employment screening
  * During outbreak investigations and during early stages of an institutional epidemic when MRSA prevalence is still low or when a new strain is propagating rapidly

Health-care workers: source, vector, or victim of MRSA?
Lancet Infect Dis 2008;
Werner C Albrich, Stephan Harbarth

Caveats

* Organisms that cause nosocomial outbreaks (eg Gram-negative water organisms, fungi, GPCs, including *Staph. aureus*) can be isolated frequently from nonsterile environmental sources and staff
* Random culture surveys may increase the cost of an investigation substantially and may identify the wrong source
* Cultures should only be taken from environmental sources and staff implicated by epidemiologic data and are rarely helpful otherwise
* Culture surveys of nonsterile areas (eg floors, sinks, walls) that do not have plausible connections to the outbreak waste valuable resources and frequently yield uninterpretable data
* Do not discount epidemiologically sound hypothesis based on negative cultures
* Ensure that results and hypothesised transmission dynamics are biologically plausible
* Molecular typing eg WGS should be used where possible to link isolates

Outbreak Investigations

Consuelo Beck-Sague, MD; William R. Jarvis, MD; William J. Martone, MD

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY February 1997

Summary

* One component of an outbreak investigation
* Search the literature, especially for rarer pathogens
* Review epidemic curve
  * May suggest person-to-person transmission or common source
* Start swabbing when:
  * Particular organisms associated with outbreaks eg Gram negatives, atypical mycobacteria found
  * Outbreak not resolving with control measures
* Who/where to swab:
  * Environment, fomites, staff, patients, depending on organism
* How to swab:
  * Ensure standardised swabbing
  * Purposeful sampling
  * Accredited laboratory
* Correlate with epidemiological and clinical data
* Save isolates for molecular typing
  * Match with clinical samples
* Eliminate source – outbreak resolves