Legionella pneumophila: The Wesley Hospital Outbreak – Five Years Later

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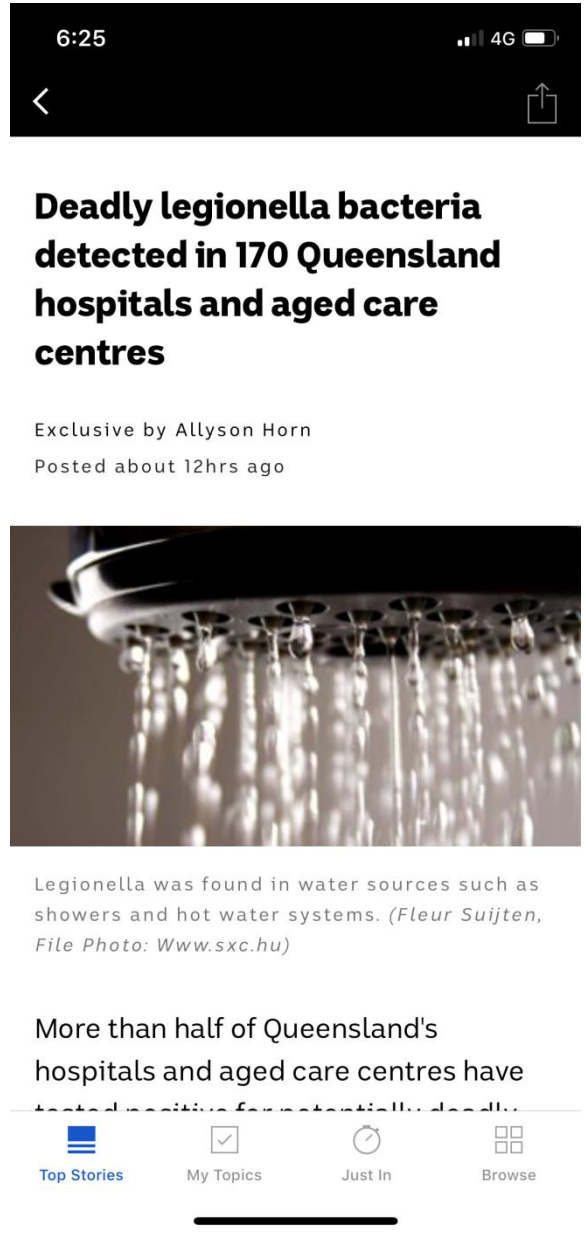
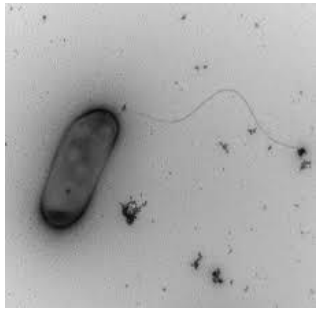
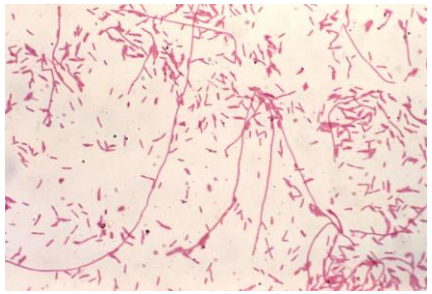


ABC News App. 12/11/18

Legionella pneumophila



- Family – *Legionellaceae*
  - Type species – *L. pneumophila*
- Motile, gram-negative, non-spore forming bacilli - 0.3 x 1.3 μm (free)



- Biofilm resident: Lakes, rivers, streams, thermal pools, mud
  - Requires :
    - Regional bacterial flora - *in vitro* satellitism
    - Amoebae – selective amplification which correlates poorly with culture results

- Manufactured water distribution systems - ubiquitous
    - Potable water supplies, air conditioning cooling towers
    - Spa pools, fountains, humidifiers, nebulisers, ice machines, water coolers
- Biofilm burden increased:
    - temperature, slow or no flow in WDS, heat transfer, sludge, high nutrient levels, low biocide residuals
- Quantity ≠ risk of disease
    - Method?
- High transmission risk: aerosol generation at any POU

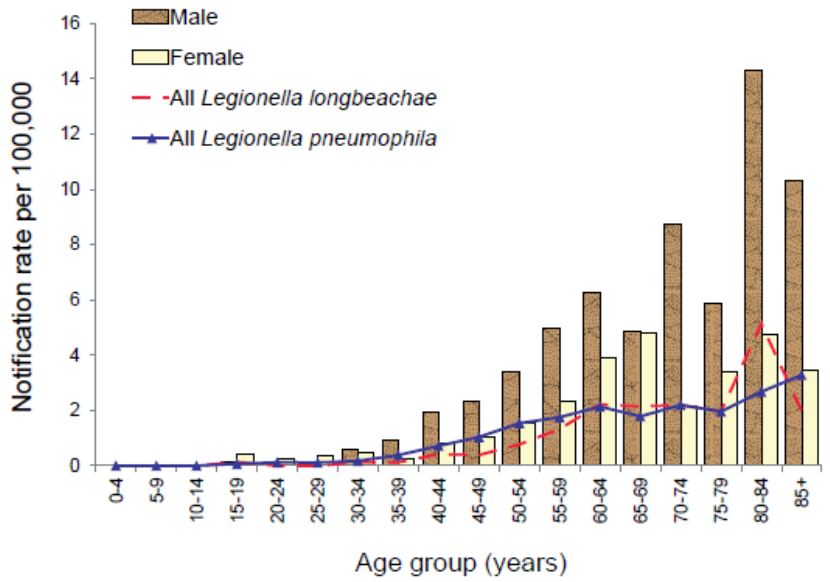
Infection & Disease

- Almost exclusively Human
- Inhalation of aerosols or aspiration
  - Can drift up to 3 km
  - NOT person – person
- Dose-response difficult to determine in animals
  - 1200 – 100000 viable organisms (maybe 1?)
- Risk factors: COPD, Advanced age, therapeutic immunosuppression, transplantation
- Severe pneumonia – Legionnaire's disease
- Mild illness - Pontiac fever
- *L. pnemophila* SG1 (LpSG1) – 95% of Legionnaire's disease globally
  - 25% of all environmental isolates
  - ~50% of Australian Legionella notifications

Table 24: Notifications, notification rates and deaths for legionellosis, Australia, 2014, by species and state or territory

	State or territory									
Species	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust.	Deaths
L. longbeachae	1	17†	4	16	19	5	9	93*	164	5
L. pneumophila	1	41	3‡	45‡	20†	2	60	23†	195	6
L. micdadei	0	1‡	0	0	0	0	1	0	2	1
L. sainthelensi	0	0	0	0	1	0	0	0	1	0
Unknown species	0	11	0	33	0	1	17‡	0	62	1
Total	2	70	7	94	40	8	87	116	424	13

Figure 104: Notification rate for legionellosis, Australia, 2014, by age group, sex and species

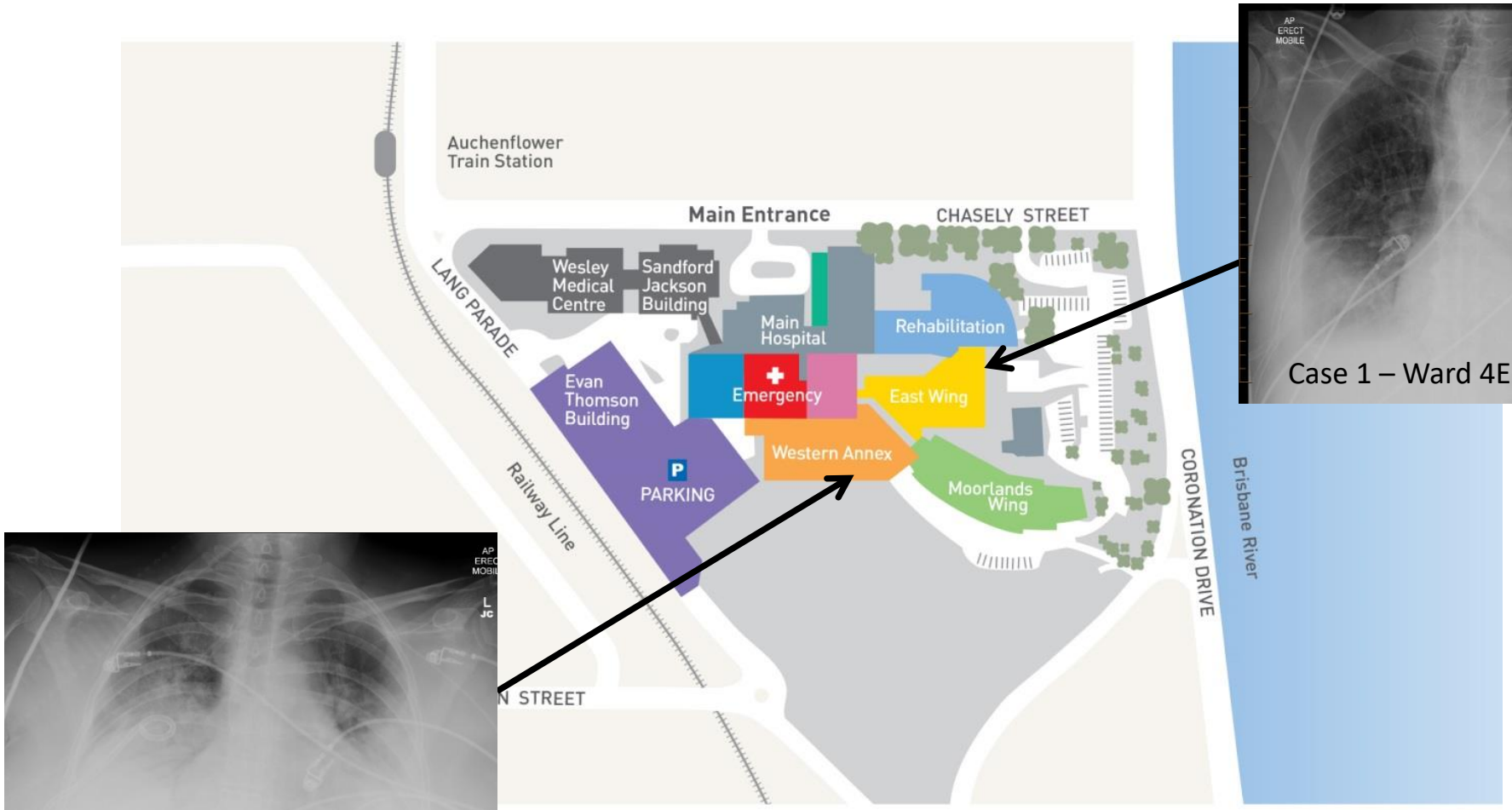


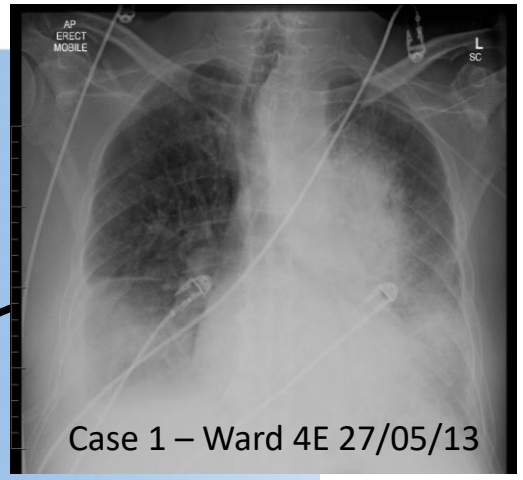
Commun Dis Intell 2016;40(1):E48–E145.

Australian Nosocomial Legionnaires' Disease Outbreaks

Year	City	Facility	Source	Proven Cases
1979	Ballarat	Psychiatric Hospital	Potable water	5
1986	Adelaide	Hospital	Cooling Tower	
1999	Melbourne	Haematology Clinic	Unidentifiable	2
2011-15	Brisbane	Tertiary Private Hospital	Potable Water	4

May & June 2013

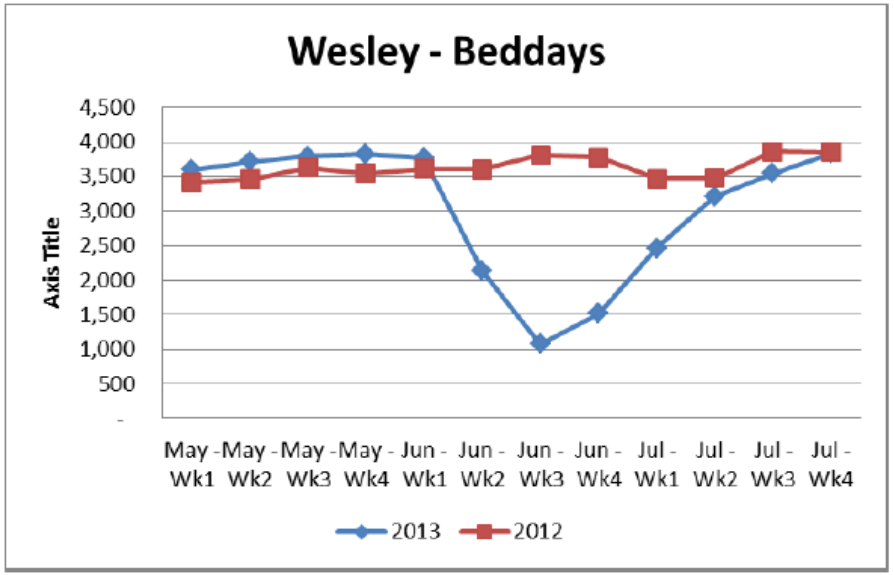




Case 1 – Ward 4E 27/05/13

Case 2 – Ward 4W 3/06/2013

The Intervention - Baseline



- Critical Incident Team (50 FTE for 28/7)
- Hospital closed – no showers
- Recall 1400 recently-discharged patients
- Telephone Hotline
- Testing of inpatients with new LRTI symptoms
- Rescheduling >2000 surgical lists elsewhere
- Review of all Aircon surveillance cultures & warm-water system temperature monitoring
- Review of Legionella testing previous 5 years + previous year of inpatient deaths where “pneumonia” was coded
- Delay of care
  - Necessary to prevent further cases
  - How long can the delay last?
- Close co-operation with QLD Health & CHO
- When can a building or institute be “Cleared”?

The Intervention – WDS Biofilm Removal

- Reduce WDS biofilm burden
- Scalding of plumbing in all buildings – certain to fail
  - 3105 taps & showerheads & >30km of pipe, ring mains, drop mains and risers
  - 22 Hot Water Systems & 1 Ml of water storage tanks
  - 17% POU culture positivity decreased to 5% - it failed!
- Definitive remediation
  - Installation of backflow prevention between buildings
  - East Wing $\rightarrow$ Moorlands $\rightarrow$ Main
  - Biofilm removal - Alkaline detergent – pH=10 with Chlorine (about 10ppm)
  - **Then** Chlorination to 10ppm – disinfect residual
  - 3 cycles – to achieve macroscopically clear water & negative Bactiquant assay
- Evaluation of intervention
  - Water cultures

The Intervention – Water System Risk Reduction

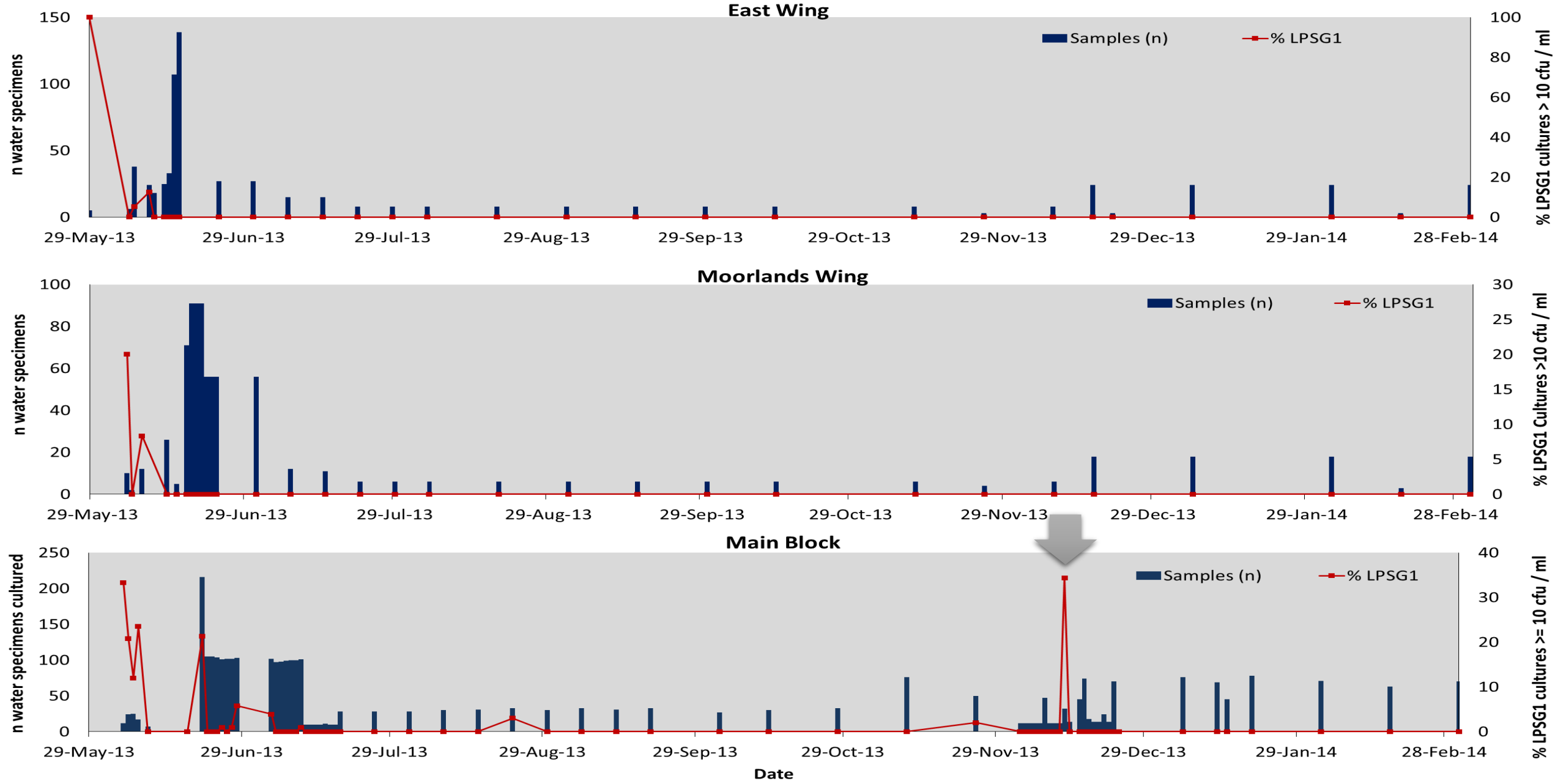
- Mapping of Hospital WDS, identification of POU, aerosol potential, heat transfer & dead legs
- Removal of “long” segments of water main – eg – from under bitumen roads
- Identification & removal of all (?) dead legs
  - “Fingertip audit” - 9/12 of 5 nights per week – 2 plumbers
  - ~810 dead legs removed
- Repair of legacy plumbing problems
  - Rehabilitation Ward – Conversion to a continuous cold loop main
  - POU Filters in Main Block (persisting High HPC)
  - No chilled filtered water – room temperature
- Filter pre-storage tank
  - Aria – Commissioned 3/11/2016

Maintenance Disinfection & Health Risk Reduction

- Awareness of water supply disruptions / possible impacts – “Critical Events”
- Maintenance Chlorination
  - Free chlorine down to 1-2ppm – to Drinking water standard
  - New water main for Dialysis and CSSD
- Removal of all tap aerators
- All nebulisers – single use
- All cold water dispensers set to room temperature – not Cold
- Filters at all POU in Main Block
  - Scaled back now to Oncology floor only.
- Removal of persistently-positive outlets (LpSG1 or high HPC)
- Circulation of water within storage tanks
- Fire Sprinklers – management of patient exposure if accidental triggering

Verification Monitoring HPC and *Legionella sp.*

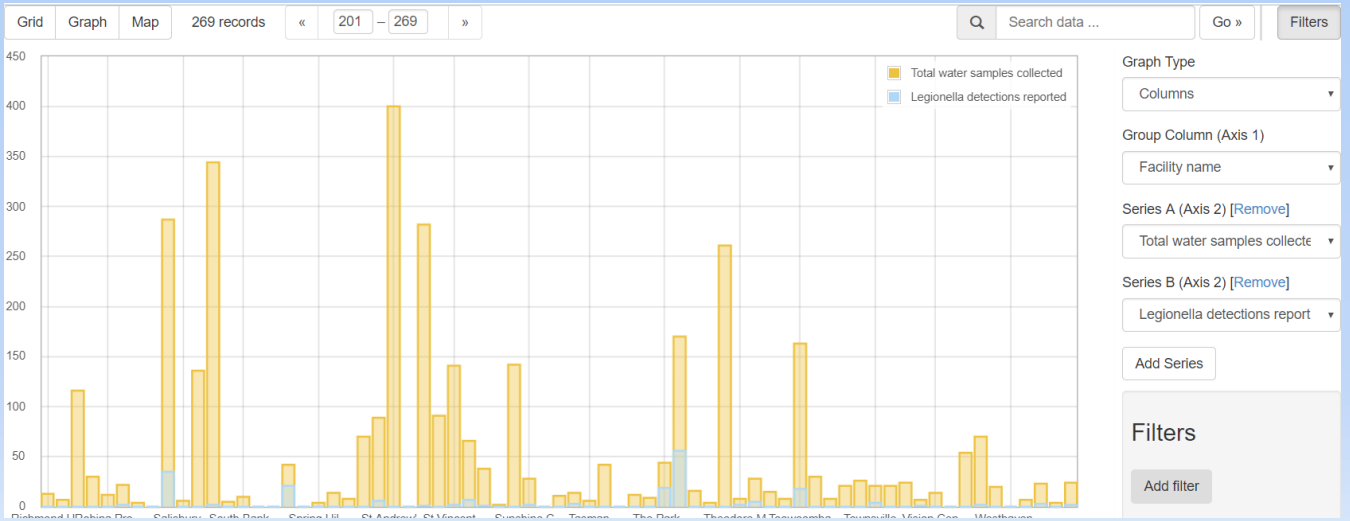
- HPC & Legionella sp. culture
  - AS 3896:2017 – 100ml samples & LLD 10 cfu/ml
  - AS 5132:2017 – 1000ml samples & LLD 100 cfu/l
- How many, frequency and POU depend on:
  - WDS anatomy & location of high risk areas – slow flow, little-used areas
  - Nature of any intervention – remedial *vs* maintenance phase
  - Number and location of high-risk patients
- Acute phase – all circuits in region daily for 7/7 after treatment
  - Then weekly…..fortnightly……monthly
- Maintenance phase - once control is achieved (!)
  - POU tested – hot & slow flow / distal – cold & high-risk POU – Oncology wards
  - 10 samples from each building, each month
  - All plumbing circuits tested 4 times per year
  - All test results recorded on Datasabre & CAD drawings of entire WDS
  - High HPC and Legionella positives – managed and reported as per WQRMP.


East Wing
Samples (n)
% LPSG1
n water specimens
% LPSG1 cultures > 10 cfu / ml
150
100
50
0
100
80
60
40
20
0
29-May-13
29-Jun-13
29-Jul-13
29-Aug-13
29-Sep-13
29-Oct-13
29-Nov-13
29-Dec-13
29-Jan-14
28-Feb-14
Moorlands Wing
Samples (n)
% LPSG1
n water specimens
% LPSG1 Cultures >10 cfu / ml
100
80
60
40
20
0
30
25
20
15
10
5
0
29-May-13
29-Jun-13
29-Jul-13
29-Aug-13
29-Sep-13
29-Oct-13
29-Nov-13
29-Dec-13
29-Jan-14
28-Feb-14
Main Block
Samples (n)
% LPSG1
n water specimens cultured
% LPSG1 cultures >= 10 cfu / ml
250
200
150
100
50
0
40
30
20
10
0
29-May-13
29-Jun-13
29-Jul-13
29-Aug-13
29-Sep-13
29-Oct-13
29-Nov-13
29-Dec-13
29-Jan-14
28-Feb-14
Date

TWH Water Surveillance Cultures 2013-2018

Year	*n* Samples	Negative Legionella	LpSG1	Other *Legionellae*	% Positive
2013	4234	4069	115	52	3.94
2014	2877	2873	3	1	0.14
2015	1839	1831	1	7	0.44
2016	1178	1176	0	2	0.17
2017	360	360	0	0	0.00
2018	300	300	0	0	0.00
Total	**10788**	**10609**	**119**	**62**	1.67

Queensland Health Data H1 - 2017



https://data.qld.gov.au/dataset/13b74043-9b3e-4a33-b32f-1c389b3995b4/resource/c260da52-4c7e-4b38-9ba5-a0eed559a940/view/8686b1b0-177b-4b2f-a95c-8a4ee2291420

Hospital-wide Eradication of a Nosocomial *Legionella pneumophila* Serogroup 1 Outbreak

Paul B. Bartley,[1,2,a] Nouri L. Ben Zakour,[3,4,a] Mitchell Stanton-Cook,[3,4] Raghuram Muguli,[5] Luis Prado,[1,2] Vyt Garnys,[5] Katherine Taylor,[2] Timothy C. Barnett,[3,4] Glen Pinna,[6] Jennifer Robson,[7] David L. Paterson,[4,8] Mark J. Walker,[3,4] Mark A. Schembri,[3,4] and Scott A. Beatson[3,4,a]

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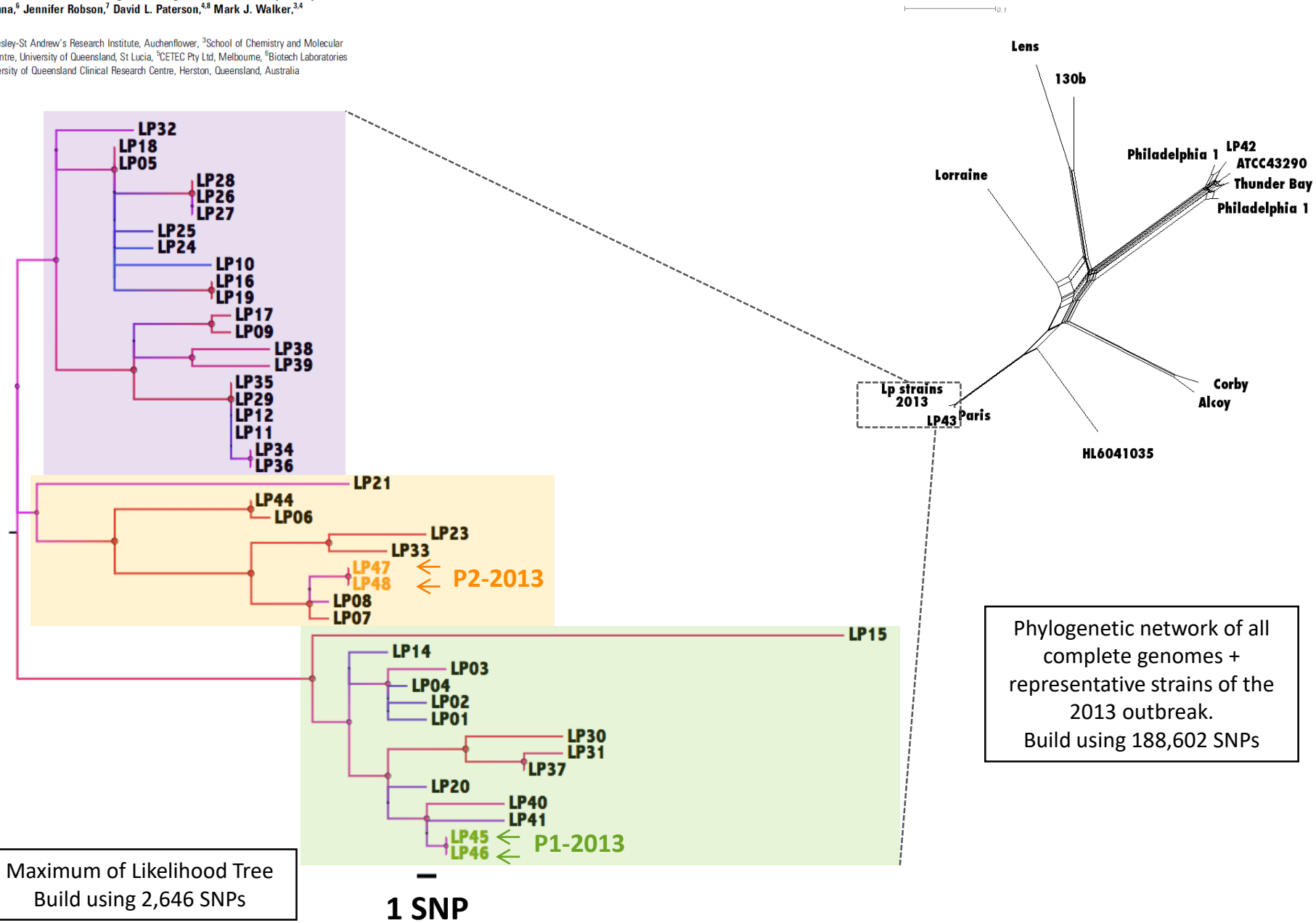
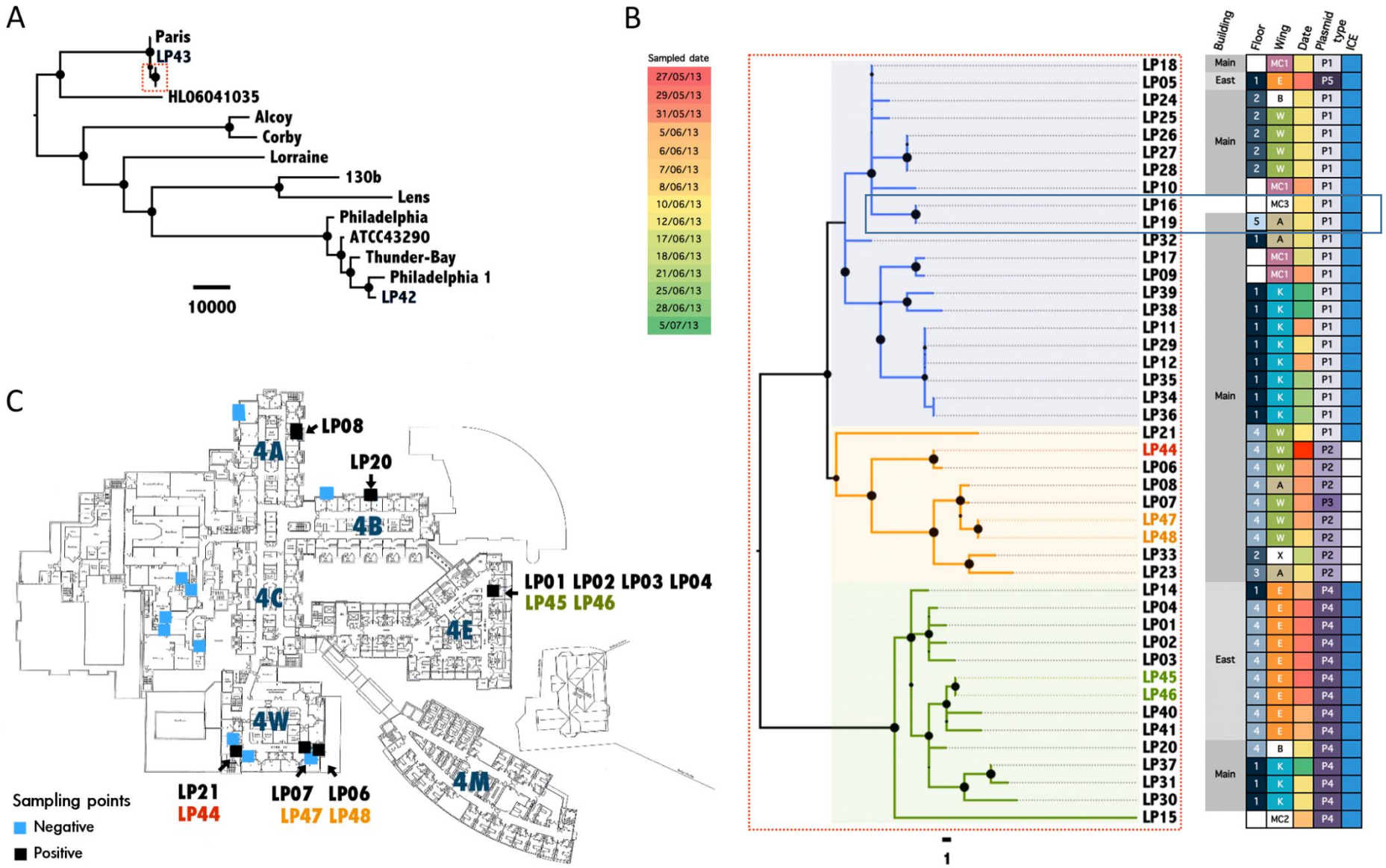
Very few SNPs distinguish the strains of the 2013 outbreak



Maximum of Likelihood Tree
Build using 2,646 SNPs

Phylogenetic network of all complete genomes + representative strains of the 2013 outbreak.
Build using 188,602 SNPs


A
Paris
LP43
HL06041035
Alcoy
Corby
Lorraine
130b
Lens
Philadelphia
ATCC43290
Thunder-Bay
Philadelphia 1
LP42
10000
B
Sampled date
27/05/13
29/05/13
31/05/13
5/06/13
6/06/13
7/06/13
8/06/13
10/06/13
12/06/13
17/06/13
18/06/13
21/06/13
25/06/13
28/06/13
5/07/13
Building
Floor
Wing
Date
Plasmid
type
ICE
LP18
LP05
LP24
LP25
LP26
LP27
LP28
LP10
LP16
LP19
LP32
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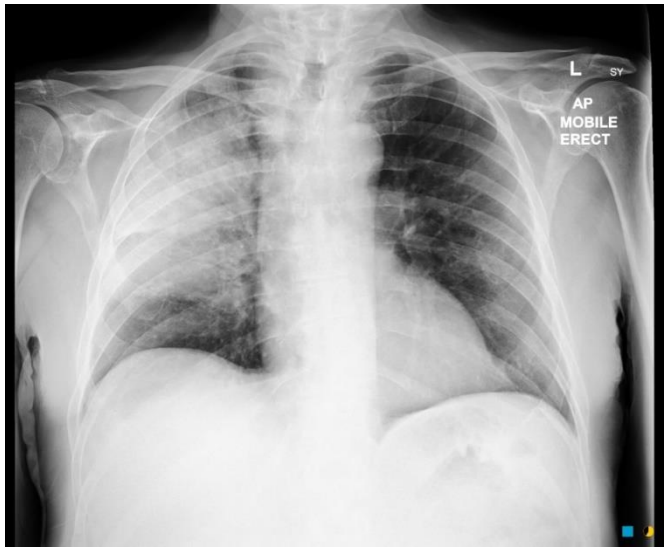
LP09
LP39
LP38
LP11
LP29
LP12
LP35
LP34
LP36
LP21
LP44
LP06
LP08
LP07
LP47
LP48
LP33
LP23
LP14
LP04
LP01
LP02
LP03
LP45
LP46
LP40
LP41
LP20
LP37
LP31
LP30
LP15
1
C
LP08
4A
LP20
4B
4C
LP01 LP02 LP03 LP04
LP45 LP46
4E
4W
4M
LP21
LP44
LP07 LP06
LP47 LP48
Sampling points
Negative
Positive

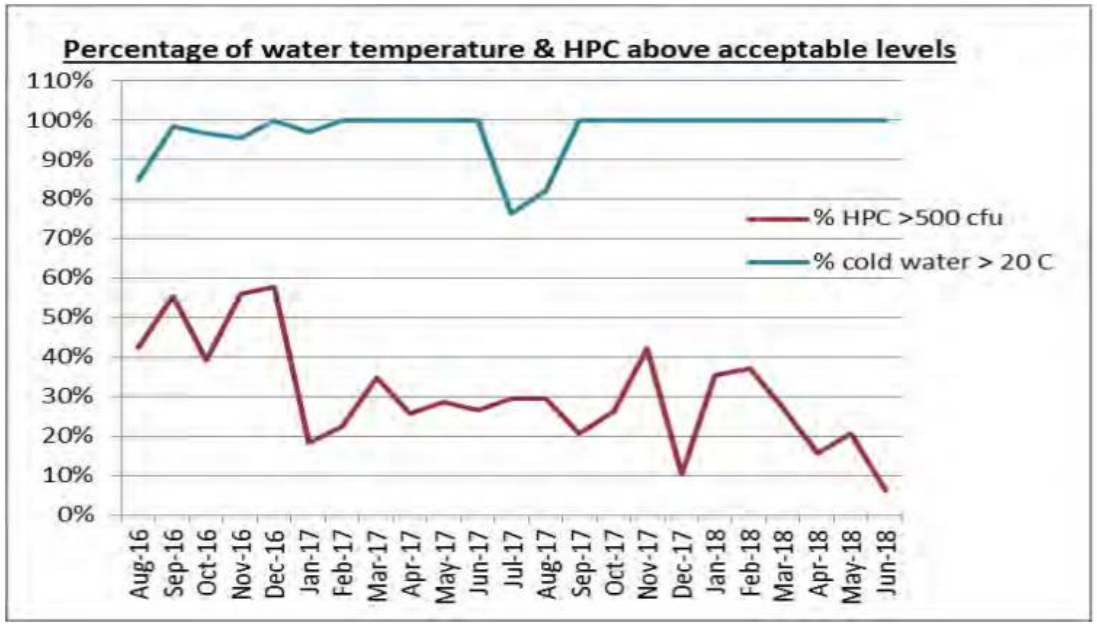
Ice Machines

- Advice to test ice machines
  - Positive *Legionella* sp. Cultures from ice & water October 2015
  - Haem / Onc and Dialysis – removed and destroyed
- Repeated December 2015 - Replacement Haem / Onc ice machine
  - LpSG1 positive
  - Machine removed and all Haem/Onc and ID VMPs informed by DMS
- Fourth case – Palliative care ward – HAP January 2016
- Carbon filter on intake removing Cl^-
- WGS – Ice and patient isolates genetically indistinguishable from 2013 outbreak strain
- No ice machines in TWH & commercial supplier of ice for orthopaedics.

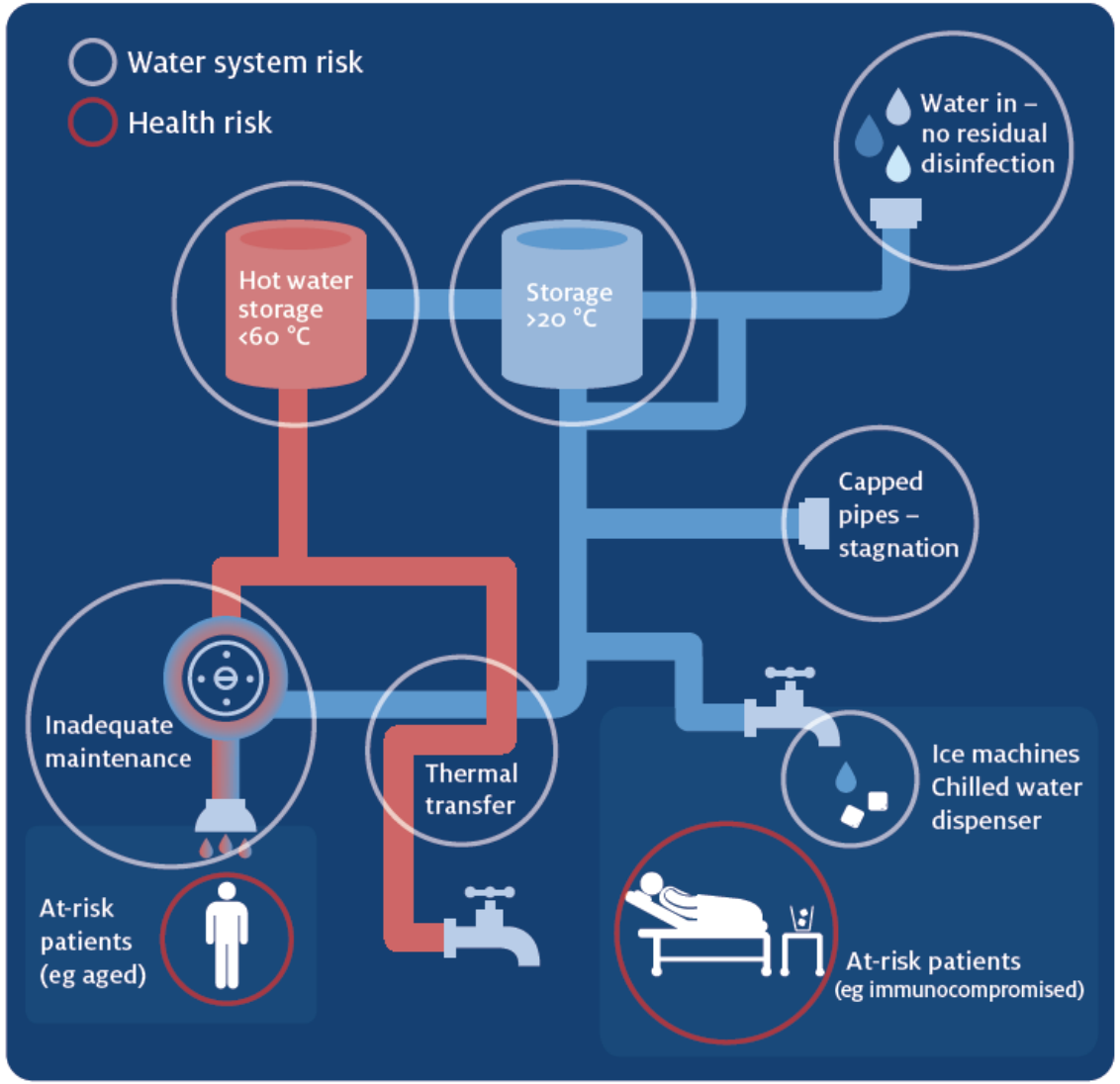


Co$t

- To FY15 - $2.6 million
  - Including immediate plumbing remediation, water remediation, Advertising and Media & Filters
- FY16 and FY17 - $850 000 pa
  - Filters $500 000 & Testing $150 000
- FY18 $266 000
  - Testing $66 000, Aria $100 000

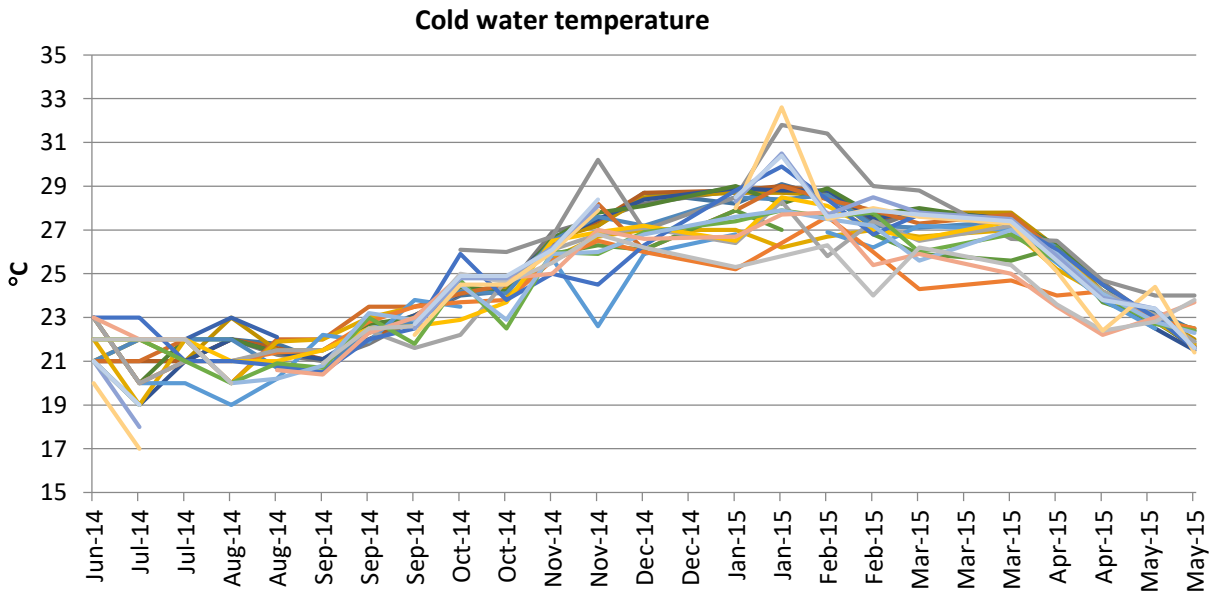


Risks To Modify



Monitoring of Intervention

Operational Monitoring	Verification Monitoring
Turbidity	HPC
Filters	LpSG1 & L sp.
Heavy Metals	Control Limits
Temperature	Action plan when detected
pH	
Biocide residuals	
Includes location, number, method & frequency of tests	



Wesley Legionella Experience

- Clonal outbreak – persisting for > 4 years in WDS & add-ons
- Accept its ubiquity in WDS & risk to patients - “There is no safe level of Legionella”
- Risk management - WQRMP - It is all about WDS biofilms
  - Where the system risks are and plans for remediation
  - Where the high-risk patients are & how to protect them
  - May apply to other opportunistic pathogens: NTM, CRAB, *Pseudomonas sp*. *Etc*
  - Guide to handling high HPCs and LpSG1 detections
- Identify and reduce risk first
  - Incoming water quality & handling
  - Dead leg removal and low-flow prevention, minimise aerosol generation & exposure
  - Biocides & Filters
- Testing - verification of efficacy of interventions & maintenance
  - Monitor the biofilm & Lp1 – statistically valid and WDS-pertinent
- Lab technology upscaling – 1l samples, qPCR, dPCR, EIAs & metagenomics

Acknowledgements

Wesley Hospital

Kathy Taylor

Chris Beck

Luis Prado

Wesley VMOs

UCH Executive

Richard Royle

Kirsten Price

David Gray

Nursing Staff

Support Staff

UQ – AIDRC & AWMC

Nouri Ben Zakour

Mitchell Stanton-Cook

Timothy Barnett

David Paterson

Mark Walker

Mark Schembri

Scott Beatson

Philip Bond

CETEC Consulting

Vyt Garnys

Raghuram Muguli

Biotech Labs.

Glen Pinna

SNP

Jenny Robson

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