

# Outbreak Investigation in Health Care Facilities

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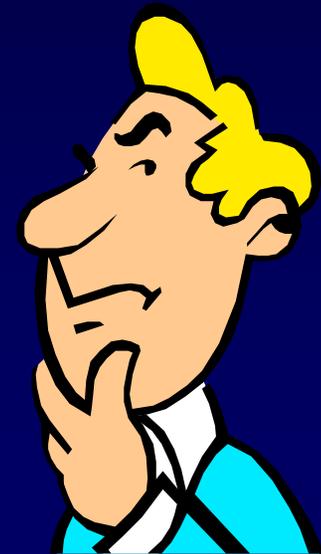
Your taxes at work

# Health Care Facilities

- **Hospital**
- **Private physician's office**
- **Outpatient clinic**
  - **Dialysis centers**
  - **Ambulatory surgery**
  - **Endoscopy centers**
  - **Miscellaneous boutiques**
- **Long term care facilities**
  - **Nursing homes**
  - **Rehabilitation centers**
  - **Institutions for mentally or physically handicapped**

# What is an Outbreak?

- Increase in occurrence of an infection, disease, complication
- Minimum number depends on the background rates:
  - 2-3 cases of a rare infection may be an outbreak
  - Significant increase in large rates
- Usually decision made empirically on experience
- Statistical tests:
  - Rare events: Poisson distribution
  - Higher rates: Comparison of observed vs expected rate



# Health Care Acquired Infection (HAI) vs Community Acquired Infections (CAI) Outbreaks

## 1. HAI are more common than CAI

- Incidence: 1 to 20% patients, average 5-6
- Common infections: BSI, UTI, RTI & SSI +...
- Most HAI are endemic → challenge is detecting abnormal ↑
- From NNIS: about 5% of HAI occur as outbreaks
- Small outbreaks of few cases ( $\leq 5$ )

## 2. Special conditions:

- Underlying conditions ↑ susceptibility to infections
- Invasive devices / procedures

## 3. Antibiotic resistance common

## 4. Risk of litigation → reticence from management & HCW

## 5. Ample documentation

# Objective: Investigate to Prevent

- Identify source /mode of spread of outbreak
- Prevent further transmission
- Learn lessons for future outbreaks:
  - New sources
  - Emerging agents
  - Unusual modes of transmission
  - Complications of new procedures



**Prevention  
does not wait**

# Negative Effects of Outbreaks

Outbreaks cause

- **Morbidity, mortality**
- **Prolongation of stay**
- **Additional procedures**
- **Increased cost**
- **Bad reputation**



# Reporting

- Report triggered by:
  - Abnormal pattern (increase) in HAI routine surveillance
  - Increase from microbiology lab
  - Unusual agent: *Rhodococcus bronchialis*
  - Unusual site, unusual host
  - Report from physicians, nursing, pharmacy, radiology...
  - Report from patients, families, employee
- Reason for reporting:
  - Genuine concern to prevent future infections
  - Prevent legal action or adverse publicity
  - Disgruntled employee or whistle blower



# Think Before You Jump



You have a brain  
Use it!

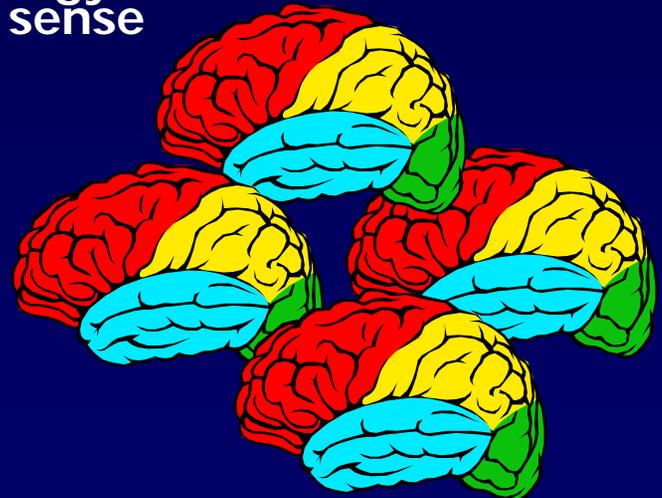


You have 2 ears and 1  
mouth, use them to  
communicate



Other people have brains  
Use them

Epidemiology is 90%  
common sense



**Statistics**  
**or**  
**Common Sense**  
**or**  
**Both ?**

# Increase of Rare Events

- The probability of  $x$  events randomly distributed to occur in an interval of time  $t$  follows the Poisson distribution.
- General Formula giving the probability of a rare event to occur  $x$  times within a certain time

$$P(x) = \frac{e^{-m} m^x}{x!}$$

- $e = 2.71828$
- $x$  = observed number of events
- $x!$  or factorial  $x = 1 \times 2 \times 3 \times \dots \times (x-1) \times x$
- $m$  = expected number of events
- Calculate, use a statistical table or a Poisson calculator

# Increase in Rare Events

**Poisson Calculator**

lambda= 1

Prob. X is exactly 5 = 0.0031.

**How it works:** The calculator above takes the place of the traditional textbook table. Students should enter the proper Poisson parameter (lambda) for the distribution they are interested in calculating probabilities for. Students specify the relevant "x" value and then select among choices such as "exactly", "no more than", etc. Hit "Compute!" to get the answer.

Expected

Result

Observed

Poisson Calculator	
Expected m	1
Observed x	2
Probability	0.1839588

Poisson Calculator	
Expected m	1
Observed x	3
Probability	0.0613196

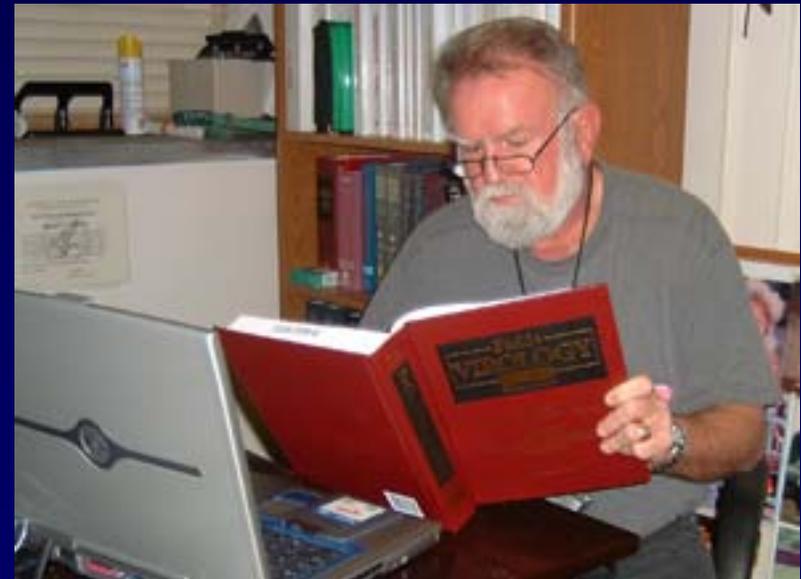
Poisson Calculator	
Expected m	1
Observed x	4
Probability	0.0153299

**So You Decided to Investigate...**

**Then what ?**

# Learn about topic ?

- Colleagues
- OPH Infectious Disease Epidemiology
- Lab personnel
- Book for a summary of the topic:
  - APHA Manual of Control of Communicable Disease
  - Academy of Pediatrics Red Book
- Articles: National Library of Medicine, PubMed
- Infection Control Textbooks



# Investigation

# Involve Facility Personnel



- ICP, hospital epidemiologist, Infection Control Committee members
- Facility Administration, Risk management personnel, Communicator
- Chief of service, physicians, nurses
- Staff from unit involved: head nurse, other staff
- Lab
- Medical records

# Confidentiality



- **Protected if investigation led by the State:**
  - **HIPAA allows reporting to Public Health for investigations**
  - **State Law requires confidential data to be available to Public Health**
  - **State Law guarantees confidentiality of details of the investigation**
  - **State Law prevents details of the investigation to be subject to subpoena**
- **Freedom of Information Act (FOIA) applies to CDC investigations**

# Confidentiality

TITLE 40: PUBLIC HEALTH AND SAFETY

CHAPTER 1. DIVISION OF HEALTH AND HEALTH OFFICERS

PART I. STATE DIVISION OF HEALTH

§3.1. Confidentiality of public health investigations; prohibited disclosure and discovery; civil penalties

A. All records of interviews, questionnaires, reports, statements, notes, and memoranda procured by and prepared by employees or ... in connection with special morbidity and mortality studies and research investigations to determine any cause or condition of health, ... hereinafter referred to as "confidential data", are confidential and shall be used solely for statistical, scientific, and medical research purposes

B. **All confidential data shall be made available to the state health officer** when necessary for the purpose of controlling nuisances dangerous to the public health, including but not limited to communicable, contagious, and infectious diseases, as well as illnesses, diseases, and genetic disorders or abnormalities.

F. **No part of the confidential data** in the possession of the office of public health or the state health officer **shall be available for subpoena** nor shall it be disclosed, discoverable, or compelled to be produced in any civil, criminal, administrative, or other proceeding, nor shall such records be deemed admissible as evidence in any civil, criminal, administrative, or other tribunal or court for any reason.

## Describe the problem

- **Collect basic information**
- **Contact names**
- **Event description**
- **Clinical records**
- **Lab confirmations**
- **Info useful to complete /confirm initial story**



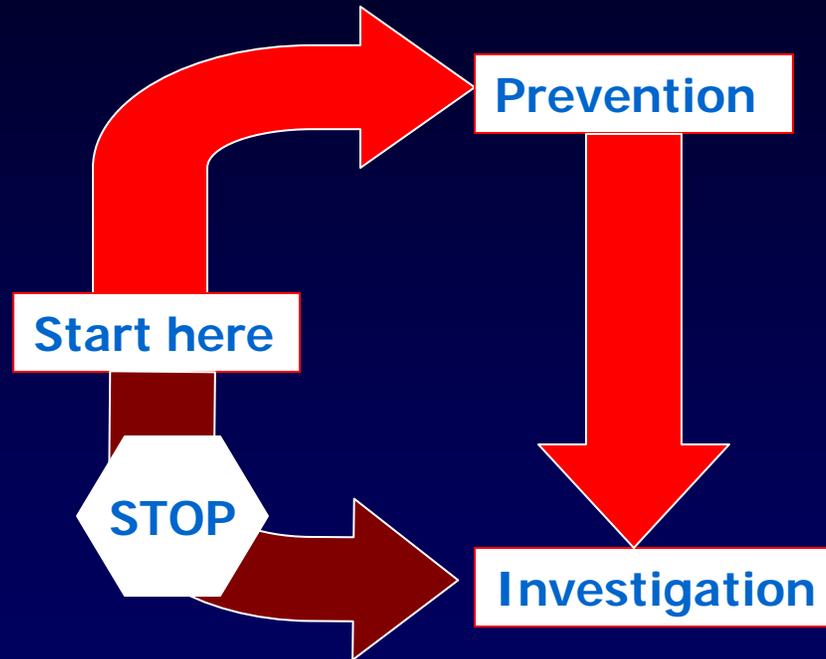
# Prepare a plan for investigation



# To Do List

- **Collect numbers**
- **Laboratory support**
- **Get basic information on the disease /conditions**
- **Is this unusual = outbreak ? Make sure that there is nothing "NEW" causing increase Ascertain diagnosis: Make sure it is ...**
- **Prepare a case definition**
- **Identify and count the cases**
- **Case finding: identify additional cases**
- **Basic descriptive epidemiology**
- **Time**
- **Place**
- **Person**
- **Analyze**
- **Hypothesis, verify and refine**
- **Case Control study**

# Think Prevention First



# Laboratory Support

- **Laboratory support important**
- **Often agent known and prevalent throughout facility, need special testing:**
  - **Genetic typing: PFGE, MLST, Ribotyping, RLFP, Plasmid analysis**
  - **Phage typing**
  - **Serotyping**
  - **Antimicrobial sensitivity**

PFGE: Pulse Field Gel Electrophoresis

MLST: Multi Locus Sequence Typing

RFLP: Restriction Fragment Length  
Polymorphism

# Collect Numbers

- Collect any numbers that would permit comparison and decide whether numbers are really increased
- Is the outbreak /number increase real ? Compared with baseline occurrence and timeline

- There are no baseline info
- Look back at several months /years of data to calculate baseline rate
- Acceptable to use a sample to save time
- Sometime, too time consuming to calculate baseline, then estimate



# Is this an outbreak ?

## OUTBREAK / EPIDEMIC

=More cases than  
expected in given place  
over given time



Always doubt increase

Other than an outbreak,  
what else could prompt  
an increase in reported cases?

# Is this an outbreak /epidemic ?

## What could cause an artificial increase ?

- **Alterations in surveillance system:**
  - **New personnel: ICP, nurse, infection control committee...**
  - **New definition**
  - **New case finding method**
  - **New procedures in reporting**
- **New physician interested in disease**
- **Increased awareness: CME, pharmaceutical rep visit,**
- **New Laboratory procedure:**
  - **New diagnostic tests, laboratory equipment**
  - **New technician**
- **Increase in susceptible population:**
  - **New ward for ...**

Case

# Collect Case Data

- **Demographic information**
- **Dates admission, transfer to other units, discharge**
- **Date onset of illness**
- **Clinical description**
- **Underlying conditions**
- **Laboratory test results**
- **Invasive procedures**
- **Severity of illness, but not specially devised for HAI risk characterization**
  - **APACHE: Acute Physiologic and Chronic Health Evaluation**
  - **PRISM: Pediatric Risk of Mortality score**
  - **Surgical site classification**
  - **ASA: American Society of Anesthesiologists**

# Prepare a case definition

## CDC Definitions of Nosocomial Infections

### Definitions of Nosocomial Infections

The ability of data collectors to define infections as nosocomial and identify their sites consistently is of paramount importance. Use of uniform definitions is critical if data from one hospital or with an aggregated database (such as the NNIS system).<sup>1-3</sup> The NNIS system defines a nosocomial infection as a localized or systemic condition 1) that results from adverse reaction to the presence of an infectious agent(s) or its toxin(s) and 2) that was not present or incubating at the time of admission to the hospital (7, and *NNIS Manual*, Section XIII, May 1994, unpublished). For most bacterial nosocomial infections, this means that the infection usually becomes evident 48 hours (i.e., the typical incubation period) or more after admission. However, because the incubation period varies with the type of pathogen and to some extent with the patient's underlying condition, each infection must be assessed individually for evidence that links it to the hospitalization.

There are several other important principles upon which nosocomial infection definitions are based.<sup>4</sup> First, the information used to determine the presence and classification of an infection should be a combination of clinical findings and results of laboratory and other tests. Clinical evidence is derived from direct observation of the infection site or review of other pertinent sources of data, such as the patient's chart (detailed in a later section of this chapter). Laboratory evidence includes results of cultures, antigen or antibody detection tests, or microscopic visualization. Supportive data are derived from other diagnostic studies, such as x-ray, ultrasound, computed tomography (CT) scan, magnetic resonance imaging (MRI), radiolabel scan, endoscopic procedure, biopsy, or needle aspiration. For infections whose clinical manifestations in neonates and infants are different from those in older persons, specific criteria apply.

Second, a physician's or surgeon's diagnosis of infection derived from direct observation during a surgical operation, endoscopic examination, or other diagnostic studies or from clinical judgment is an acceptable criterion for an infection, unless there is

compelling evidence to the contrary (e.g., information written in the wrong patient's record, presumptive diagnosis that was not substantiated by subsequent studies). For certain sites of infection, however, a physician's clinical diagnosis in the absence of supportive data must be accompanied by initiation of appropriate antimicrobial therapy to satisfy the criterion.

There are two special situations in which an infection is considered nosocomial: (a) infection that is acquired in the hospital but does not become evident until after hospital discharge and (b) infection in a neonate that results from passage through the birth canal.

There are two special situations in which an infection is not considered nosocomial: (a) infection that is associated with a complication or extension of infection already present on admission, unless a change in pathogen or symptoms strongly suggests the acquisition of a new infection, and (b) in an infant, an infection that is known or proved to have been acquired transplacentally (e.g., toxoplasmosis, rubella, cytomegalovirus, or syphilis) and becomes evident at or before 48 hours after birth.

There are two conditions that are not infections: 1) *colonization*, which is the presence of microorganisms (on skin, mucous membranes, in open wounds, or in excretions or secretions) that are not causing adverse clinical signs or symptoms, and 2) *inflammation*, which is a condition that results from tissue response to injury or stimulation by noninfectious agents, such as chemicals.

The information that follows contains the criteria that comprise the definitions of nosocomial infections (*NNIS Manual*, Section XIII, May 1994, unpublished). It lists the 13 major site categories and the 48 specific sites or types of infection for which criteria have been developed, beginning with the most frequently occurring sites of infection in hospitalized patients—urinary tract, surgical site, pneumonia, and primary bloodstream—followed by other sites of infection lists alphabetically by major site category (e.g., bone and joint, central nervous system).

Two additional points are important to understand with regard to definitions of nosocomial infections.<sup>4</sup> First, the preventability or inevitability of an infection is

A-1

Reprinted from: Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections. In: Olmsted RN, ed.: *APIC Infection Control and Applied Epidemiology: Principles and Practice*. St. Louis: Mosby; 1996: pp. A-1-A-20.

- Start with CDC definition

- How strict:

- initial definition with loose criteria
- dynamic process
- refine as more info obtained
- narrow → fewer cases identified; loose → some unconf cases



# Case Definition

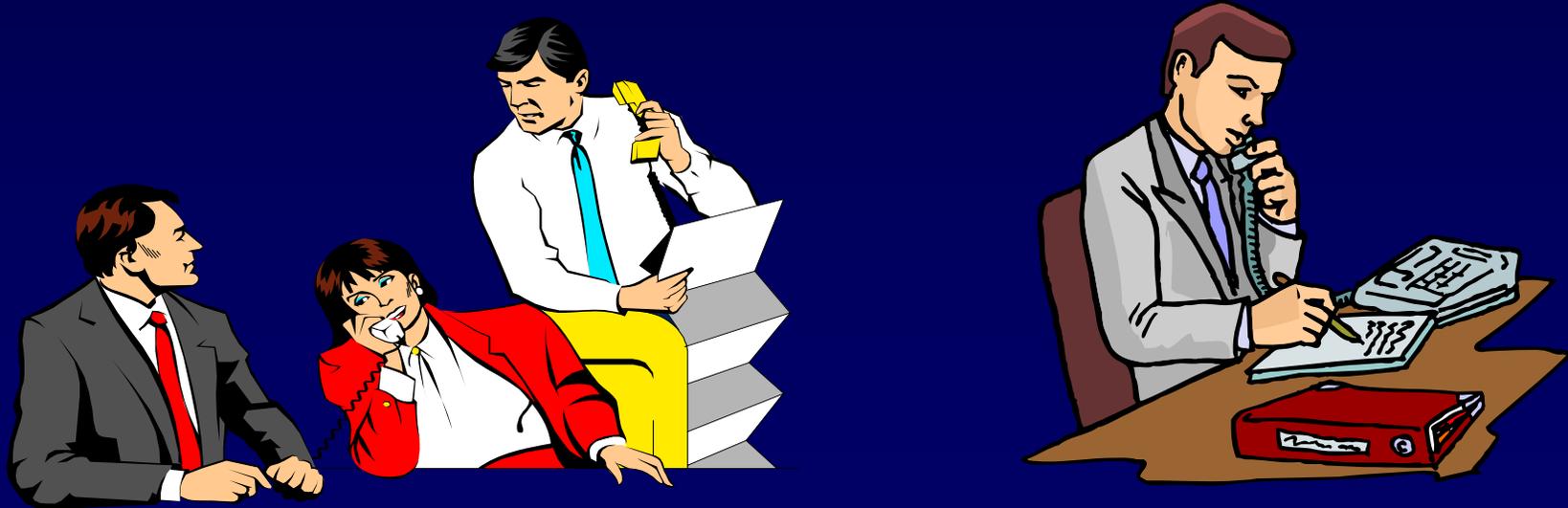
- **Diagnosis: Clinical description if applicable  
+ Lab test**
- **Time:**
  - **Admitted, present during, ...**
  - **Time frame: From 01/01/01 to 01/31/01**
- **Place: Unit, ward, surgery suite....**
- **Person: All or limit to age or occupational group, etc.**

- **Confirmed**
- **Probable**
- **Possible**



# Identify additional cases

- Interview staff, patients
- Review patient records
- Review lab records



# Denominator

- **Patients admitted, discharged**
- **Surgical procedures**
- **Device day: Intravascular line, ventilator, urinary catheter**

# Descriptive Epidemiology

As a result of case finding, a database is built up with basic information. This database is to be used to do a basic descriptive epidemiologic study. This will be useful to build some hypothesis.

## What should be in this database ?



# Source of Information

- Log books
  - Operating or delivery room
  - Emergency department
  - Nursing unit
  - ICU (admission log book, discharge logs)
  - Procedure room
- Microbiology record
- Employee health records
- Infection surveillance data
- Patient medical records
- Operative notes
- Pathology reports
- Hospital billing records
- Radiology procedure notes, records
- Pharmacy records
- CSS records
- Purchasing records



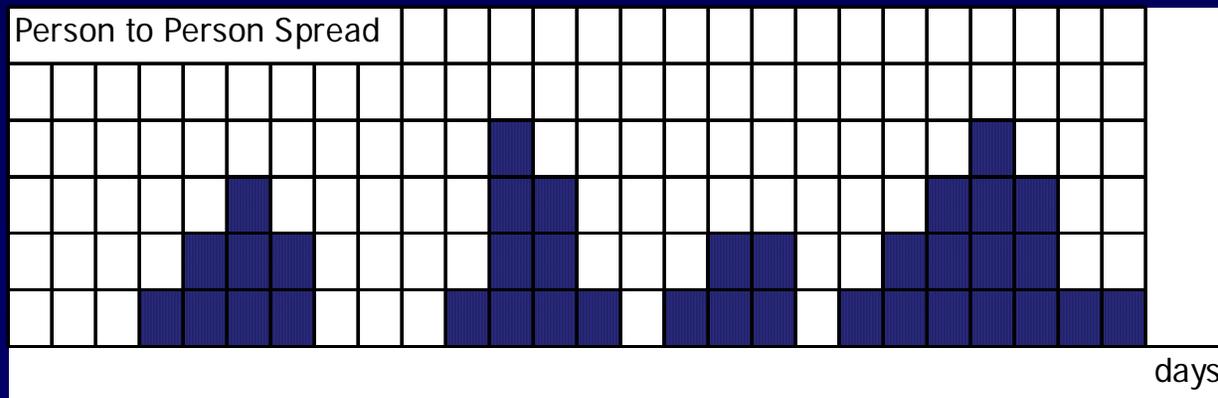
# Time, Space, Person



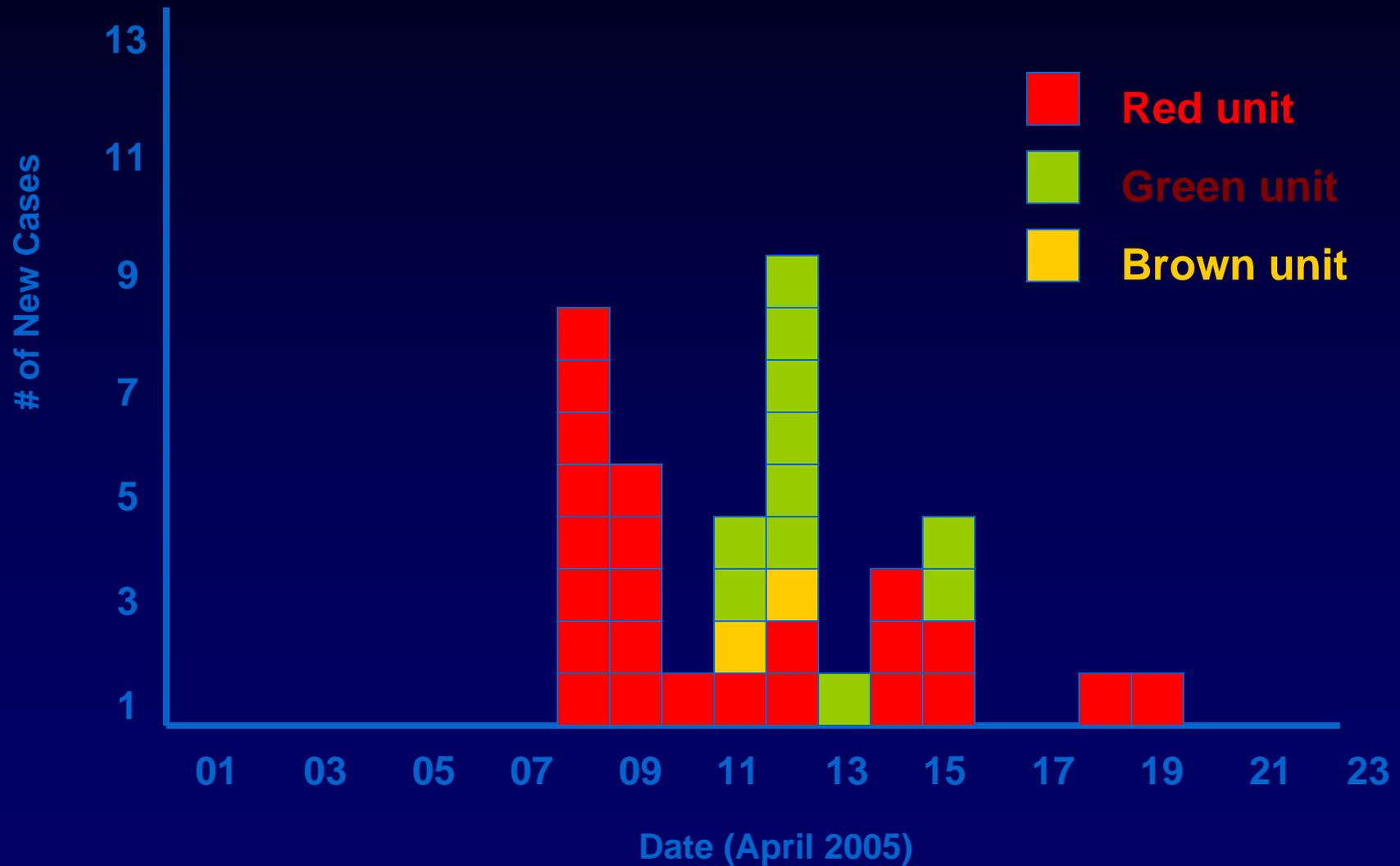
# Time: Epidemic Curve

Common Source										
				8						
				7	14					
				6	13					
			2	3	12	12				
		4	1	5	11	9	10	11		
1	2	3	4	5	6	7	8	9	10	days

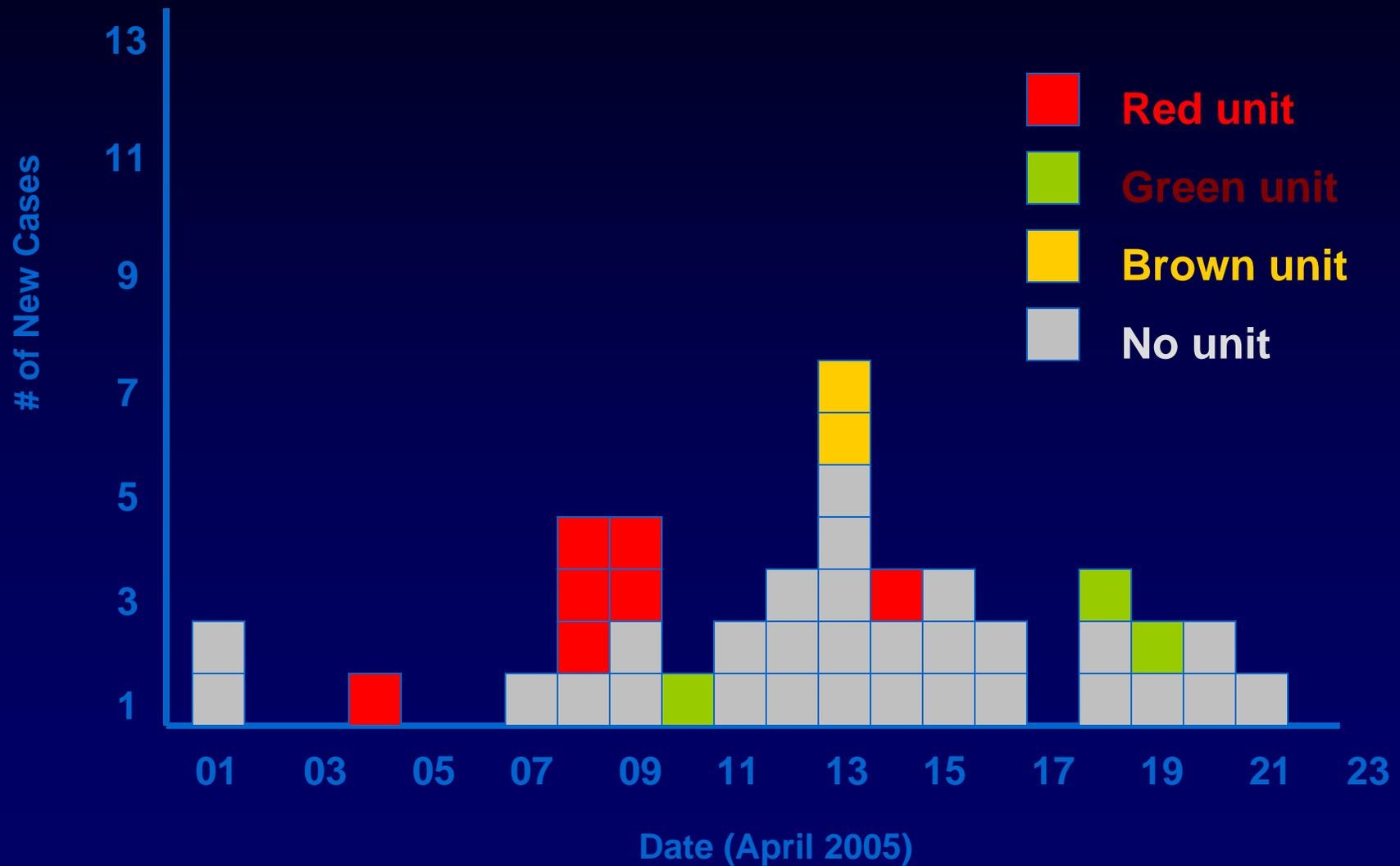
Continuous Source													
				7									
		2		6	8				10		13		
		1		3	4	5		11	9		12		
1	2	3	4	5	6	7	8	9	10	11	12	12	days



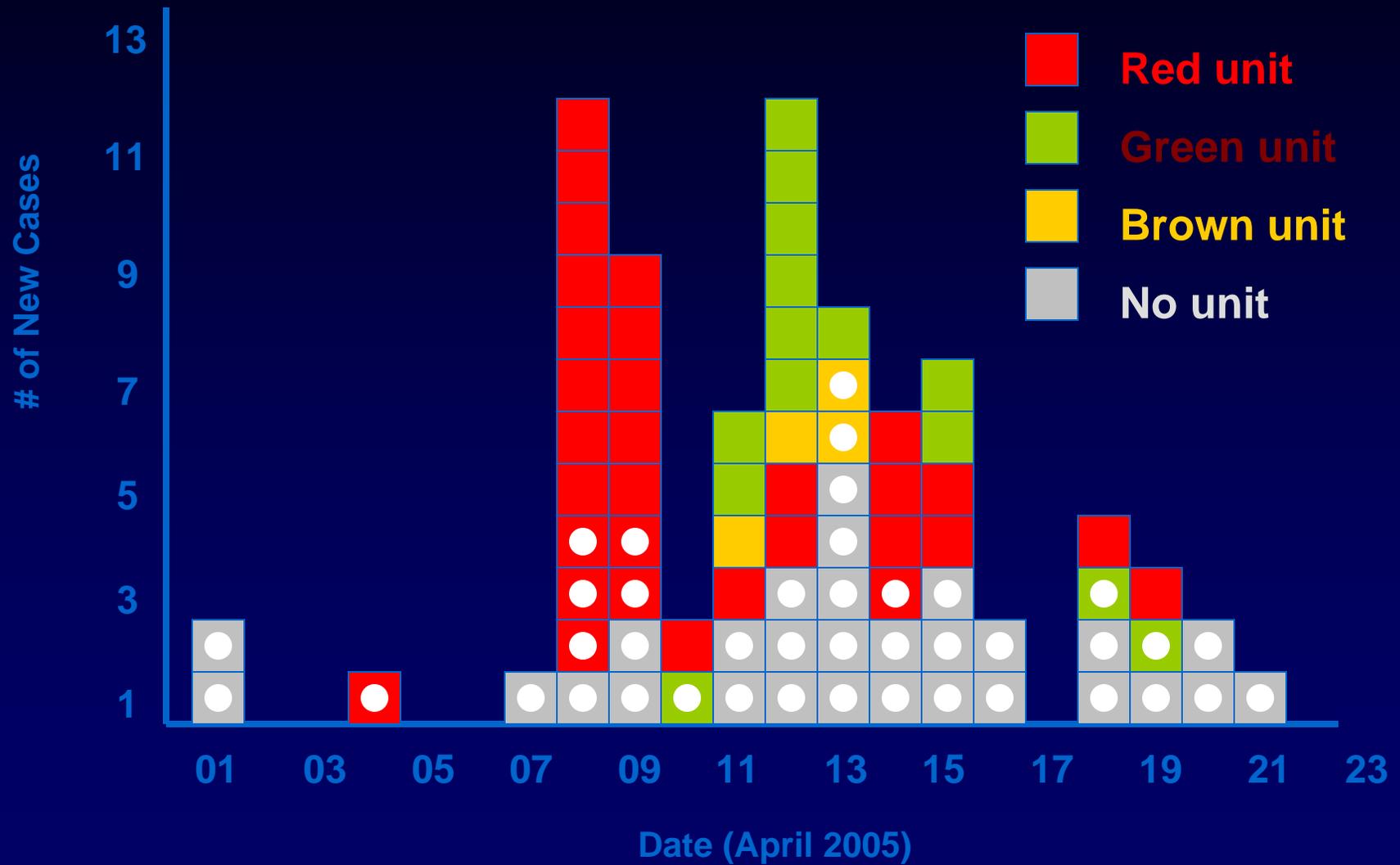
# EpiCurve: Resident cases



# EpiCurve: Employee cases

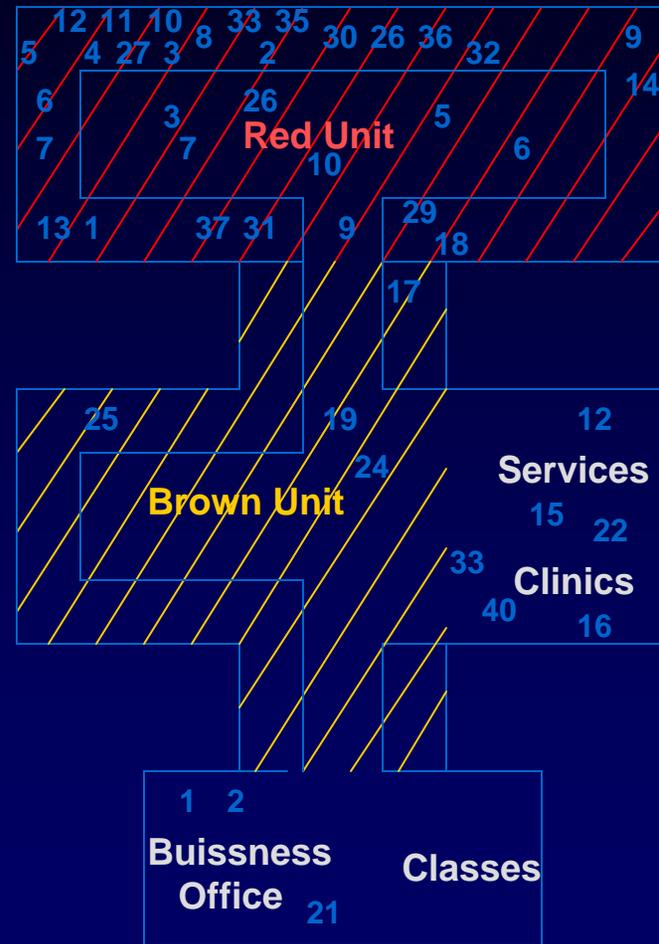


# All cases



# Space: Map

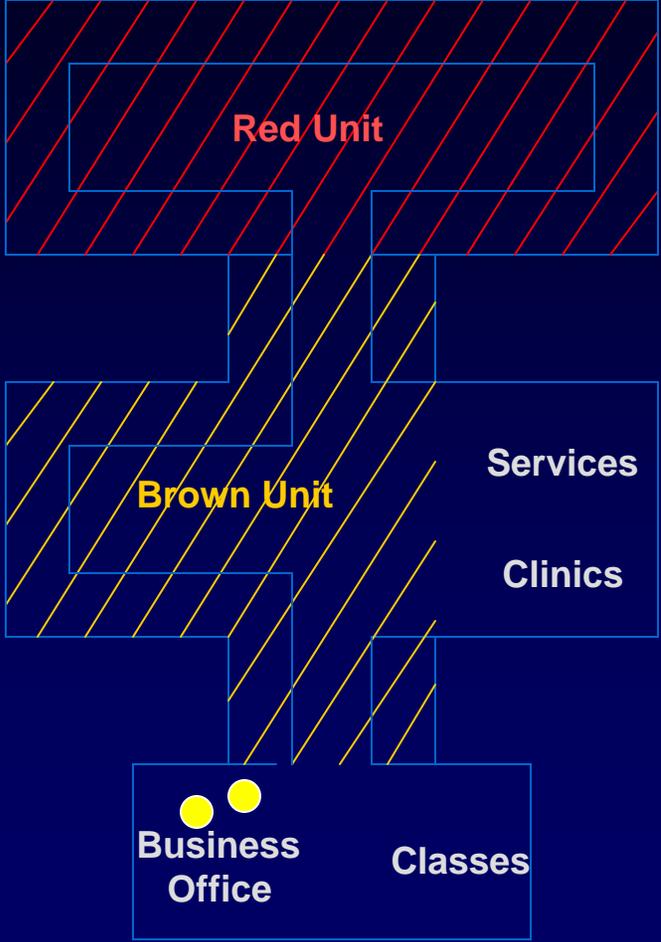
- Plotting cases on map  $\Rightarrow$  leads on nature & source of outbreak
- Useful to track spread by water, air, person to person, distribution route of contaminated item
- Indicate occurrence of cases & not rates



04/01/2005



Ground floor

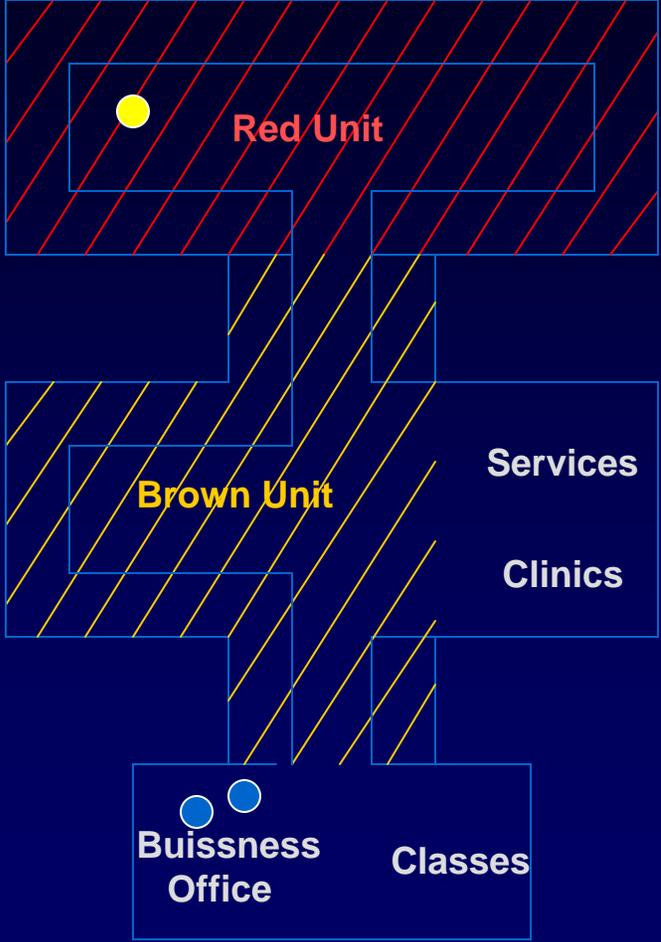


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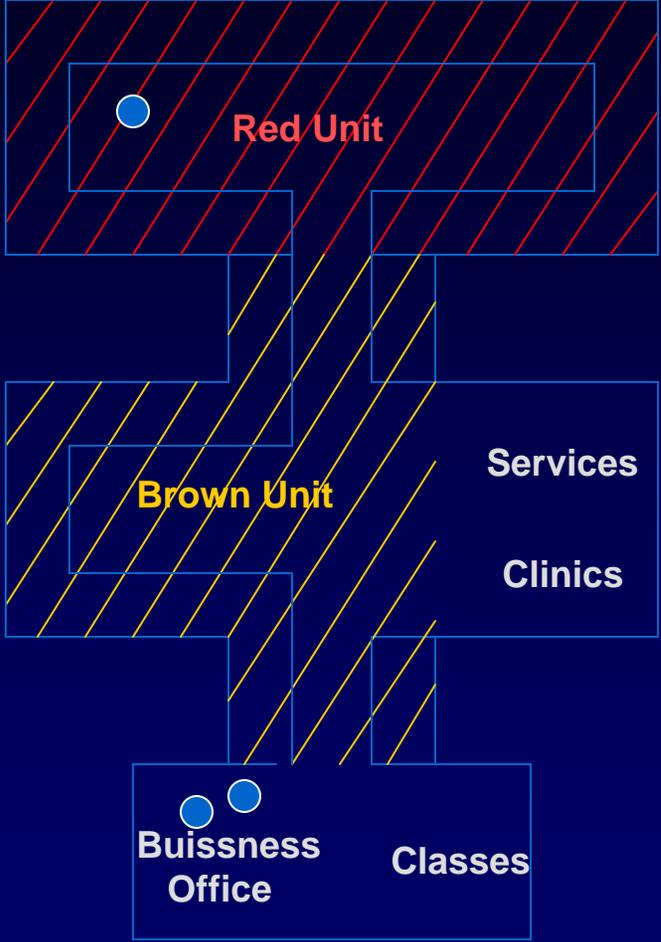


Ground floor



2nd floor

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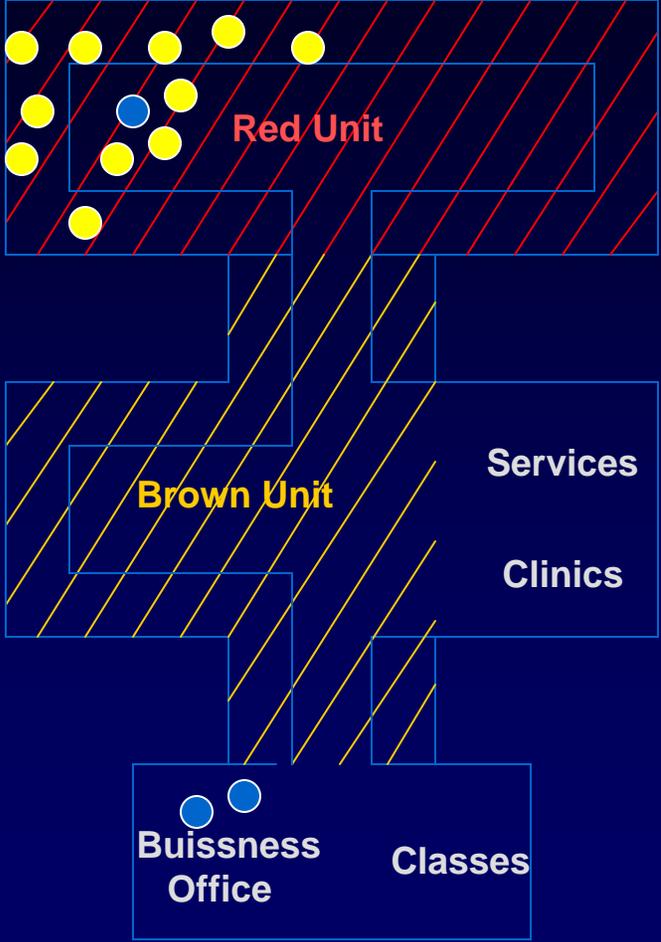
Ground floor

2nd floor

04/08/2005



Ground floor

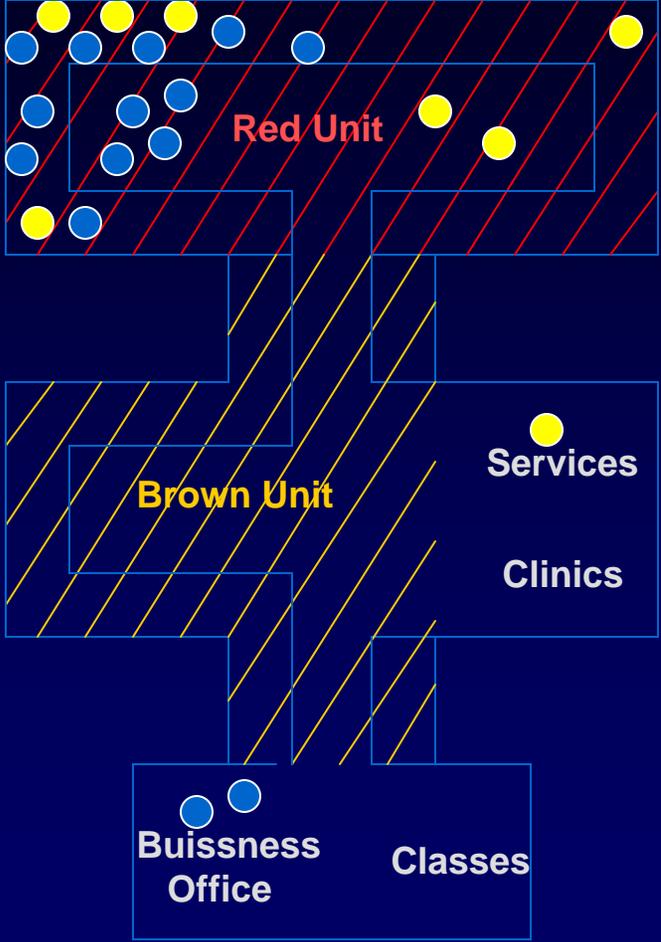


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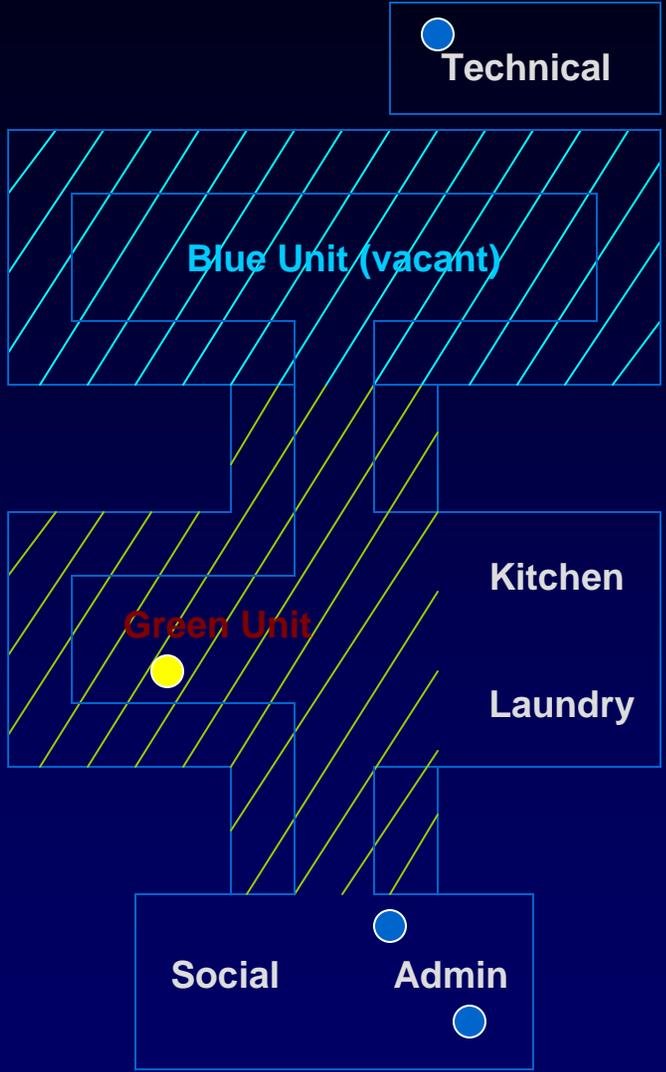


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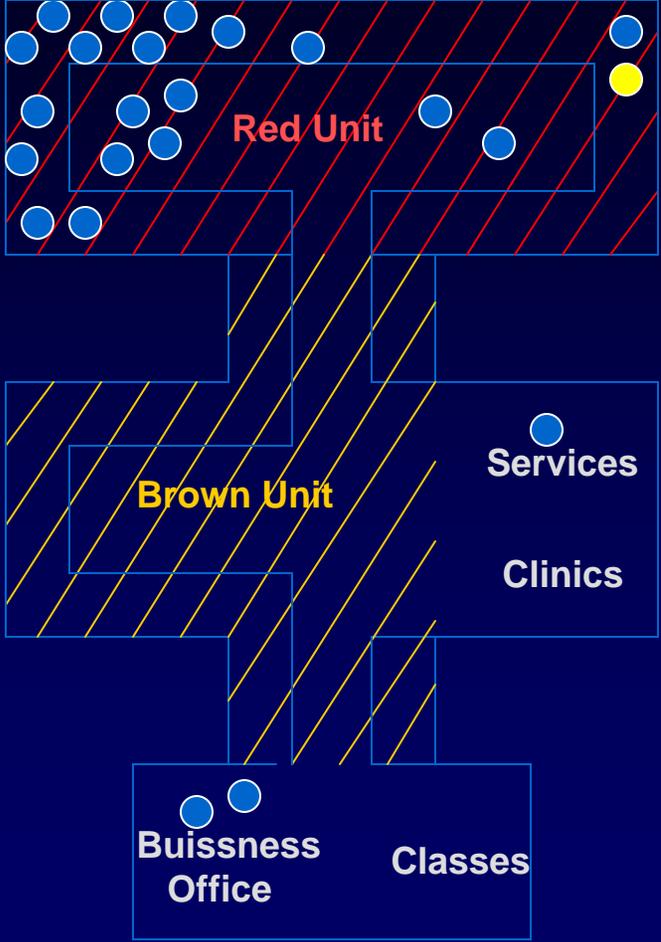


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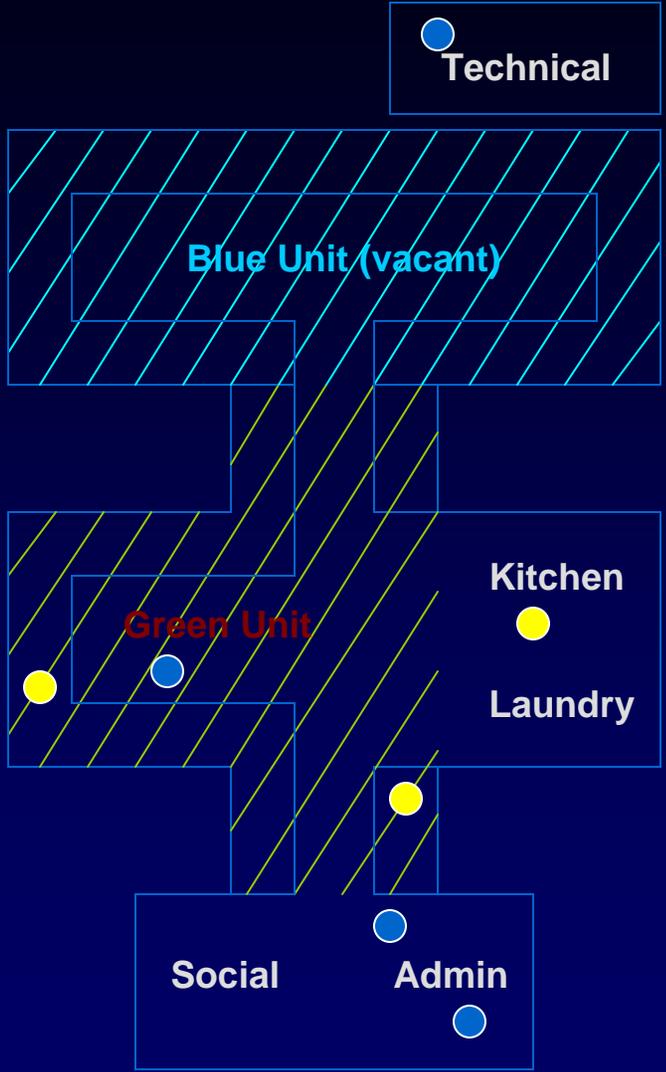


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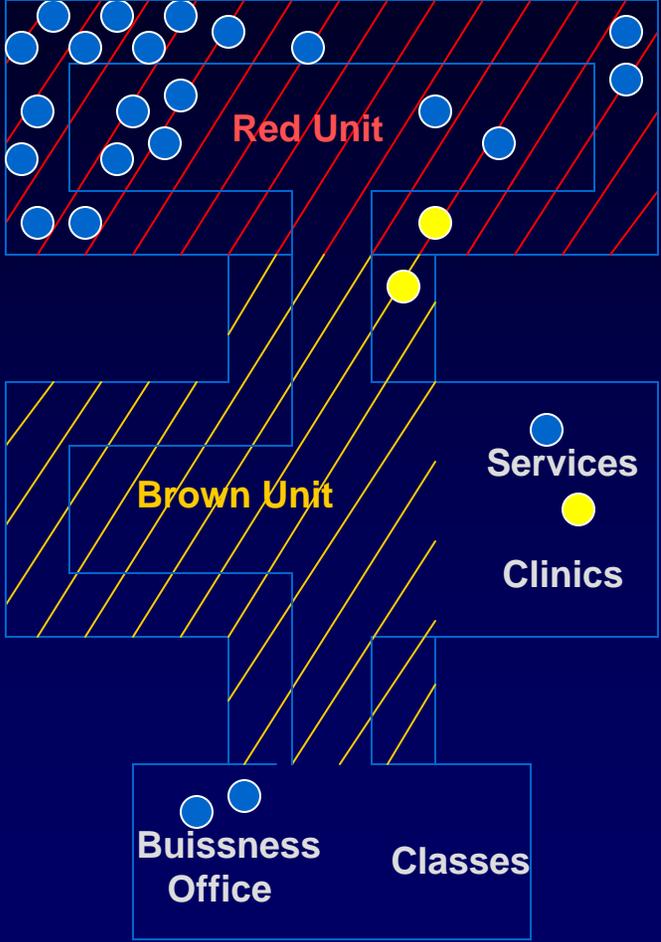


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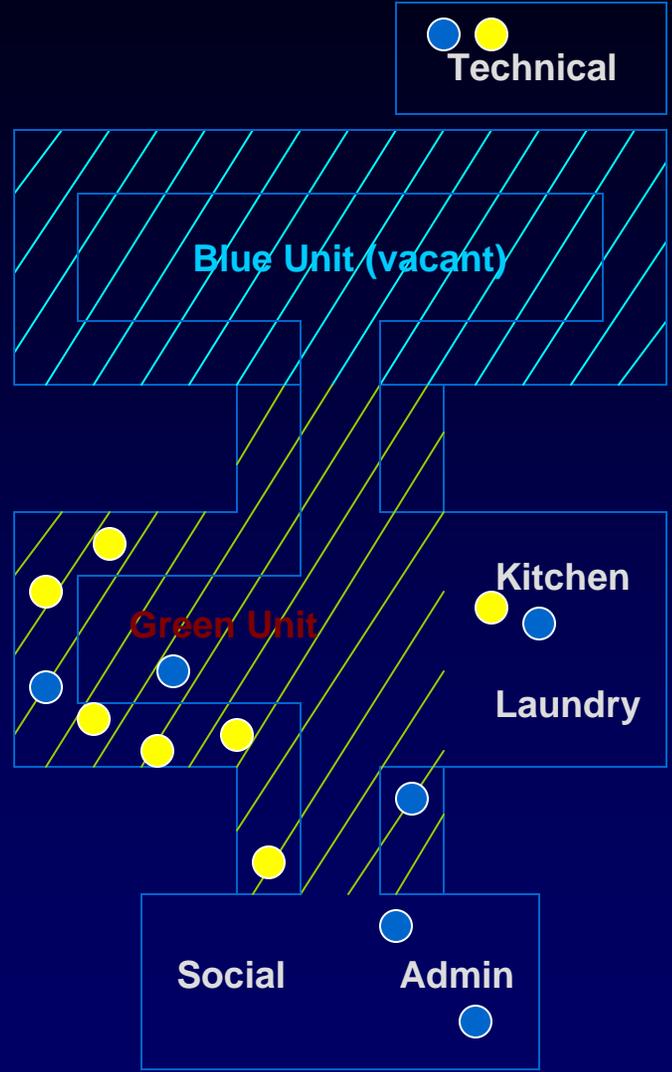


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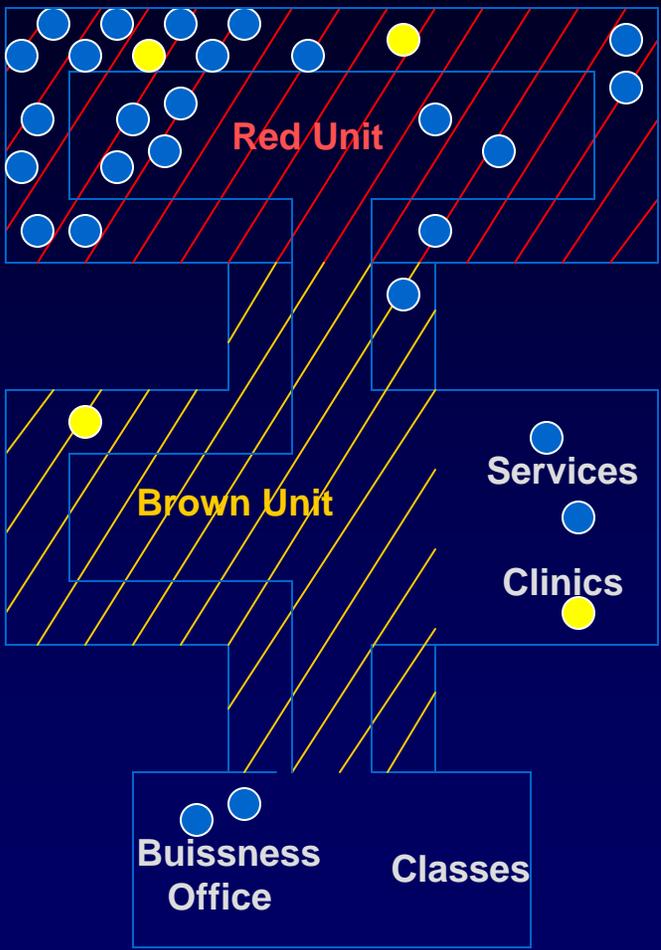


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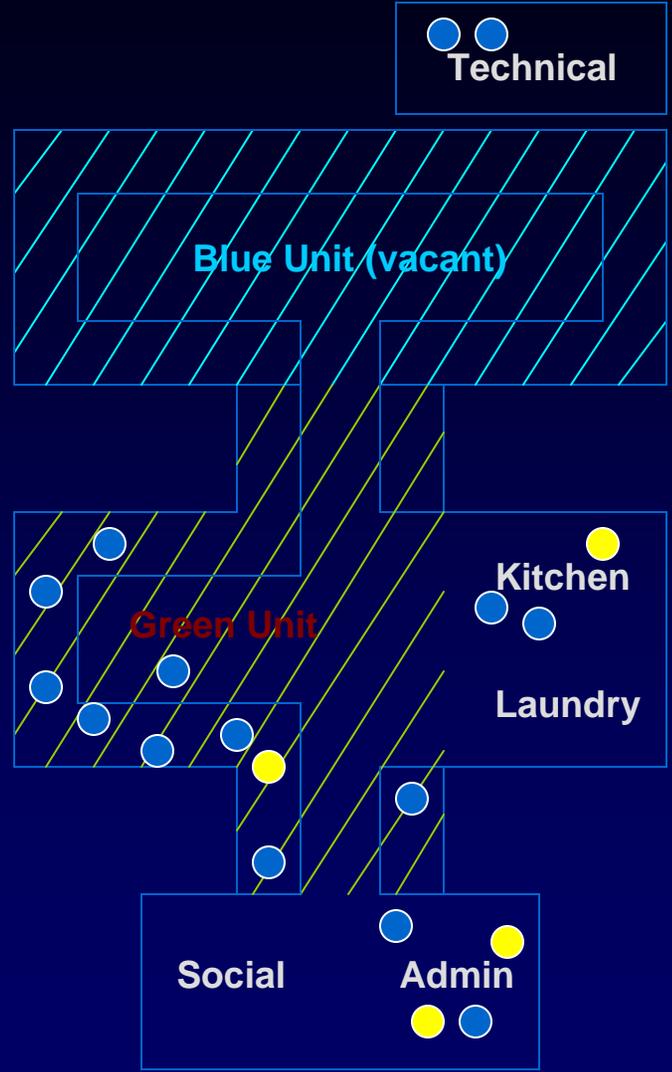


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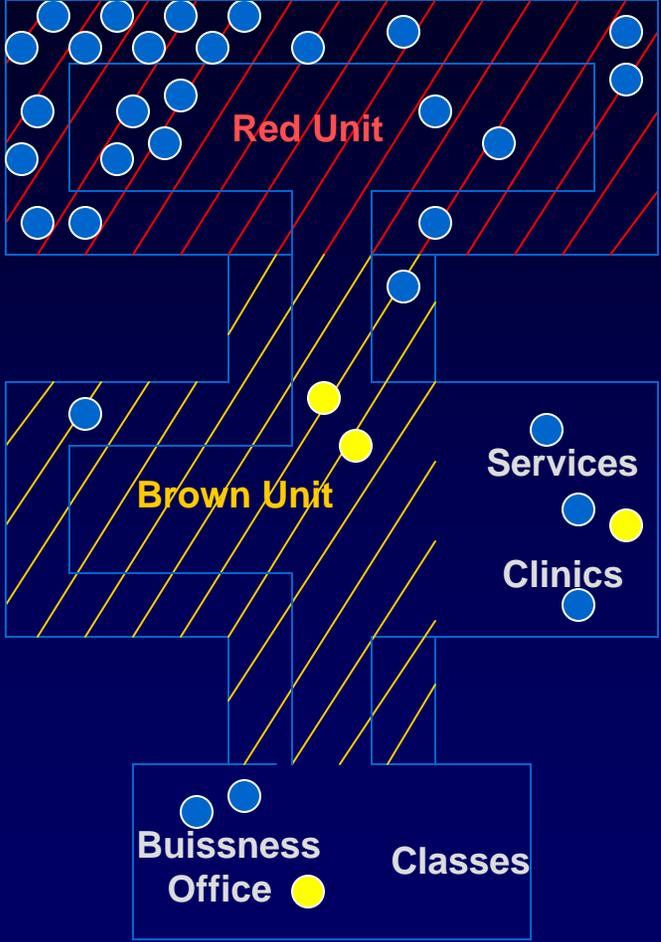


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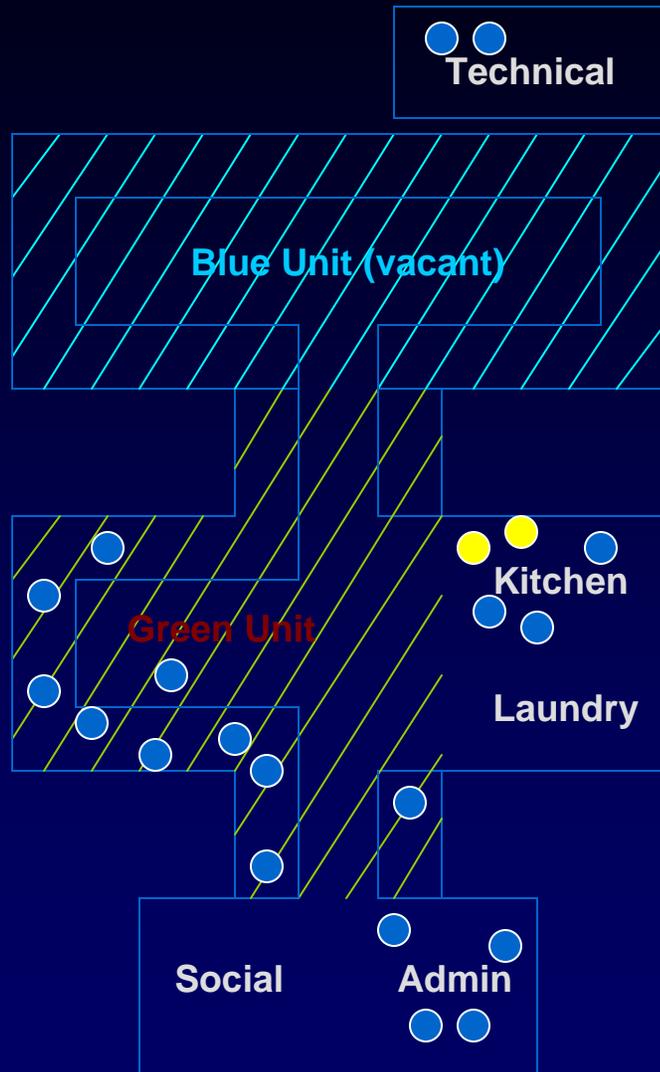


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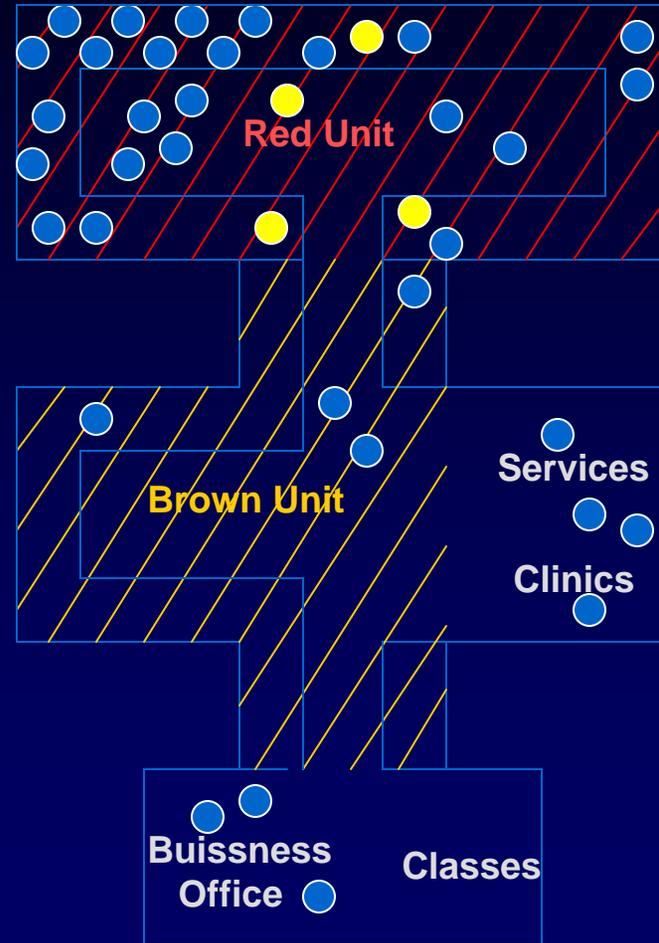


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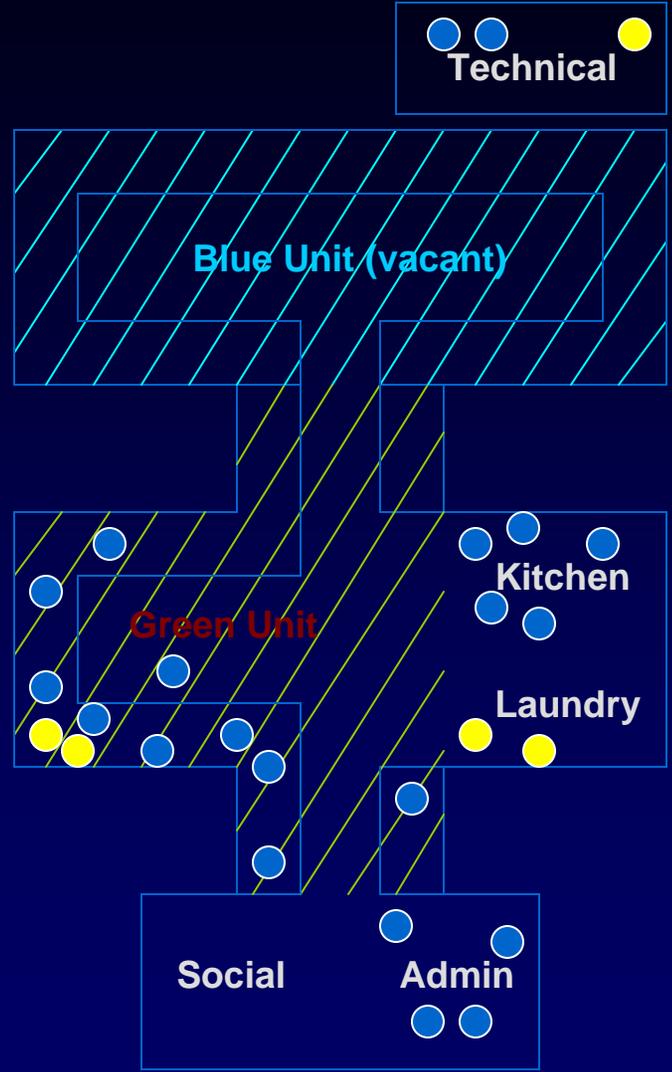


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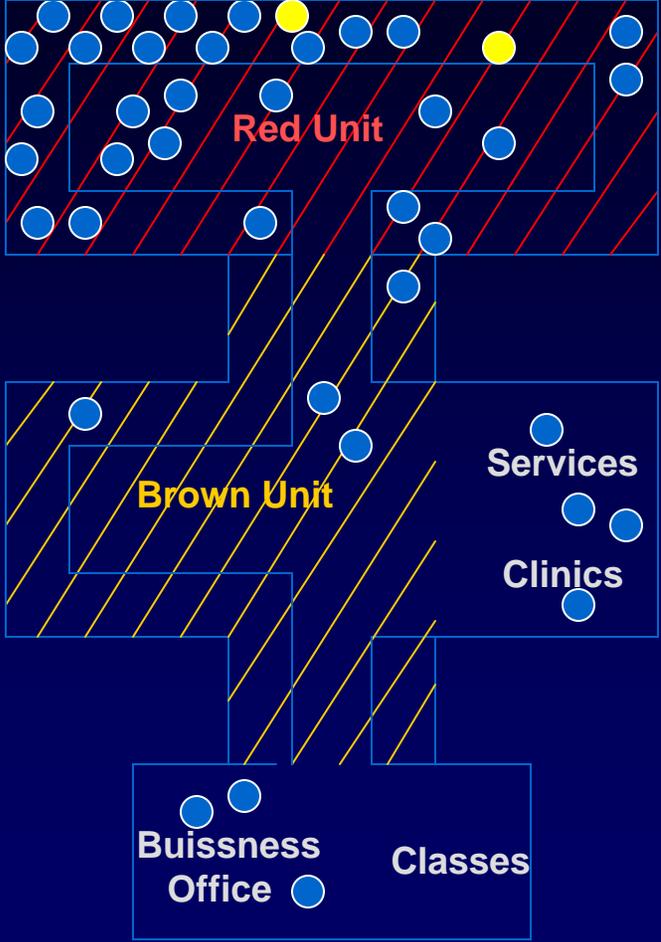


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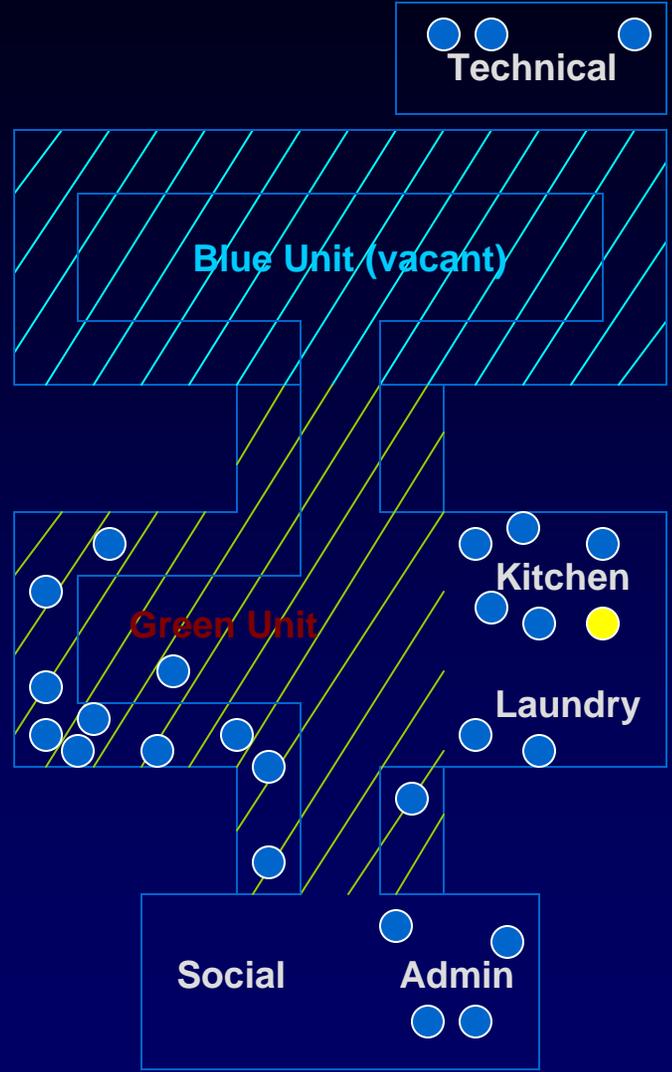


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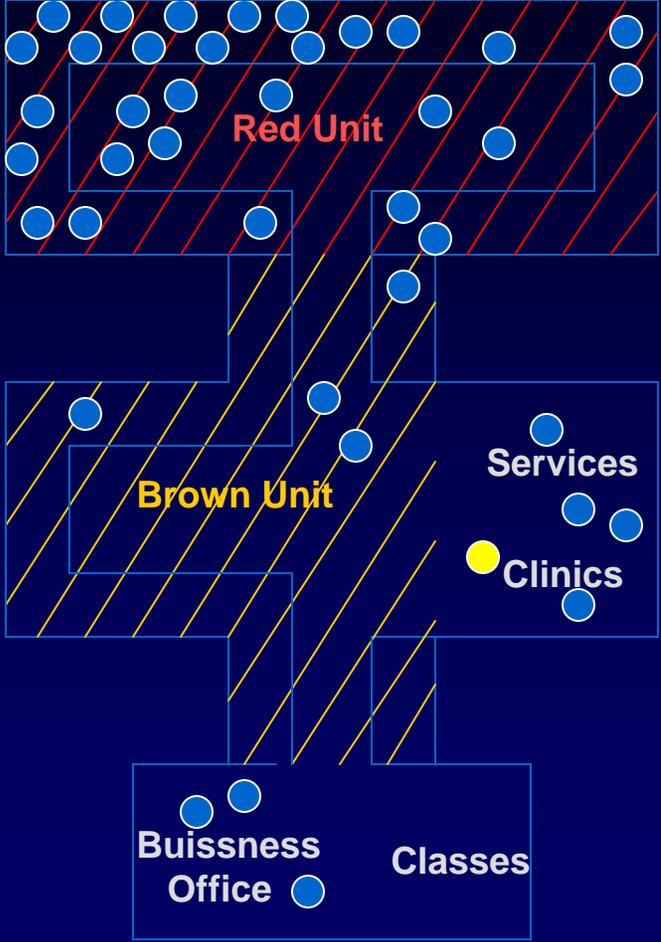


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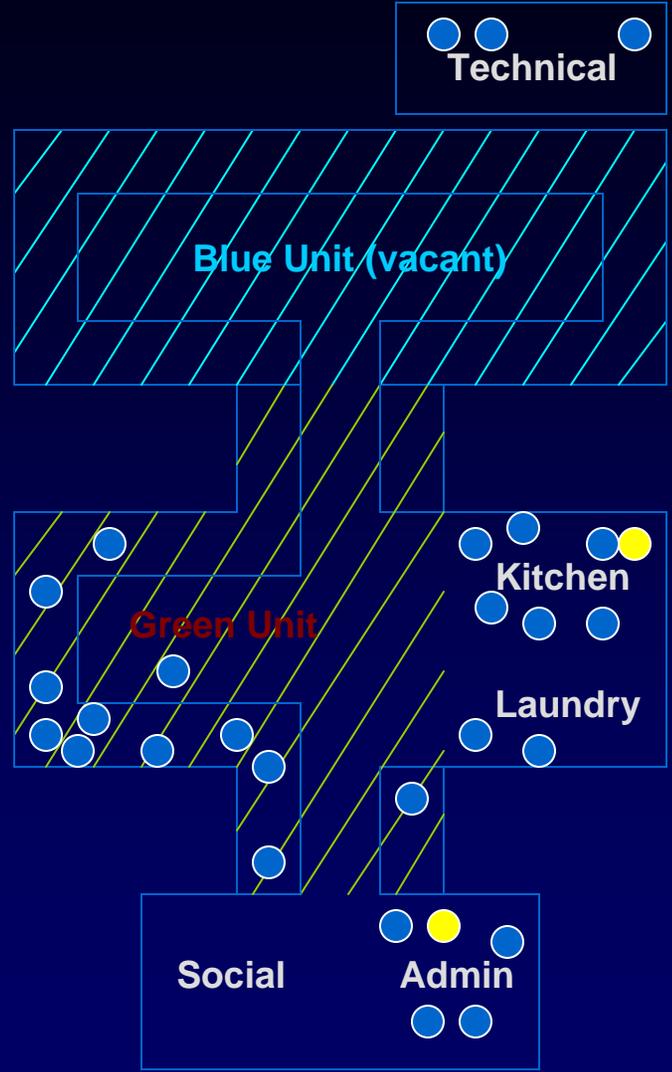


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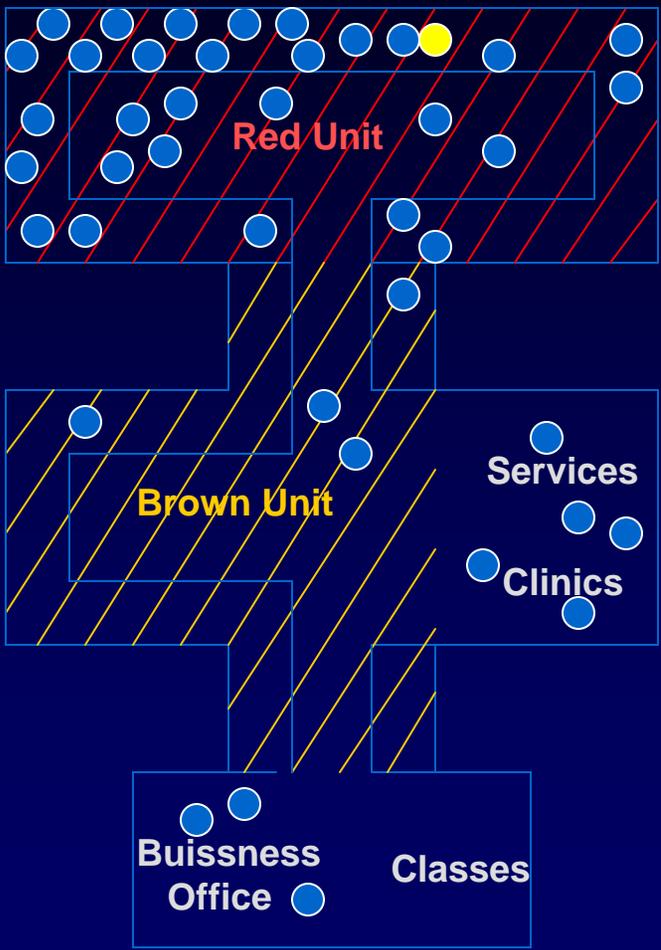


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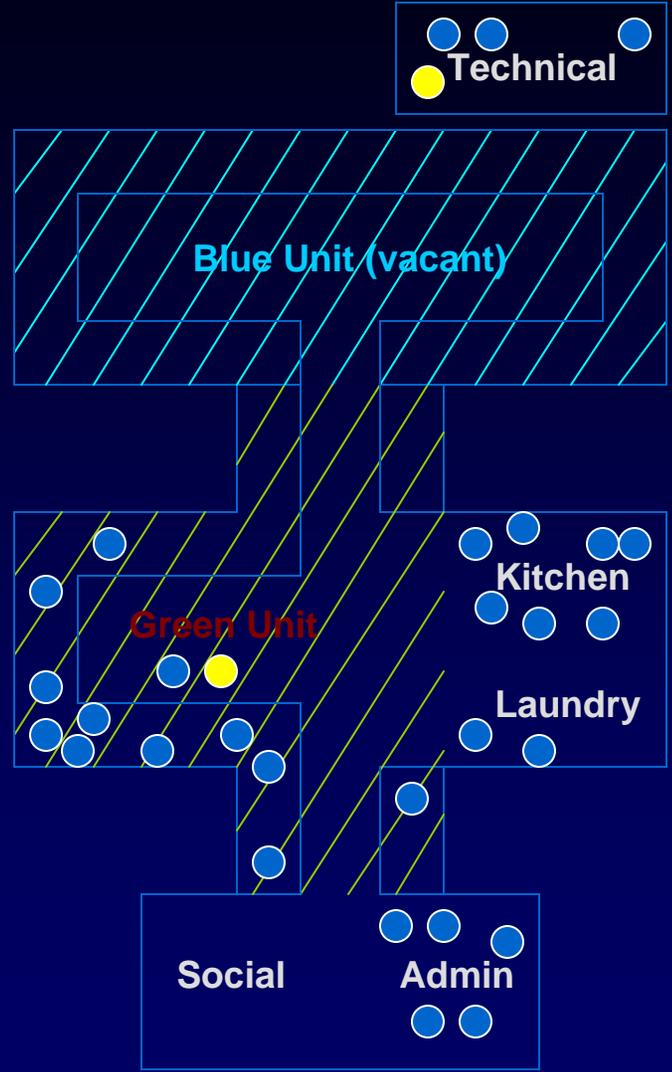


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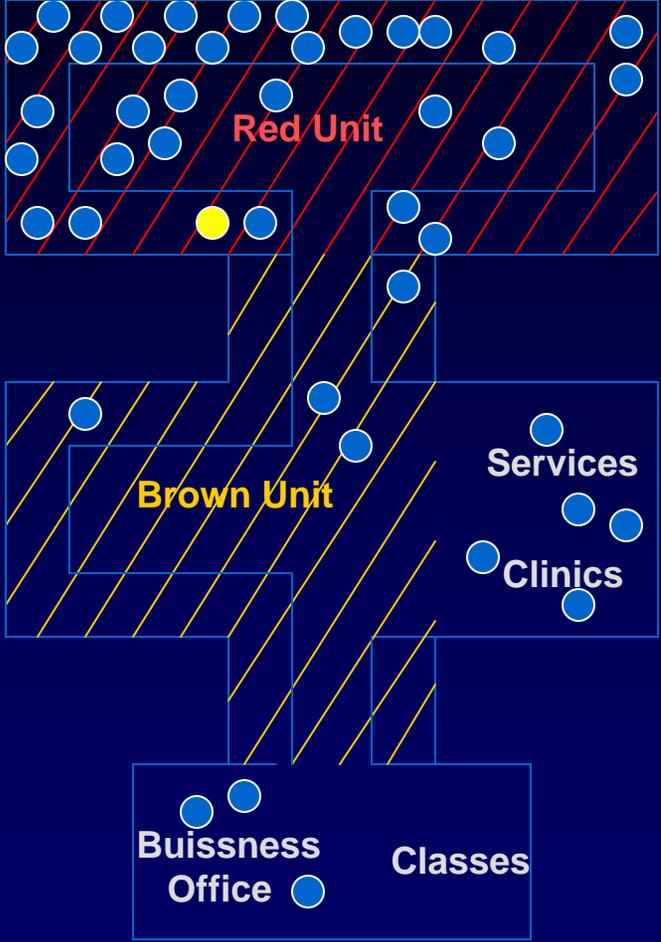


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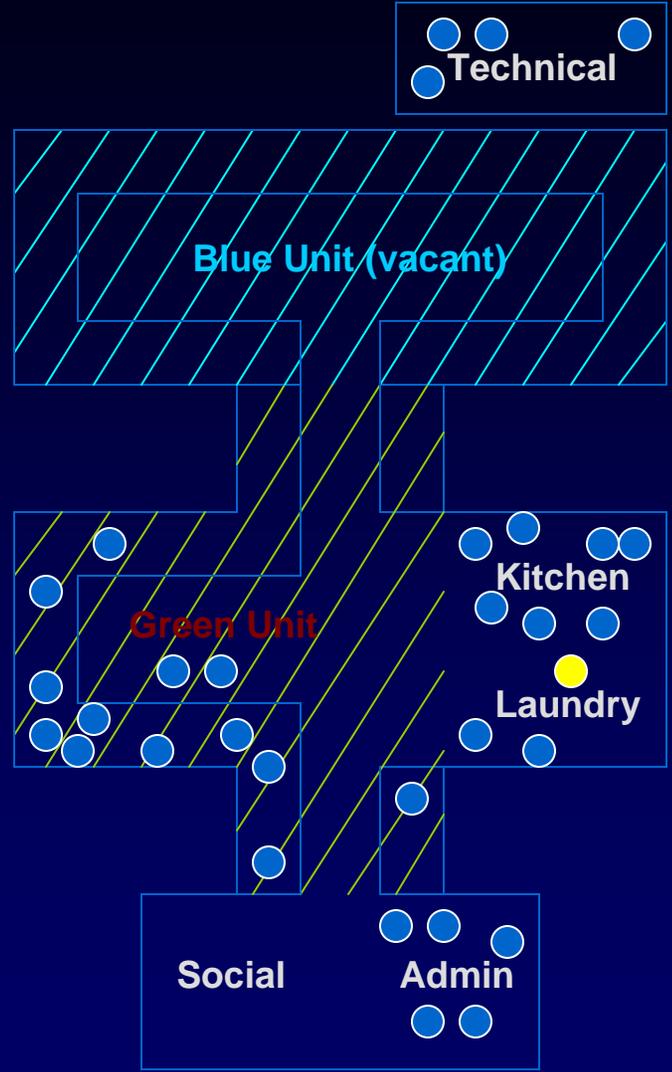


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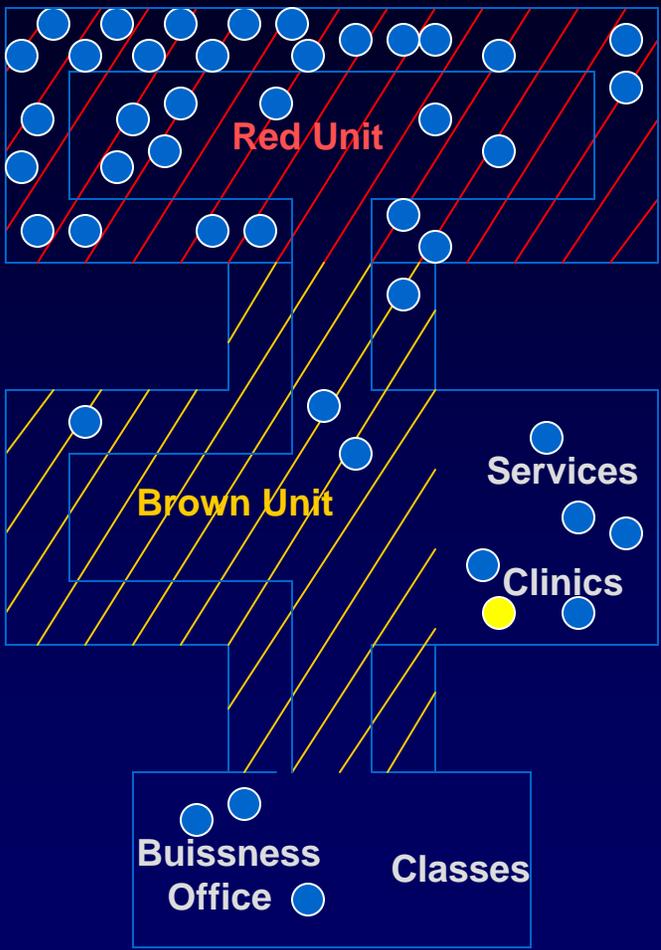


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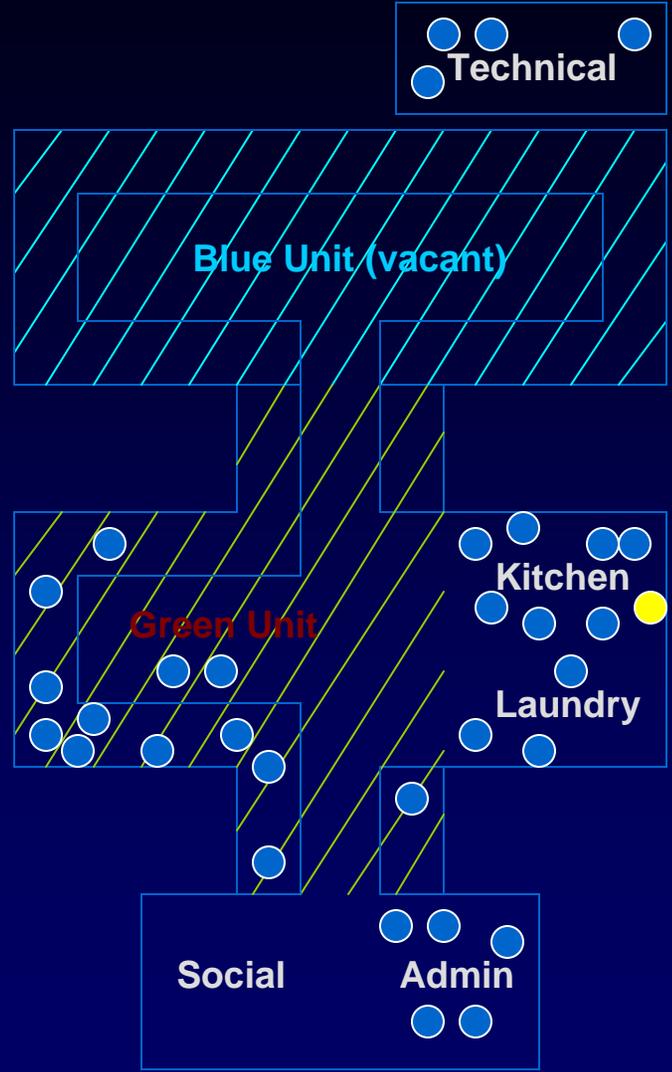


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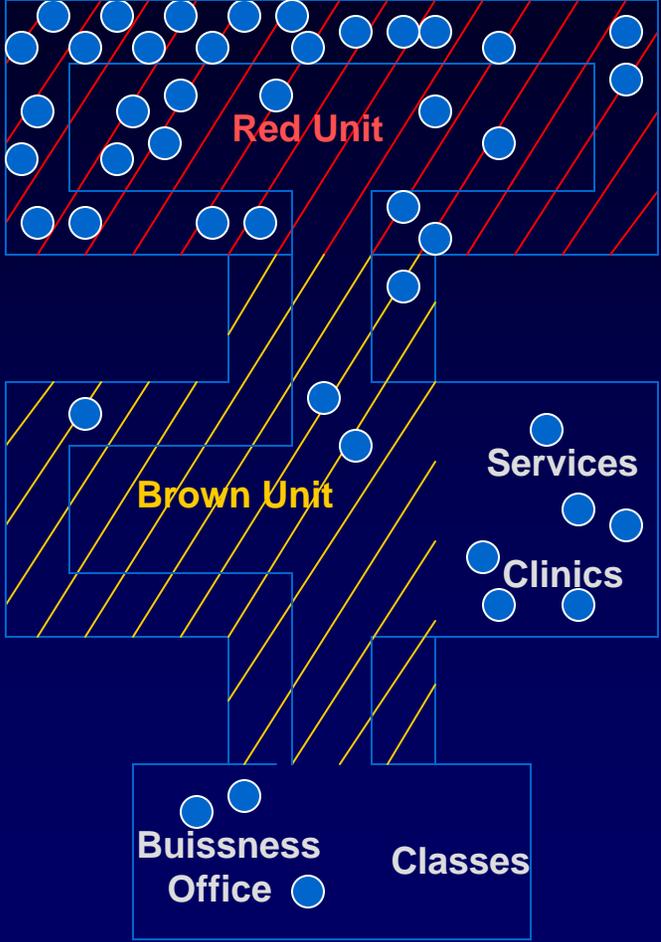


2nd floor

04/21/2005



Ground floor



2nd floor

# Person

- Age, gender
- Health status:
  - increased susceptibility,
  - risk factors,
  - underlying disease
- Exposure to ...
  - Procedures
  - Drug, IV line



**Study**

# Hypothesis

- Formulate 1+ hypothesis as outbreak cause
- Hypothesis based on results of preliminary investigation
- With hypothesis
  - Selecting questions, exposure, additional testing of individuals / environment
  - Always easier to find something after knowing what to look for
- The hypothesis = tool to help
  - Flexible to allow changes
  - Do NOT make all efforts to confirm it
  - Watch for clues leading in another direction

# Hypothesis

- **Decision-making process in outbreak similar to the clinical etiologic diagnostic process**
- **Community is concerned, not an individual**
- **Data gathering = Initial evaluation of the situation**
- **Working or tentative hypothesis = diagnosis is made**
- **Additional investigation and laboratory testing necessary to reach conclusion**
- **Intervention (or therapeutic) trial may be attempted and may provide additional clues.**

# Study Design

- **1- Measure increase in number of diseases to qualify for outbreak  
Design: Retrospective and descriptive**
- **2-CASE CONTROL very common**
  - **Cases and controls asked about risk factor: Surgery by A versus others, exposure to product /device A vs others**
  - **Odds of disease among exposed versus non-exposed**
- **3-PROSPECTIVE STUDY: Prospective study possible if still in progress: follow up of exposed individuals**
- **4- RETROSPECTIVE COHORT study can be constructed and attack rates among exposed versus not exposed can be determined.**

# Select Control Carefully

- *Cacarella fecalis* was recognized as major cause of diarrhea, resistance is a concern
- Case control study planned
- Case = carrier of cefalocide resistant *cacarella* in stools
- Risk factor investigated: use of cefalo/antibiotics (AB)
- Diabetes is a risk factor for *cacarella* colonization (resistant or not)

- Control = No *cacarella* in stools
- Carriers 50% received AB
- Controls 50% received AB
- OR will turn close to 1: No association
- OR for diabetes is high; risk is to interpret diabetes as risk factor AB resistant *cacarella*

- Control = *Cacarella* susceptible in stools
- Carriers 50% received AB
- Controls fewer % received AB because AB exposure would have eradicated *Cacarella* susceptible organisms
- OR will turn out very high:
- Strong association
- OR for diabetes close to 1

# Select Control Carefully

High rate of MRSA infections post CABG in surgical suite A, but not in surgical suite B. An inspection shows no major difference between the layout, policies... between suite A and B.

- Control = CABG + No MRSA infections in surgical suite A
- No major associations found

- Control = CABG + No MRSA infections
- High OR for surgical team A
- High OR for patient coming referred from community hospitals

**Why:** Team A usually operates in suite A and most of his patients are referral from community hospitals and nursing homes with high prevalence of MRSA colonization. Team B usually operates in suite B with most patients coming from the community with low prevalence of MRSA colonization

# Select Risk Factors Carefully

- Cases with respiratory infections, all intubated → check respiratory therapy procedures: Ventilator used, duration, respiratory therapists, nurses, medication, tube changes
- Cases with SSI → consider
  - Pre-operative: patient, underlying conditions, ward, nurse, surgeons, pre-operative stay duration, surgical prep
  - Operative: Suite, technique, instruments, prosthesis, medications (anesthesia), staff, transfusion, duration, potential contamination of sterile field
  - Post-operative: Recovery room, ICU staff, procedures (IV lines)

# Case Control Study: Odds Ratio

	Cases (Disease)	Controls (No disease)	Total
Exposed (Ate food)	40	10	50
Not Exposed (Did not eat)	10	40	50
Total	50	50	100

80% of those exposed became sick

20% of those not exposed became sick

Relative risk = 80%/20% = 4 BUT do not use RR in case control

Use Odds Ratio (OR) =  $\frac{\text{Odds of Disease in Exposed} = 40 / 10}{\text{Odds of Disease in Not Exposed} = 10 / 40}$

$$= \frac{40 * 40}{10 * 10} = 16$$

# Odds Ratio



# Odds Ratio

```
C:\Epi6\STATCALC.EXE
EpiInfo Version 6          Statcalc          November 1993
+ Disease -
+ | 40 | 10 | 50
- | 10 | 40 | 50
E | 50 | 50 | 100
x
p
o
s
u
r
e

Analysis of Single Table
Odds ratio = 16.00 (5.46 <OR< 48.86)
Cornfield 95% confidence limits for OR
Relative risk = 4.00 (2.26 <RR< 7.08)
Taylor Series 95% confidence limits for RR
Ignore relative risk if case control study.

Chi-Squares      P-values
-----
Uncorrected      : 36.00  0.0000000 ←
Mantel-Haenszel: 35.64  0.0000000 ←
Yates corrected: 33.64  0.0000000 ←

F2 More Strata; <Enter> No More Strata; F10 Quit
```

# p Value

```

C:\EPI2000\STATCALC.EXE
EpiInfo Version 6          Statcalc          November 1993
+ Disease -
+ 2      8      10
- 1      9      10
E 3      17     20
x
p
o
s
s
u
r
e

      Analysis of Single Table
      Odds ratio = 2.25 (0.12 <OR< 77.62*)
      Cornfield 95% confidence limits for OR
      *Cornfield not accurate. Exact limits preferred.
      Relative risk = 2.00 (0.21 <RR< 18.69)
      Taylor Series 95% confidence limits for RR
      Ignore relative risk if case control study.

              Chi-Squares      P-values
      Uncorrected      :      0.39      0.5311678
      Mantel-Haenszel:      0.37      0.5416181
      Yates corrected:      0.00      1.0000000
      Fisher exact: 1-tailed P-value: 0.5000000
                   2-tailed P-value: 1.0000000

      An expected cell value is less than 5.
      Fisher exact results recommended.

      F2 More Strata; <Enter> No More Strata; F10 Quit

+ Disease -
+ 20     80     100
- 10     90     100
E 30     170    200
x
p
o
s
s
u
r
e

      Analysis of Single Table
      Odds ratio = 2.25 (0.93 <OR< 5.52)
      Cornfield 95% confidence limits for OR
      Relative risk = 2.00 (0.99 <RR< 4.05)
      Taylor Series 95% confidence limits for RR
      Ignore relative risk if case control study.

              Chi-Squares      P-values
      Uncorrected      :      3.92      0.0476704 ←
      Mantel-Haenszel:      3.90      0.0482298 ←
      Yates corrected:      3.18      0.0747059

      F2 More Strata; <Enter> No More Strata; F10 Quit

+ Disease -
+ 200    800    1000
- 100    900    1000
E 300    1700   2000
x
p
o
s
s
u
r
e

      Analysis of Single Table
      Odds ratio = 2.25 (1.72 <OR< 2.94)
      Cornfield 95% confidence limits for OR
      Relative risk = 2.00 (1.60 <RR< 2.50)
      Taylor Series 95% confidence limits for RR
      Ignore relative risk if case control study.

              Chi-Squares      P-values
      Uncorrected      :      39.22      0.0000000 ←
      Mantel-Haenszel:      39.20      0.0000000 ←
      Yates corrected:      38.44      0.0000000 ←

      F2 More Strata; <Enter> No More Strata; F10 Quit
  
```

## Attack Rate in Retrospective or Prospective Cohort

- **Attack rate:**
  - **Not technically a 'rate'**
  - **Proportion of persons infected (cases) / population at risk in %**
  - **Attack rate = measure of risk**
  - **Calculable only if total population at risk known**
  
- **Collect accurate denominator**
  - **Some denominators impossible to obtain: number of people eating in a fast food restaurant, number of people drinking tap water**
  - **Difficult to make difference between**
    - **exposed (presumably at risk) and**
    - **really at risk (exposed but not immune to the infection, for example, because of proper vaccination).**

# Plausibility

- May be necessary to conduct study to demonstrate plausibility
- Reservoir? Mode of transmission?
- Examples:
  - Simulates procedures on-site or lab experiments
  - Check air flow
  - Place plates to collect settling microbes

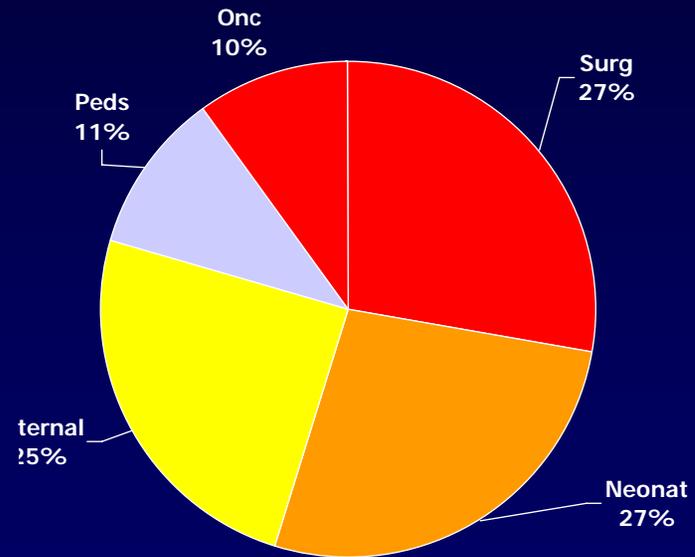
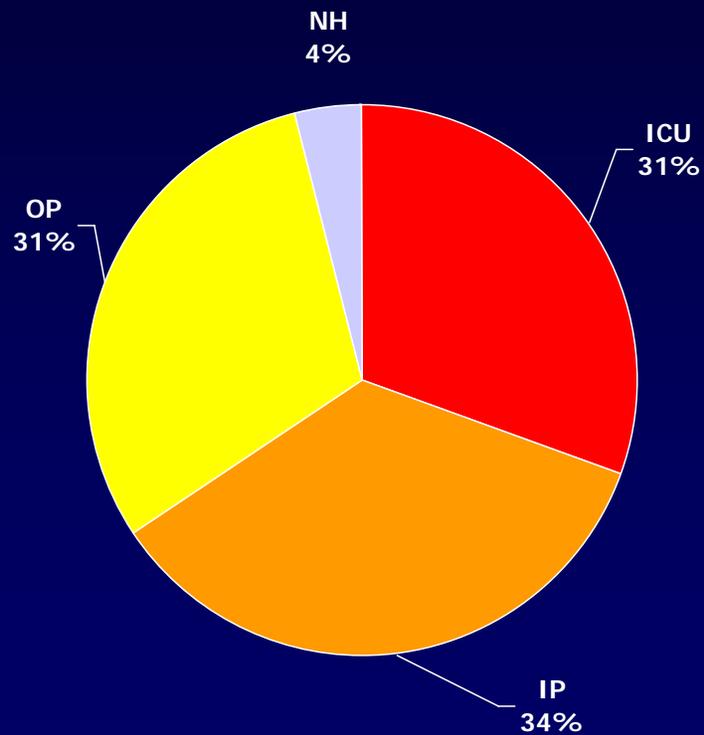
# **Epidemiology of HAI Outbreaks**

# HAI Outbreaks

- **Bias towards investigating unusual outbreaks**
  - **Outbreak of common pathogen (E.coli) in common site (UTI) is likely to be ignored**
  - **Uncommon pathogen would stand out (Stenotrophomonas maltophilia)**
- **Distribution of agents, source, modes of transmission depend on facility, type of patients, disease**

# Frequency

- Only 2 to 5% of all NI occur in outbreaks
- 1,561 outbreaks in [www.outbreak-database.com](http://www.outbreak-database.com):



# Agents

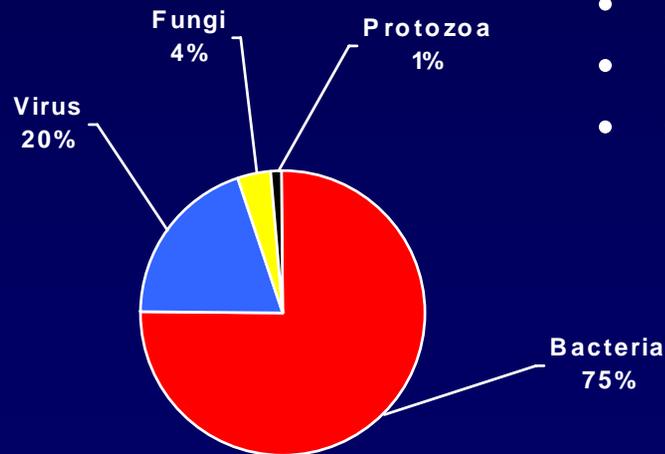
## Common outbreak agents

- Staphylococcus aureus
- Pseudomonas aeruginosa
- Klebsiella pneumoniae
- Serratia marcescens
- Enterobacter cloacae
- E.coli
- Acinetobacter baumannii
- Burkholderia cepacea
- Legionella pneumophila
  
- M.tuberculosis
- Candida albicans
- Aspergillus
  
- Rotavirus
- Norovirus
- RSV
- HBV
- HCV

## Common HAI agents

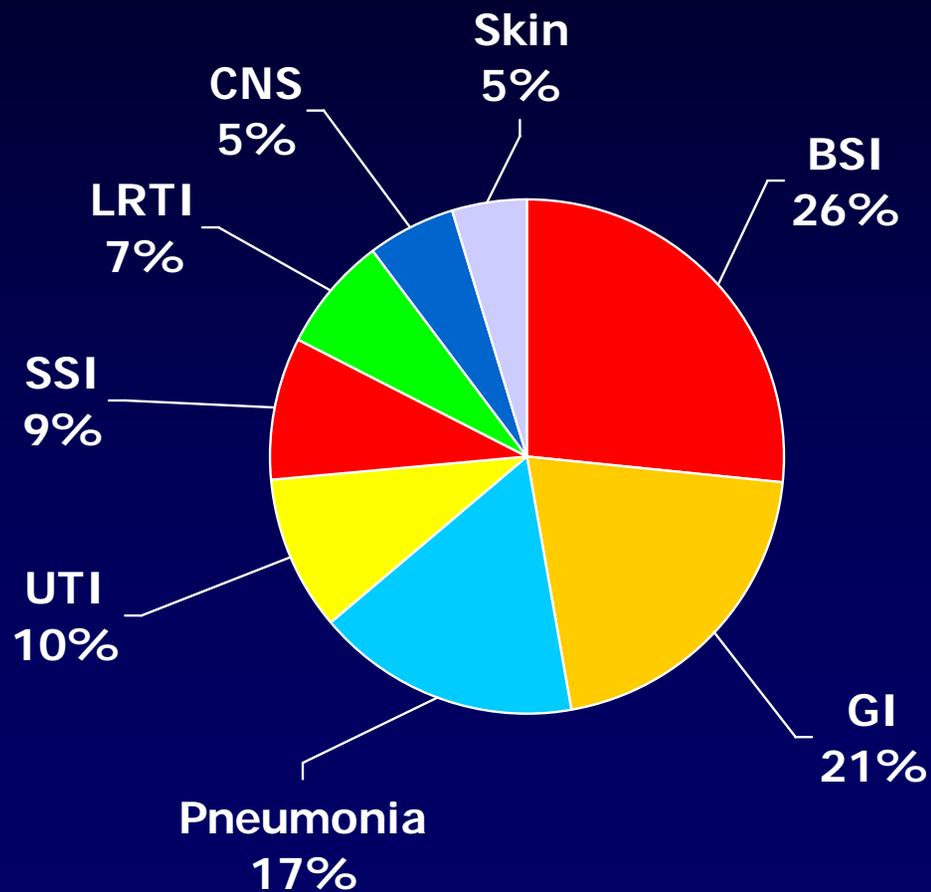
8 species of bacteria = 75% of all bacterial isolated:

- Staphylococcus aureus
- Enterococcus spp
- Haemophilus influenzae
- Escherichia coli
- Klebsiella spp
- Enterobacter spp
- Proteus spp
- Pseudomonas aeruginosa
  
- Streptococci
- Serratia
- Candida albicans



# Infection Types

- Gastmeier P 2005. How outbreaks can contribute to prevention of nosocomial infection: Analysis of 1,022 outbreaks. Infection Control & Hospital Epidemiology Vol 26 #4: 357
- 1966-2002: 1,022 published outbreaks in literature

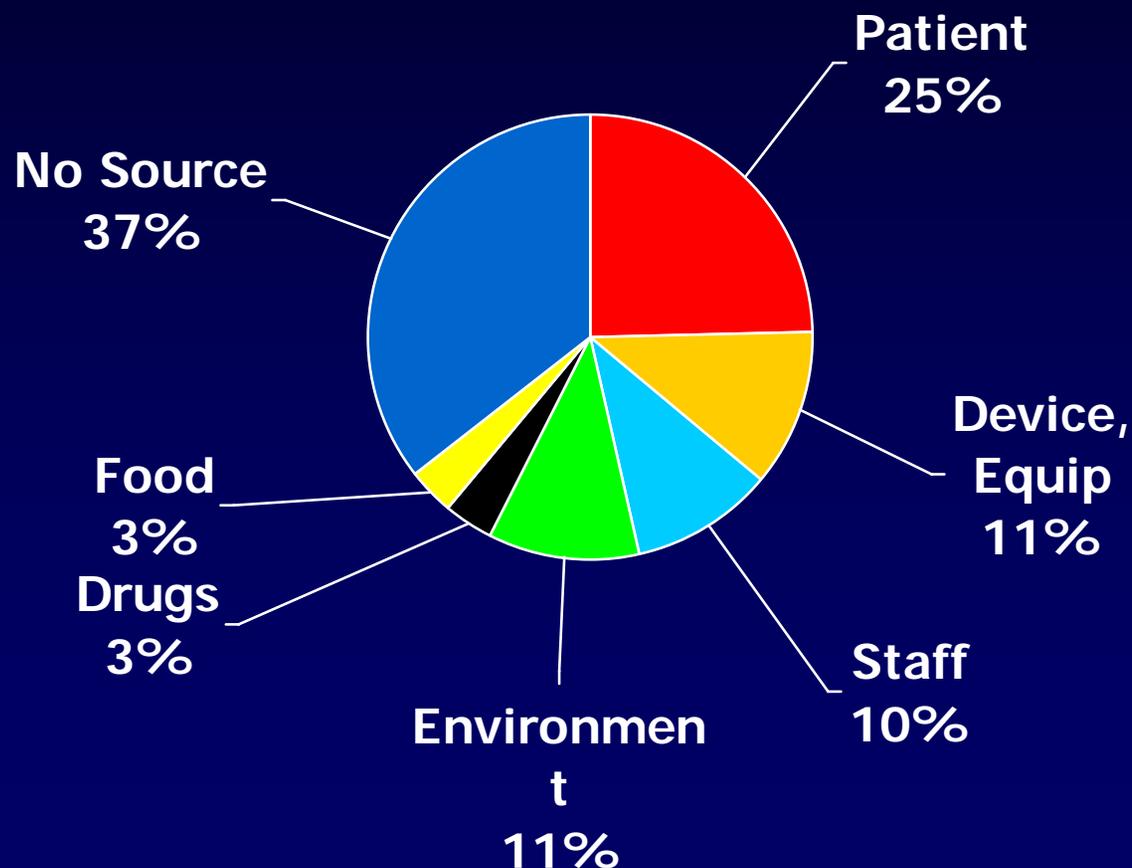


## Outbreaks often not published

- GI tract: Norovirus, rotavirus, Salmonella, Campylobacter
- RTI: Respiratory Syncytial Virus

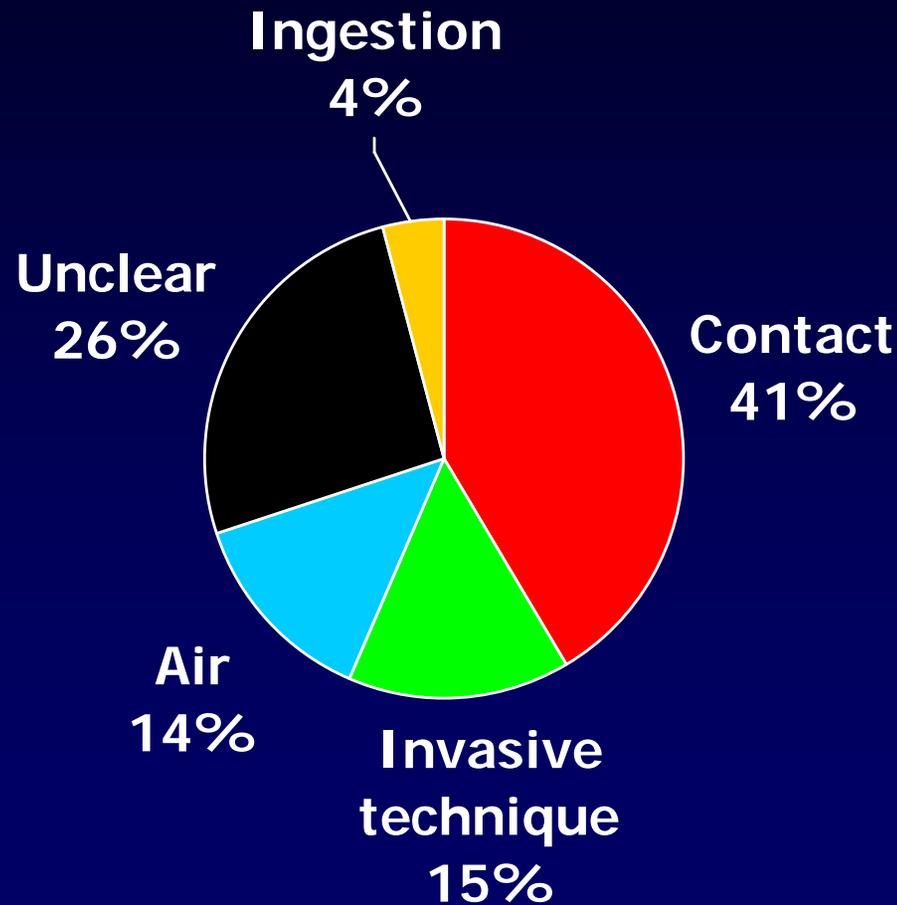
# Sources

- Gastmeier P 2005. How outbreaks can contribute to prevention of nosocomial infection: Analysis of 1,022 outbreaks. Infection Control & Hospital Epidemiology Vol 26 #4: 357
- 1966-2002: 1,022 published outbreaks in literature



# Modes of Transmission

- Gastmeier P 2005. How outbreaks can contribute to prevention of nosocomial infection: Analysis of 1,022 outbreaks. Infection Control & Hospital Epidemiology Vol 26 #4: 357
- 1966-2002: 1,022 published outbreaks in literature



# Outbreak: Contact Transmission

- Antibiotic resistant organisms
- MRSA
- Gram neg rods
- VRE
- Clostridium difficile
- HCW Hands
- Contaminated fomites
- Roaming patients, family
- Colonized HCW disseminator
- Contaminated environment
- Norovirus
- RSV

# Outbreak: Airborne

- Influenza
- SARS
- Tuberculosis
- HCW disseminator
- Admitted patients
- Visitors

# Outbreak: Droplet

- Pertussis
- Influenza
- SARS
- Strep grp A
- HCW disseminator
- Admitted patients
- Visitors

# Outbreak: Blood, Body Fluids

- Hemodialysis
- Laboratory
- Dental Clinics
- Surgery
- HBV
- HCV
- HIV

# Outbreaks

Blood stream infections (BSI)

Intra-vascular line colonization  
Solutions  
Multi-use vials

MRSE, MRSA

Hemodialysis

Water quality  
BBF

Pyrogenic reactions  
HBV  
HCV

ImmunoCompromised

ICU  
NICU

BSI

MRSA, MRSE  
Fungi

# Outbreaks

Respiratory Therapy

Water quality

Pseudomonas  
Acinetobacter

Hemodialysis

Water quality  
BBF  
BSI

Pyrogenic reactions  
HBV  
HCV  
MRSA, MRSE

ImmunoCompromised

ICU  
NICU

BSI

MRSA, MRSE  
Gram Neg rods  
Fungi

# Pseudo Outbreaks

# Pseudo Outbreaks

- **Laboratory contamination of samples**
- **Inclusion of colonization**
- **Perceived increase of cases because prior surveillance was inadequate**

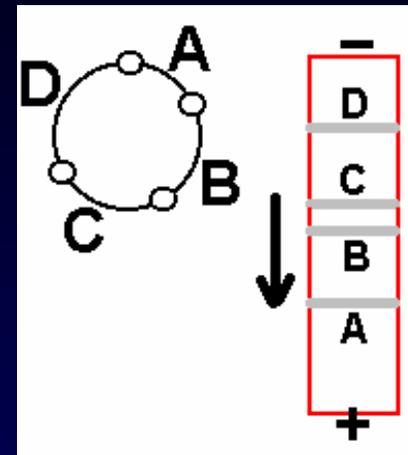
# Lab Studies

# Lab Tests in Hospital Outbreaks

- Easier to obtain microbiological samples
- Typing of microorganisms important to prove chains of transmission
- Environmental cultures
  - Helpful only if epidemiologic link
  - Presence in environment may not be linked to transmission
  - Culture only if implicated by epidemiology (common sense)
- Staff cultures
  - Helpful only if epidemiologic link
  - Colonized HCW may not be transmitter

# Molecular Epidemiology Techniques

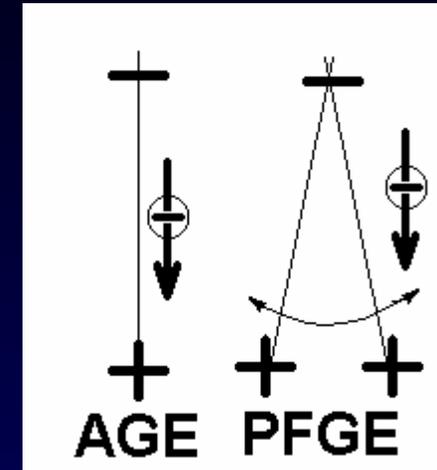
- Plasmid or Chromosomal DNA
- Whole or Fragmented:
  - Restriction endonuclease cuts DNA molecules at restriction sites
  - Enzymes selected carefully to generate appropriate fragments
  - Some are frequent cutters, others not



- ± Amplified by Polymerase Chain reaction (PCR)
  - millions copies of specific DNA segment produced in few hours. Product can then be digested and separated by electrophoresis.
  - major advantage PCR = detect DNA from microorganisms that cannot be cultivated

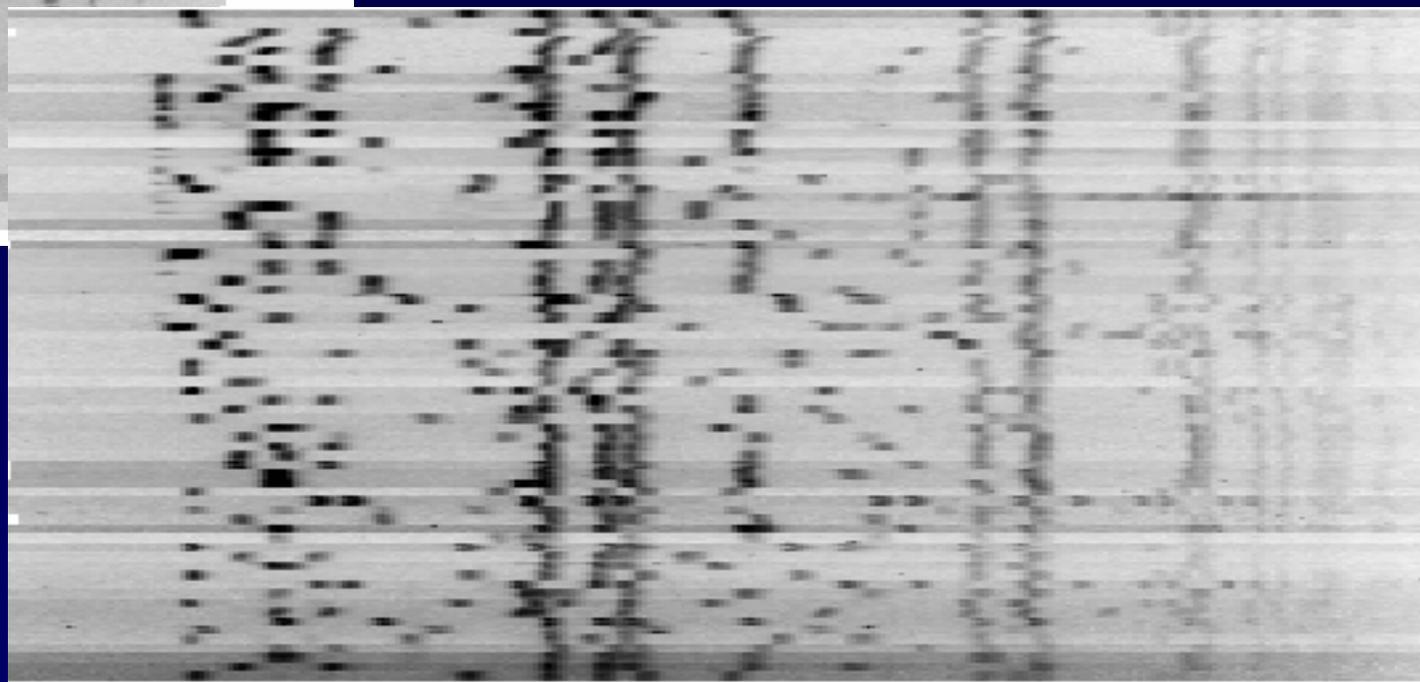
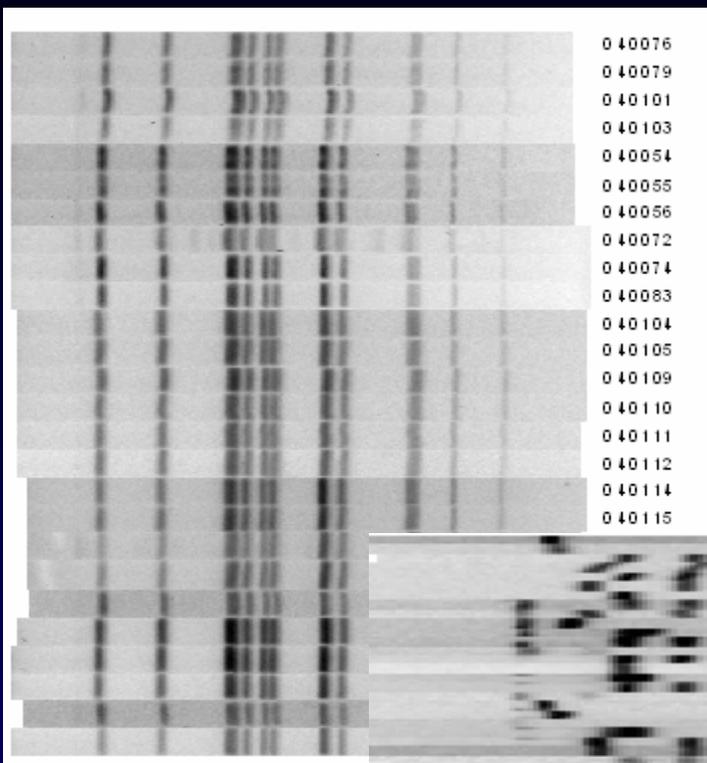
# Molecular Epidemiology Techniques

- **Polyacrylamide Agar Gel Electrophoresis**
  - Plain
  - Pulsed Field



- **±Transfer to nitrocellulose:**
  - **Restriction Fragment Length Polymorphism (RFLP) analysis with DNA probes or Southern Blot analysis**
  - **DNA fragments hybridized with chemically or radioactively labeled DNA or RNA probe which binds to only a few fragments with complementary sequences.**
  - **RFLP using insertion element IS110 method of choice to type Mtb**

# PFGE



# Preventive Measures

# Closures

- No laws, regulations as to when to close wards
- Common sense reasons to close:
  - High impact: mortality, disability
  - Clear onset
  - Persistence in spite of implementation of other control measures
- Exit strategy: define criteria for re-opening ward
- Closures are rare: <10% of outbreaks



# Prevention at Source of Infection

- **Human source:**
  - **Isolation or treatment of the human source**
  - **Isolation ineffective if asymptomatic cases or carriers**
  - **Length of time the patient is infectious after treatment must be known**



# Prevention of Transmission

- **Contact and indirect contact: Prevent contact, wear gloves if contact is necessary**
- **Airborne:**
  - **Wearing mask with sufficient filtering ability.**
  - **Simple surgical mask sufficient for large droplet (as long as the mask is dry)**
  - **Masks with HEPA type filters for droplet nuclei**
- **Food and water borne: Avoid suspected food and water.**



# Prevention: Protection of At Risk Person

- Protection of susceptible individuals
- Immunization (passive or active, if time permits)
- Chemoprophylaxis.

# Communication

- **Most outbreak investigation have some urgency**
- **Public, public health officials, other officials, hospital management...**
- **They are concerned**
- **They want to find out the cause and the remedy applied ASAP**
- **Urgency should not translate into panic & sloppy investigation**
- **Time is necessary**
  - **To collect the information,**
  - **To locate the cases,**
  - **To run lab tests**
- **Overanxious people need to be told about the process and estimated time to carry out a proper investigation**
- **If preliminary prevention was addressed: NO PROBLEMS**