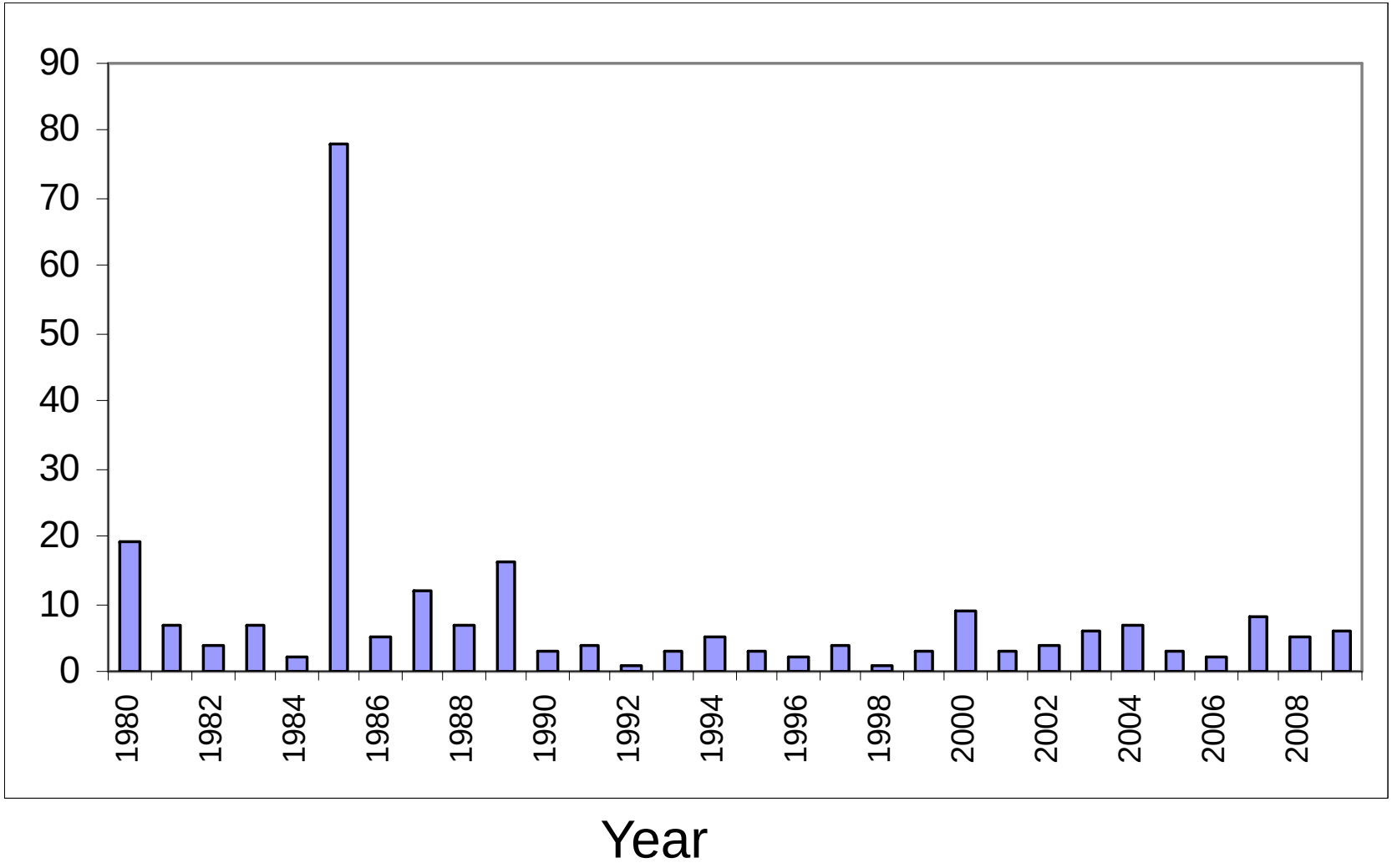
Infection Control Measures For Legionnaires' Disease in Healthcare Settings

Dr Tim Boswell

Consultant Medical Microbiologist &
Infection Control Doctor

Nottingham University Hospitals, UK

Nosocomial Legionnaires' Disease, UK 1980-2009



Epidemiol. Infect. (1990), **104**, 361–380
Printed in Great Britain

The Stafford outbreak of Legionnaires' disease

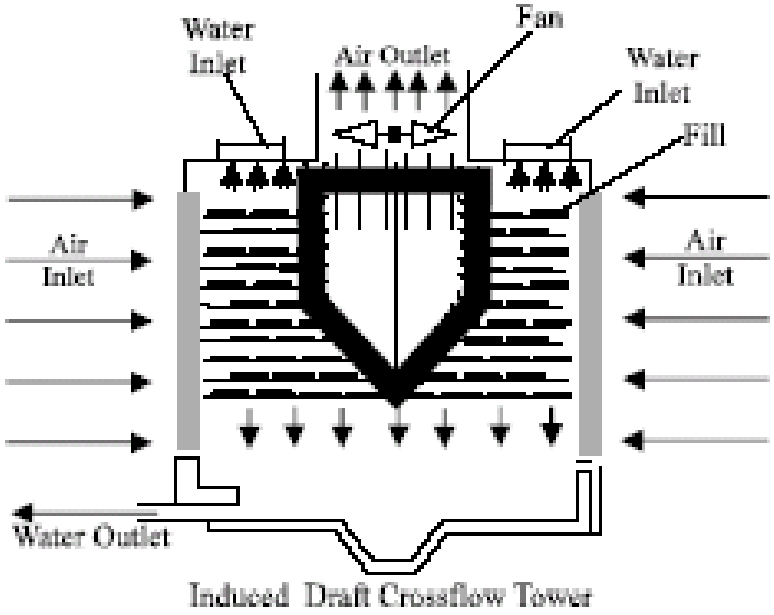
M. C. O'MAHONY[1], R. E. STANWELL-SMITH[1], H. E. TILLETT[1], D. HARPER[1], J. G. P. HUTCHISON[2], I. D. FARRELL[2], D. N. HUTCHINSON[3], J. V. LEE[4], P. J. DENNIS[4], H. V. DUGGAL[5], J. A. SCULLY[5] AND C. DENNE[5]

[1] *Public Health Laboratory Service Communicable Disease Surveillance Centre, 61 Colindale Avenue, London NW9 5EQ*
[2] *Birmingham Public Health Laboratory, East Birmingham Hospital, Bordesley Green East, Birmingham B9 5ST*
[3] *Preston Public Health Laboratory, Meadow Street, Preston PR1 6PS*
[4] *Public Health Laboratory Service Centre for Applied Microbiology and Research, Porton Down, Salisbury SP4 0JG*
[5] *Mid-Staffordshire District Health Authority, Corporation Street, Stafford ST16 3SR*

(*Accepted 1 January 1990*)

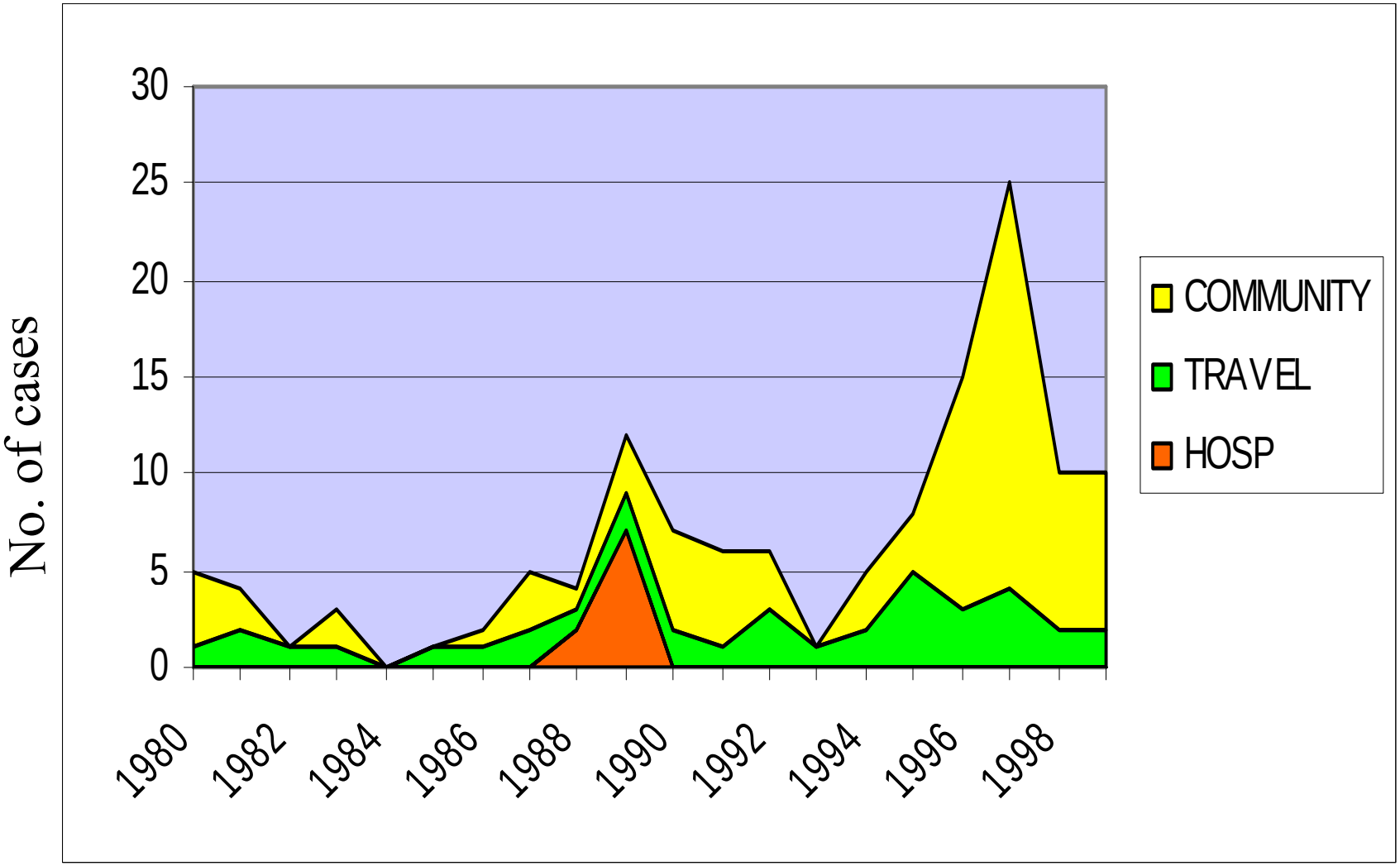
SUMMARY

A large outbreak of Legionnaires' disease was associated with Stafford District General Hospital. A total of 68 confirmed cases was treated in hospital and 22 of these patients died. A further 35 patients, 14 of whom were treated at home, were suspected cases of Legionnaires' disease. All these patients had visited the hospital during April 1985. Epidemiological investigations demonstrated that there had been a high risk of acquiring the disease in the out patient department (OPD), but no risk in other parts of the hospital. The epidemic strain of *Legionella pneumophila*, serogroup 1, subgroup Pontiac 1a was isolated from the cooling



Induced Draft Crossflow Tower

Legionnaires' Disease in Nottingham 1980 to 1999



Epidemiol. Infect. (1993), **110**, 105–116

Outbreak of Legionnaires' disease at University Hospital, Nottingham. Epidemiology, microbiology and control

A. COLVILLE[1], J. CROWLEY[2], D. DEARDEN[1], R. C. B. SLACK[1] AND J. V. LEE[2]

[1] *Department of Microbiology and Public Health Laboratory, and*
[2] *Environmental Microbiology Reference Unit, University Hospital, Queen's Medical Centre, Nottingham NG7 2UH*

(*Accepted 11 September 1992*)

SUMMARY

Twelve patients in a large teaching hospital contracted Legionnaires' disease over a period of 11 months. The source was a domestic hot water system in one of the hospital blocks, which was run at a temperature of 43 °C. Five different subtypes of *Legionella pneumophila* serogroup 1 have been isolated from water in different parts of the hospital, over a period of time. Only one subtype, Benidorm RFLP 14, was implicated in disease. Circumstantial evidence suggested that the outbreak may have been due to recent colonization of the hot water system with a virulent strain of *Legionella pneumophila*. The outbreak was controlled by raising the hot water temperature to 60 °C, but careful surveillance uncovered two further cases in the following 30 months. Persistent low numbers of *Legionella pneumophila* were isolated from the domestic hot water of wards where Legionnaires' disease had been contracted, until an electrolytic unit was installed releasing silver and copper ions into this supply.

BBC Mobile | News | Sport | Weather | iPlayer | TV

NEWS ESSEX

Home | World | UK | England | N. Ireland | Scotland | Wales | Business | Politics | Health | Education | Sci/Env

24 August 2011 Last updated at 19:04

5 Share

Basildon hospital Legionnaires' patient death probe

The death of a patient with Legionnaires' disease at an Essex hospital is being investigated by the police and Health and Safety Executive.

Basildon University Hospital confirmed the patient died on Saturday.

Managers said they had started their own investigation when the diagnosis was made a week earlier.

This is the third death linked to hospital since 2002

In 2010 there were three cases of Legionnaires' at the hospital; one man died and two others successfully responded to antibiotics.

The Health Protection Agency and the Health and Safety Executive have been informed of the latest case.

Rel

'Leg
at h

Pro

Basildon Billericay Wickford Recorder

News | Sport | Leisure | Local Info | Announcements | Events | Family | Contact Us | Jobs | Hom

National | Royal Wedding | Billericay | Echo News | More News | V Festival 2009 | Archive | Free Email Bulletins |

Basildon Recorder » News »

NEWS

Doctor says he wasn't trained to tackle legionnaires' disease

1:50pm Thursday 17th November 2011

By Jon Austin »

Print | Email | Comments(5)

Tweet

THE man in charge of stamping out legionnaires' disease at Basildon Hospital before a fatal outbreak told an inquest he had no formal training to tackle the bug.

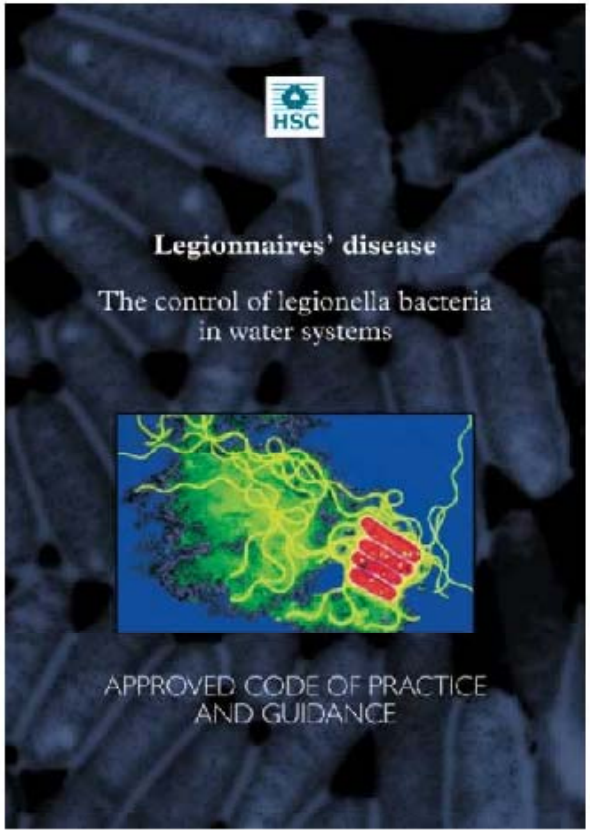
Infection Control Measures for LD in Healthcare Settings

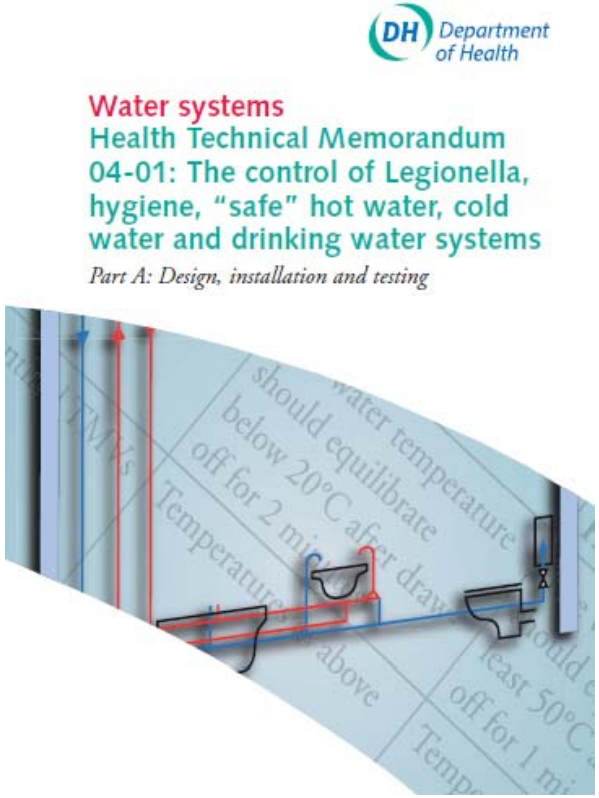
- Primary prevention
  - Engineering controls/proper management of water systems
    - Cooling towers
    - Hot and cold water distribution system
  - Routine culturing of water for legionella (?)
  - Clinical protocols
  - Administration & management arrangements
    - Legionella committee

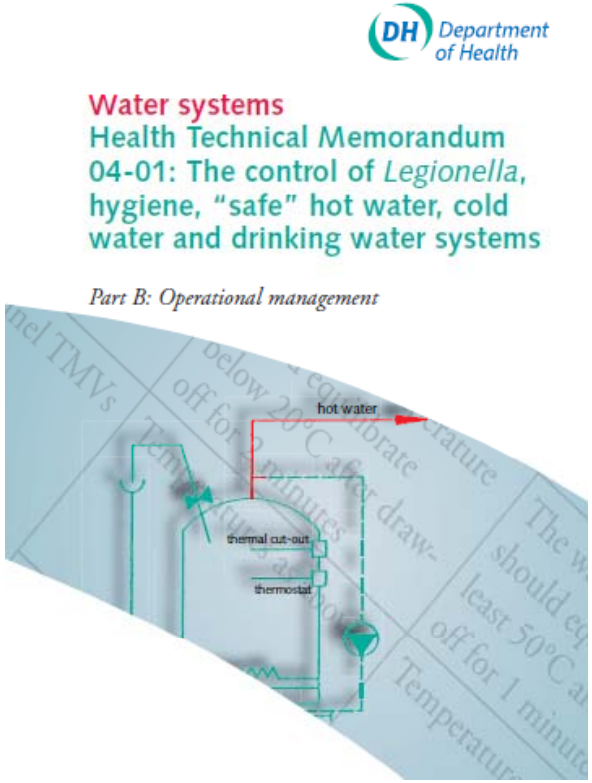
Infection Control Measures for LD in Healthcare Settings

- Secondary prevention
  - Surveillance (clinical awareness, appropriate laboratory diagnostics)
  - Actions when a nosocomial case is identified
    - Identification of possible environmental sources
    - Additional microbiological tests eg typing
    - Active case finding
    - Control measures
    - Communication
    - Formal notification

UK Guidelines







Management of water systems

- Cooling towers
  - Registration with local authority
  - Regular maintenance
  - Regular dosing with biocides
  - Mandatory regular sampling for legionella
- Hot and cold water distribution systems
  - Regular maintenance and checks
    - Storage tanks, calorifier, pumps, TMVs,
  - Regular checks on temperature parameters
    - Cold <20^{0}C, Hot >60^{0}C leaving calorifier, >50^{0}C in all parts of the distribution system
  - Regular flushing of outlets if not in use
  - Other methods of control e.g. chlorine dioxide, silver/copper ionisation, UV treatment
  - Risk assessment regarding regular water sampling for Legionella

Legionella Infection Control Issues for Clinical Staff

- Flushing of outlets if not being used
- Avoidance of using hospital tap water for certain procedures
  - Cleaning or respiratory therapy equipment including nebuliser acorns
  - Mouthcare for ventilated/highly immunosuppressed patients
  - Humidifiers
- Bronchoscope rinse water (TEE)

MHRA

Medicines and Healthcare products Regulatory Agency

Safeguarding public health

Medical Device **ALERT**

Ref. MDA/2004/020
Issued: 26 May 2004

For:

IMMEDIATE ACTION	
ACTION	✓
UPDATE	
INFORMATION REQUEST	

	Further Information
DEVICE: Reusable nebulisers	*
PROBLEM: Potential risk of transmission of Legionella bacteria due to poor drying after cleaning.	*
ACTION BY: All medical, nursing and purchasing staff responsible for the use and purchase of these devices.	
ACTION: • Follow manufacturer's instructions for cleaning and thorough drying. • Users must ensure no droplets of water remain in the nebuliser before reuse. • Never reuse nebulisers designated as single-use.	*
DISTRIBUTED to: NHS Trusts (England) – Chief Executives Commission for Social Care Inspection (CSCI) – Headquarters Healthcare Commission (CHAI) – Headquarters Primary Care Trusts (England) – Chief Executives	*
CONTACTS: Details of MHRA contacts for technical, clinical and compliance aspects. Change of address or removal from address list for services registered under the Care Standards Act 2000.	*

Infect Control Hosp Epidemiol. 2003 Aug;24(8):619-22.

A nosocomial outbreak of Legionella pneumophila caused by contaminated transesophageal echocardiography probes.

Levy PY, Teysseire N, Etienne J, Raoult D.

Unité Des Rickettsies, CNRS UMR 6020, Faculte de Medecine, Université de la Mediterranée, Marseille, France.

Abstract

A case-control study of three cases of Legionella pneumophila pneumonia identified transesophageal echocardiography (TEE) as a risk factor. Patient isolates and environmental strains from water used for rinsing TEE probes were identical by pulsed-field gel electrophoresis. This is the first report of endoscopy as a potential source of legionellosis.

PMID: 12940586 [PubMed - indexed for MEDLINE]

Learning from a legionella incident - should we routinely culture hospital water?

Case History

- 69 yr male
- Severe ITP (platelets 4)
- Rx steroids, IVIG, ciclosporin, vincristine
- Splenectomy
- Immediately post-op
  - Temperature
  - CXR shows HAP
  - Rx piptazobactam and clarithromycin
  - Gentamicin and metronidazole added as no response
- Transferred to ITU and intubated at day 3
- IV co-trimoxazole added

Case history

- Day 5 BAL
  - *L.pneumophila* +ve by DIF
  - Urine antigen +ve (Biotest)
  - Legionella culture: no growth
- Rx changed to clarithromycin, ciprofloxacin and rifampicin
- Patient died at Day 12

Investigation & Control Measures

Epidemiological analysis

- Admitted on 29/9/2000 (Ward A: Haematology)
- Transferred to Ward B (Surgical short stay) 5/10/2000
- Date of onset of LD ~ 18/10/2000
- Normal incubation period 2-10 days
  - longer incubation periods reported
  - 26, 28, 63 days
  - 18 days in renal Tx patient at NUH (1999)
- DS an in-patient throughout normal incubation period

Table 1. Results of legionella water samples taken on 26/10/2000

Ward	Sample	Culture Result	Bacterial Count
Ward A	5 samples: Showers Hot taps WHBs	Legionella NOT detected	----------
Ward B	Shower (G-01)	*L.pneumophila* SG1 (Bellingham)	$8.4x10^3$/litre
Ward B	Hot tap WHB (G-01)	*L.pneumophila* SG1 (Bellingham)	$1.0x10^1$/litre
Ward B	Hot tap WHB lilac bay (outside G-01)	*L.pneumophila* SG1 (Bellingham)	$1.0x10^1$/litre

Samples also taken from patient's home

water jug - *L.pneumopila* SG1 subtype Benidorm

other samples -ve

Patient frequently used the shower on Ward B

Initial control measures

- Ward B supplied with hot and cold water services in common with 2 other wards (one directly above) and a rehab department
- Patient had been in a 6 bedded bay with an en-suite shower and toilet room, converted from a day room about 6 months earlier

- Showers and assisted baths taken out of use on Ward B and Ward C wards
- Hot water system pasteurised
- Subsequently showers taken out of use on Ward D

Case finding

Extensive active case finding exercise

All microbiologists, physicians, surgeons, nursing staff, admissions staff alerted

Press release

All potentially exposed patients and their GPs from 3 wards were contacted

Media interviews

Telephone help-line

Which strain of legionella caused the infection?

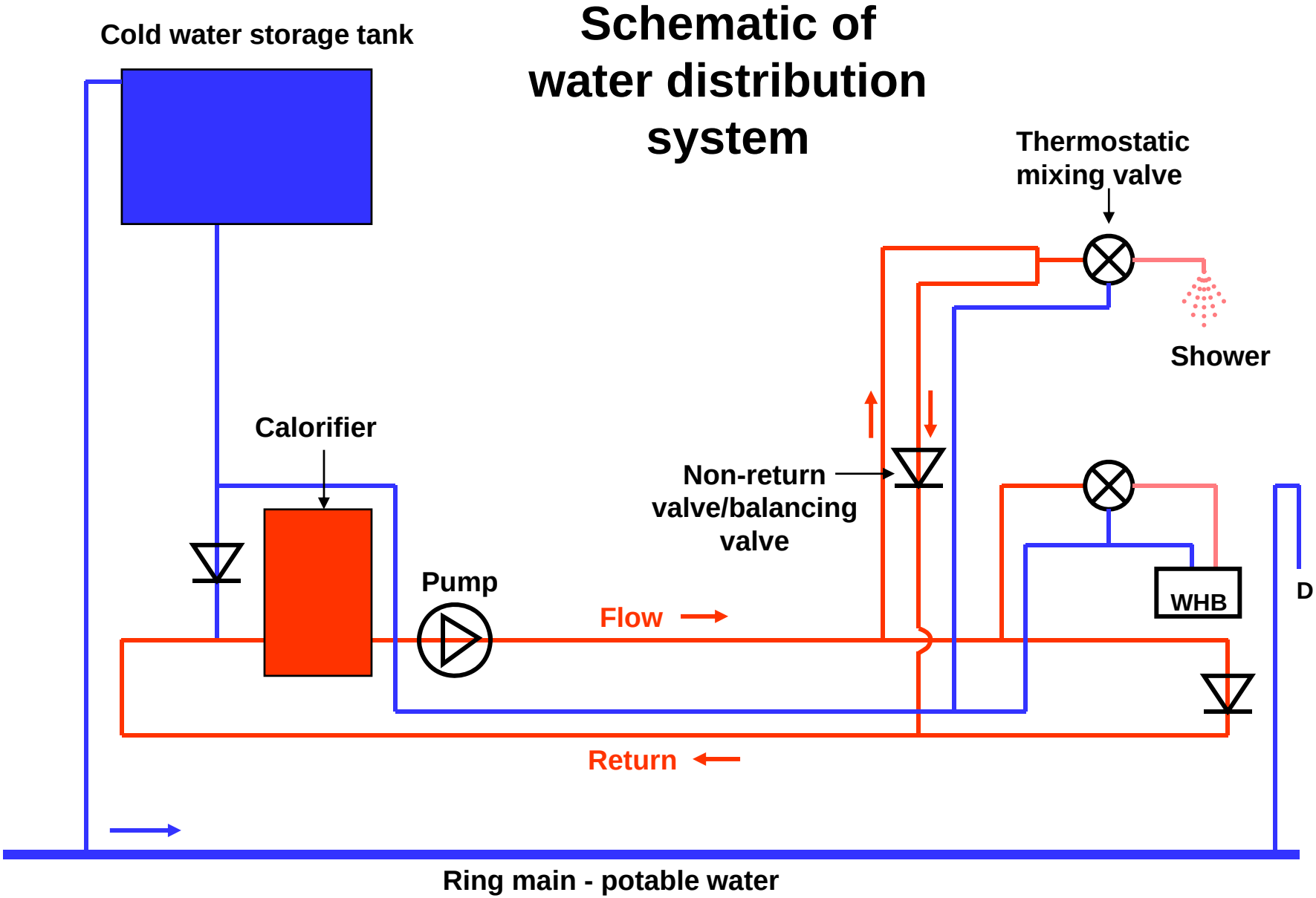
- BAL +ve for *L.pneumophila* (SG1-15) by DIF
- Culture of BAL - No growth (on clarithromycin for several days)
- Urine EIA (Biotest) +ve - detects mainly *L.pn* SG1 +/- some other serogroups
- In-house urine ELISA at Ref Lab for *L.pn* SG1 was NEGATIVE

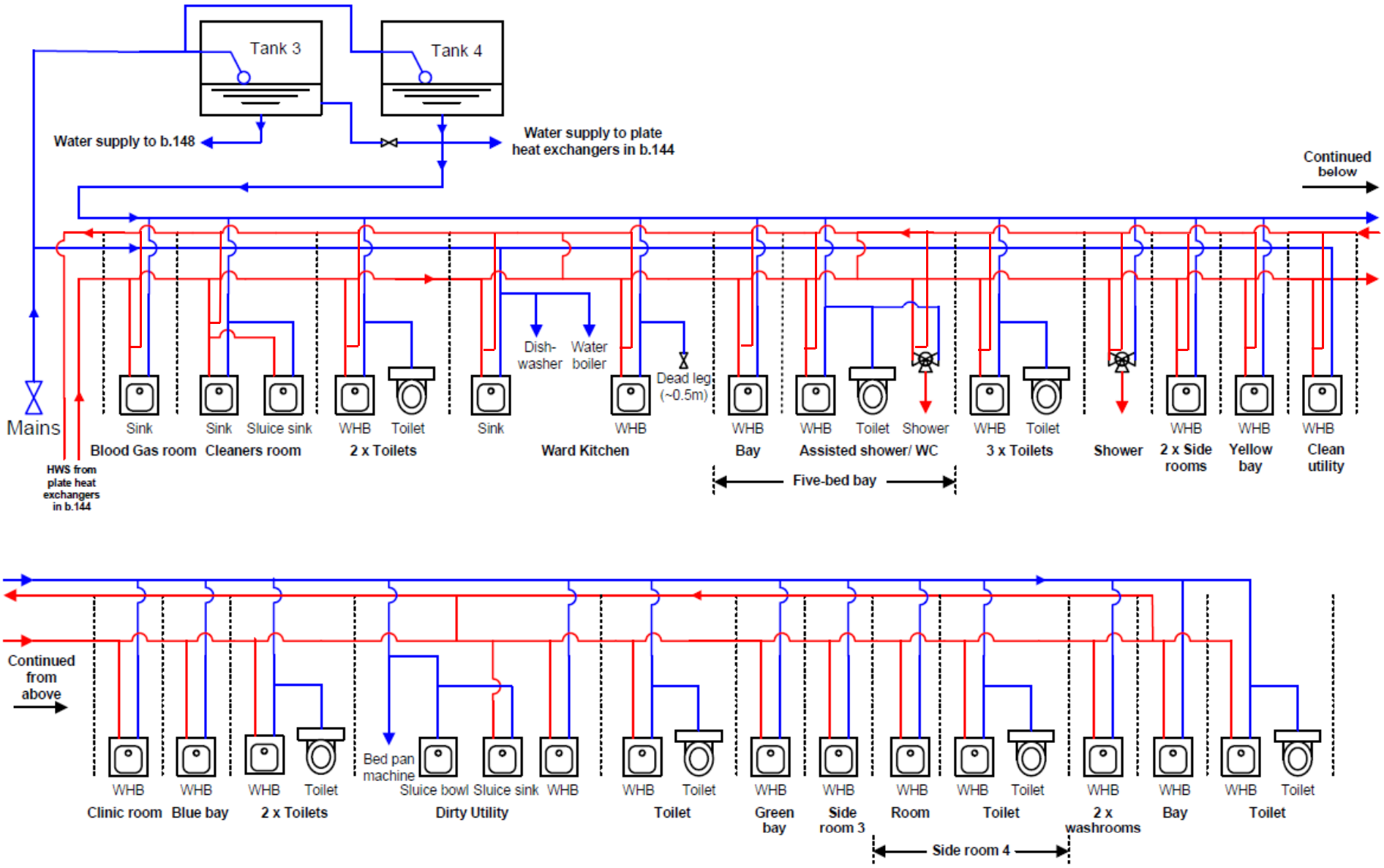
  – specific for *L.pn* SG1 Mab 2 +ve strains
  eg Philadelphia, Knoxville, Benidorm
  [the major “epidemic” strains - cause the majority of human infections]
  – doesn’t detect Mab 2 -ve strains
  eg Oxford, Olda, Bellingham
  [less pathogenic (along with other *L.pn* serogroups and other legionella spp)]

Further Ref Lab tests

- DIF repeated on stored BAL deposit with range of monoclonal antibodies
- Strong reaction with “Bellingham”
  - Others -ve
- Conclusion - infection caused by *L.pn* SG1 subtype Bellingham
  - same strain as in water on Ward B

Schematic of water distribution system




Tank 3
Tank 4
Water supply to b.148
Water supply to plate heat exchangers in b.144
Continued below
Mains
HWS from plate heat exchangers in b.144
Sink
Blood Gas room
Sink
Sluice sink
Cleaners room
WHB
Toilet
2 x Toilets
Sink
Ward Kitchen
Dish-washer
Water boiler
WHB
Dead leg (~0.5m)
WHB
Bay
WHB
Toilet
Shower
Assisted shower/ WC
Five-bed bay
WHB
Toilet
3 x Toilets
Shower
WHB
2 x Side rooms
WHB
Yellow bay
WHB
Clean utility
Continued from above
WHB
Clinic room
WHB
Blue bay
WHB
Toilet
2 x Toilets
Bed pan machine
Sluice bowl
Sluice sink
WHB
Dirty Utility
WHB
Toilet
Toilet
WHB
Green bay
WHB
Side room 3
WHB
Room
WHB
Toilet
Toilet
Side room 4
WHB
2 x washrooms
WHB
Bay
WHB
Toilet
Toilet

No “legionella” issues with this system

- Routine previous temperature recordings all satisfactory
  - Temp >60^{0}C leaving the plant room
  - Temp >50^{0}C returning to the plant room
  - Furthest point on the distribution system: water temperature >50^{0}C within a few seconds of opening the tap (no TMV)
  - Cold water temperatures all below 20^{0}C.
- No apparent issues with routine maintenance
- No schedule of routine legionella water culturing

Cold water storage tanks

Angelary calorifier

WHB in Bay on Ward B

Unsatisfactory temperature recordings

- Ward B return pipe from shower/WHBs in room G-01 (39^0C)
- Ward C return pipe from shower/WHBs in room I-01 (26^0C)
- Ward D return pipe (bottom of ward) (42^0C)

- Inadequate flow of water through these circuit
- Shower rooms installed in March/April 2000 when dayrooms on these wards converted into bays
- Pipework incorrectly installed
- Flow connected to return and vice versa & cross-connecting pipe not removed = short circuit

Ward	Sample	Culture Result	Bacterial Count
Ward B	Hairwashing sink shower	*L.pneumophila* SG1 (Bellingham)	$7.0x10^{1}$/litre
Ward B	Kitchen hot tap	*L.pneumophila* SG1	$1.0x10^{1}$/litre
Ward B	Biofilm from TMV (shower in G-01)	*L.pneumophila* SG1	----------
Ward B	Kitchen cold tap	*L.pneumophila*	$1.0x10^{1}$/litre
Ward B	Cold tap WHB WC Orange bay	*L.pneumophila* SG1	$1.2x10^{2}$/litre
Ward C	Hot tap in cleaner's store	*L.pneumophila* SG1 (Bellingham)	$1.7x10^{2}$/litre
Ward C	Hot tap WHB in shower (room I-01)	*L.pneumophila* SG1	$2.9x10^{2}$/litre
Ward C	Hot tap WHB outside shower (room I-01)	*L.pneumophila* SG1	$6.8x10^{2}$/litre
Ward C	Hot tap assisted bath	*L.pneumophila* SG1	$2.0x10^{2}$/litre
Ward C	Shower attachment assisted bath	*L.pneumophila* SG1	$6.8x10^{2}$/litre
Ward C	Shower (room I-01)	*L.pneumophila* SG1	$3.2x10^{1}$/litre
Ward C	Hairwashing sink shower	*L.pneumophila* SG1 (Bellingham)	$6.2x10^{3}$/litre
Ward C	Cold water tap WHB WC Red bay	*L.pneumophila* SG1	$5.6x10^{2}$/litre
Ward C	Cold water tap kitchen	*L.pneumophila* SG1	$1.0x10^{1}$/litre
Ward D	Shower (room G9)	*L.pneumophila* SG1 (Bellingham)	$1.3x10^{3}$/litre

Learning Points

- Hot water system can be heavily colonised with legionella despite apparently satisfactory temperature recordings
- Measuring plant-room flow and return and sentinel water temperatures (after opening a tap) is NOT sufficient to ensure hot water is flowing through all parts of the distribution system
- Pipework surface temperatures (BEFORE opening an outlet) can easily identify problems with hot water flow

Additional legionella control measures

- Enhanced temperature monitoring
  - Pipe surface temps on each main branch and sub-branch of distribution system
  - Still difficult to measure each and every “loop” on the system
- Routine water sampling for legionella for in-patient areas
  - 4 samples per ward (showers +/- WHBs) once or twice per year (risk assessment)

Legionella water sampling programme

- Established 11 years ago
- Multiple water systems
- Several systems were found to be heavily colonised on 1st testing
- A number of significant plumbing issues were found and rectified
  - Systems out of balance
  - Closed valves on return pipework
  - Incorrect modifications to pipework
  - Airlocks
- +ve cultures are now rare
  - Occasional local problem –TMV
  - No whole system issues

Conclusions

- Routine water sampling for legionella has proven to be very beneficial in minimising legionella risks

- Positive cultures can identify problems in water systems that can be missed by routine maintenance and temperature monitoring programmes

and finally a domestic danger!

Mr X

- 46 yr male
- polycystic kidney disease with ESRF
- renal transplantation 1988 & 1996
- cyclosporin, prednisolone, mycophenolate
- non-smoker
- other medical problems - asthma, gout
- previous splenectomy

Presenting complaint

2-3/7 Hx

- unwell, fatigue
- abdo pain
- mild diarrhoea
- anuria
- increasing SOB

O/E

- apyrexial
- alert, orientated
- abdo discomfort
- clear chest

Ix

- CXR normal
- FBC normal
- impaired renal function

Initial management

- Careful fluid balance
- IV cefuroxime
- ? sepsis
- ? rejection

Over next 4/7

- Increasing abdo pain
- Worsening renal function

Day 5

- Laparatomy - NAD
- Post-op ventilated on ITU for 4 hours

Clinical course

- Post-laparotomy
- Slight improvement
- Abdo pain continued on and off
- Renal function stabilised

Day 12

- Suddenly unwell
- Fever, tachycardia
- Hypotension
- Confusion

O/E

- RLL pneumonia
- Confirmed on CXR

Clinical course

- IV cefuroxime
- Day 13 to ITU
- Ventilated
- IV piptazobactam
- Bronchoscopy performed
- BAL to micro

- mc&s, AAFBs, fungi, legionella culture
- Viral & atypical screen - DIF
  - PCP, legionella, chlamydia
  - CMV, influenza A & B, RSV, parainfluenza 1-3, adenovirus

Microbiology

BAL

- strongly positive for *Legionella pneumophila*

Culture

- *L.pneumophila* SG1 subtype Benidorm grown from BAL after 4 days

Urine

- Positive by EIA for *L.pneumophila* serogroup 1

Serology

- Legionella antibody titres rose from 32 to 1024 (by IFAT)

Treatment

- IV ciprofloxacin + IV clarithromycin 7 days
- Improvement in resp.function
- Persistent swinging fever
- CMV antigenaemia test (pp65) strongly positive
- IV ganciclovir added
- fever normalised
- further 12 days of oral cipro + erythromycin
- full recovery

? Hospital-acquired LD

- Incubation 2-10 days
- Onset of pneumonia day 12 after admission (day 7 post-laparotomy)
- Outbreak committee convened
- Renal ward, ITU, theatre 2, recovery area
- No recent maintenance on water systems
- Temperature records satisfactory
- 38 water samples collected for legionella culture

Further action and results

- 3 calorifiers for H block pasteurised
- temp of hot water increased by 3^0C - return temperature to 60^0C
- flexible shower hoses disinfected 1% sodium hypochlorite
- All 38 water samples NEGATIVE for *L.pneumophila*

Samples from patient's home

- Modern house
- Simple hot water system, electrically heated
- Cold water tank above boiler
- *L.pneumophila* SG1 subtype Benidorm isolated from
- Indistinguishable from clinical isolate

Bath hot tap (1300 cfu/ml)

Hand basin hot tap (200 cfu/ml)

Kitchen mixer tap (30 cfu/ml)

Cold water tank (40 cfu/ml)

Discussion

- Acquisition of sporadic LD from domestic water systems
  - BRE study
    - 81 patient homes + matched control homes
    - 14.8% v 4.9% (p 0.03)
    - higher counts in cases v controls (p 0.006)
    - risks for legionella - cold water tank lid & position, hot water temperature
  - Nottingham Data 1999
    - 25% (4/16) homes sampled positive

Discussion 2

- Long incubation or
- Protracted prodromal illness
- ? oropharyngeal carriage of legionella with onset of LD triggered by GA/intubation and mechanical ventilation