

Chief Health Officer Branch

Review of the prevention and control of *Legionella pneumophila* infection in Queensland

Chief Health Officer's report

September 2013

Contents

Foreword	1
1.0 Summary	3
1.1 Background	3
1.2 Findings and conclusions	3
1.3 Work commenced or to be commenced in response to identified issues	4
1.4 Recommendations	5
2.0 Introduction	7
2.1 Background to the review	7
3.0 <i>Legionella</i> and legionellosis	8
3.1 <i>Legionella</i> in the environment	8
3.2 Reducing the risks of <i>Legionella</i> growth	10
3.2.1 Water systems generally	10
3.2.2 Other specific manufactured water systems	10
3.3 <i>Legionella</i> and illness	11
3.3.1 What is legionellosis and Legionnaires' disease	11
3.3.2 How it spreads	11
3.3.3 Risk of acquiring legionellosis	11
3.3.4 Incubation period, symptoms, infection rates and severity	12
3.3.5 Outbreaks	12
3.3.6 Gaps in knowledge in Australia	13
3.4 Diagnosis and notification criteria	14
3.5 Legionellosis in Queensland	14
4.0 Legionellosis outbreak at The Wesley Hospital	16
4.1 Background	16
4.2 Investigations following notification	17
4.2.1 Clinical governance and compliance with relevant Acts and standards	17
4.2.2 Compliance by Sullivan Nicolaides Pathology with the <i>Public Health Act 2005</i>	21
4.2.3 Analyses of notifications for <i>Legionella pneumophila</i> on the Notifiable Conditions System (NoCS) compared to laboratory data	23
4.2.4 Environmental site inspections and investigations	24
4.2.5 Independent review of the 2011 case of Legionnaires' disease	27
4.2.6 Water testing results for public and private hospitals across Queensland	28

5.0	Regulation and other approaches to prevention	32
5.1	Scope of approaches.....	32
5.2	Approaches to the control of <i>Legionella</i>	33
5.2.1	Current arrangements	33
5.2.2	Discussion.....	35
5.3	Approaches to detection of disease and associated public health responses	38
5.3.1	Current arrangements	38
5.3.2	Discussion.....	39
6.0	<i>Legionella pneumophila</i> infection in the community.....	39
7.0	Responses to issues identified as part of the review	41
8.0	Conclusions and recommendations.....	42
8.1	Conclusions.....	42
8.2	Recommendations	43
	Appendix 1	45
	Abbreviations	46
	Glossary	47
	References.....	51

Foreword

At the request of the Honourable Lawrence Springborg, MP, Minister for Health, I undertook a review on the prevention and control of *Legionella pneumophila* infection in Queensland following two cases at The Wesley Hospital in late May and early June 2013.

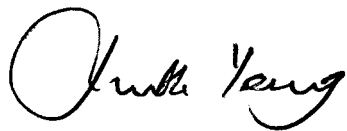
On considering the findings of this review, it is my view that:

- The Wesley Hospital responded promptly and comprehensively to the notification of positive results in two of its patients thereby minimising risk to other patients in their hospital
- following a statewide snapshot testing program, public and private hospitals have responded to the detection of *Legionella* in water samples from within their facilities, informed by guidelines issued by the Department of Health
- there is no evidence that current or past government climate change and energy efficiency policies and programs have promoted unsafe practice or contributed to any increase in risk of contracting *Legionella pneumophila* infection.

Despite Legionnaires' disease being uncommon in Australia, I have made six recommendations for the prevention and control of *Legionella pneumophila* infection. These are:

1. In the short-term, public and private hospitals and all public residential aged care facilities be required, and private residential aged care facilities be requested, to develop water quality risk management plans which include periodic testing of their water supplies for *Legionella* and heterotrophic plate count (HPC) based on risk.
2. In the medium-term, legislation be strengthened relating to the design, commissioning, installation, operation and maintenance of cooling water systems and water delivery systems in hospitals, and residential aged care facilities, through inclusion of requirements under the *Public Health Act 2005*.
3. A memorandum of understanding be developed by relevant regulatory agencies—Department of Housing and Public Works, Department of Justice and Attorney General, Department of Energy and Water Supply and Department of Health—to clearly articulate the roles of each agency and coordination arrangements with respect to *Legionella* risks in hospitals and residential aged care facilities.
4. National collaboration be sought with regard to the following:
 - finalising as a priority the Australian Technical Standard for warm water systems and subsequently the updating of the Australian Standard (AS) 3500.4 to include standards for warm water systems
 - strengthening AS 3666.2 in relation to the operation and maintenance of heated water systems
 - specific requirements for the design, installation, replacement and commissioning of drinking water systems in hospital and residential aged care facilities
 - guidelines for the operation and maintenance of drinking water systems for hospital and residential aged care facilities
 - reviewing the *Legionellosis – National Guideline for Public Health Units*
 - reviewing accreditation processes for both hospital and residential aged care facilities to determine if aspects relating to the physical environment should be strengthened.

5. An immediate upgrade of the Notifiable Conditions System (NoCS) be progressed to provide enhanced prevention and control capabilities including:
 - a reliable and efficient system for the electronic notification of notifiable conditions
 - electronic clinical information management capacity in public health units, that supports public health action in responding to notifiable diseases and outbreaks and enhances statewide reporting of outcomes, quality and activity
 - enhanced disease surveillance, outbreak detection, enhanced surveillance and early warning of disease risks, including emerging infections and pandemics.
6. A review of information for the community be undertaken in collaboration with other agencies to ensure opportunities are maximised to increase awareness of the generally low, but potential risks of *Legionella* and how to minimise them.

A handwritten signature in black ink, reading 'Jeannette Young' in a cursive script.

Dr Jeannette Young
Chief Health Officer
Queensland Department of Health
30 September 2013

1.0 Summary

1.1 Background

The review by the Chief Health Officer of the prevention and control of *Legionella pneumophila* (referred to as *L. pneumophila*) infection in Queensland was initiated at the request of the Honourable Lawrence Springborg MP, Minister for Health, on 6 June 2013. The purpose of the review was to:

- investigate the circumstances surrounding the notification of and response to Legionnaires' disease in two patients and the subsequent death of one patient, at The Wesley Hospital in Queensland in late May and early June 2013
- make recommendations regarding the future management of *L. pneumophila* in Queensland.

There has previously been no recorded hospital outbreak of legionellosis in Queensland, and there have only been a few very small outbreaks, consisting of two or three cases, of legionellosis in community settings in Queensland.

Legionella species are widespread in the environment, especially in water and in wet areas. Human exposure to *Legionella* is a common occurrence, with most experiencing no or only mild symptoms. It is not possible to totally eliminate *Legionella* from the environment.

Control measures are therefore aimed at limiting growth of the bacteria in manufactured water systems and controlling the risk of *Legionella* exposures in those people who are particularly vulnerable (people who are immunocompromised, those with chronic disease and especially those in oncology and transplant units). This vulnerable group of people includes many who are cared for in large hospitals.

It is important to emphasise that this recent outbreak has focussed the attention of the Queensland public and the media on this disease. Legionnaires' disease however, is an uncommon disease in Australia, and even less common in Queensland.

1.2 Findings and conclusions

The investigations undertaken in relation to the cases of Legionnaires' disease and the death of a patient at The Wesley Hospital found that:

- with regard to compliance by the hospital with the *Private Health Facilities Act 1999*, and in light of the absence of a requirement to test for *Legionella* in hospital water systems, although some administrative breaches of legislation were detected, none would warrant punitive action under the *Private Health Facilities Act 1999* based on information received at the time of the investigation
- there was no evidence indicating negligence or intent on the part of the hospital resulting in harm to visitors, patients, hospital staff and/or the greater community that would warrant punitive action based on information received at the time of the investigation
- the majority of issues identified during the investigation were system and process type lapses related to the administrative aspects of the hospital's management of, and response to, the outbreak of Legionnaires' disease—these mostly related to the fact that timely reporting of an unexpected death of an inpatient to the Chief Health Officer and to the Coroner did not occur

- the failure by Sullivan Nicolaides Pathology (SNP) to notify the first positive *Legionella* test result was due to deficiencies in the laboratory information system and supporting procedure document—in this case, this failure had no impact on future risks to patients given the prompt action undertaken by The Wesley Hospital.

It is the view of the Chief Health Officer that:

- The Wesley Hospital responded promptly and comprehensively to the notification of positive results in two of its patients, including extensive investigatory work and enhancements to its water infrastructure to help further reduce any future risk to patients, and active case finding to determine if any other patients had developed the infection
- SNP responded promptly on being advised by Queensland Health that the notification of the first case had not been received, identifying how and why the failure had occurred, and making the necessary modifications to its information system and supporting bench top procedures
- public and private hospitals have responded to the detection of *Legionella* in water samples from within their facilities following a statewide water testing program, informed by guidelines issued by the department—action is continuing where required
- there is no evidence that current and past government climate change and energy efficiency policies and programs have promoted unsafe practices or contributed to any increase in risk of contracting legionellosis.

However, given the system and process lapses identified, both The Wesley Hospital and SNP have been advised in writing of the non-compliance with respective Acts and advised to undertake and report back on a number of actions.

The review has identified a number of areas for improvement that would make for a more robust system-wide approach to prevention and control of *Legionella* and legionellosis. These relate to:

- regulation
- water supply to health and residential aged care facilities
- water infrastructure and water quality management, including periodic testing
- electronic data management, notification and follow-up of cases of legionellosis
- national collaboration and consistency
- information for the community.

1.3 Work commenced or to be commenced in response to identified issues

The Department of Health has commenced or will commence a number of pieces of work in relation to these issues. This will contribute to a more robust system-wide approach to the management of risks associated with *L. pneumophila*.

In relation to water infrastructure and water quality management these include:

- guidelines for the water supply response if *Legionella* is detected in the water supply of, and for the management of microbial water quality in, Queensland hospital and residential aged care facility drinking water systems, including a detailed water quality risk management plan guidance document
- progression of practical education, training and skills-based development for relevant health service managers in order to better inform Hospital and Health Services (HHSs) efforts in characterising and managing healthcare infrastructure water quality

- development of additions to the Department of Health's *Capital Infrastructure Requirements* to address the infrastructure improvements that should be implemented, including the detail of how healthcare drinking water infrastructure is disinfected prior to handover from building contractors to building owners
- an investigation into the role that incoming water quality may have the risk of *Legionella* growth within hospital water systems
- final analysis of the statewide hospital water testing data, once all re-sampling results have been obtained, to inform future work.

In relation to patient management when *Legionella* is detected in a hospital facility:

- development of a guideline to assist hospitals in ensuring they are undertaking best practice management of patients in the event of positive detections in water systems or possible hospital-acquired cases.

In relation to notification, surveillance and follow-up of potential cases:

- further investigation into the notification process in collaboration with notifying laboratories to identify the reasons why some positive legionellosis test results were not recorded on the Notifiable Conditions System (NoCS)
- review of the laboratory notification criteria for legionellosis under the *Public Health Act 2005*
- request all laboratories review their systems, processes and quality assurance and training mechanisms as they relate to notification requirements
- review of processes to improve collection, analysis and reporting of both routine and enhanced surveillance data
- review of processes for monitoring data quality and completeness in the NoCS
- review of the *Legionellosis - Queensland Health Guidelines for Public Health Units* to determine if more specific guidance is warranted in relation to public health management in cases where it is possible the exposure occurred in a hospital or residential aged care facility.

In relation to *Legionella* risk in community settings:

- review and update as required Queensland Health fact sheets, web content and guidelines for businesses and the public, including advice regarding hot water systems and spas.

1.4 Recommendations

It is recommended that:

1. In the short-term, public and private hospitals and all public residential aged care facilities be required, and private residential aged care facilities be requested, to develop water quality risk management plans which include periodic testing of their water supplies for *Legionella* and heterotrophic plate count (HPC)¹ based on risk.

¹ HPC is a test used to estimate the total number of all types of bacteria in an environmental sample, usually water. The lower the HPC the better the biological water quality. HPC is an indicator of how favourable the water environment in plumbing pipework, fixtures or storages is for the growth of microorganisms, such as bacteria, yeasts and moulds. It can also be used to help verify the effectiveness of disinfection processes, such as chlorination.

2. In the medium-term, legislation be strengthened relating to the design, commissioning, installation, operation and maintenance of cooling water systems and water delivery systems in hospitals, and residential aged care facilities, through inclusion of requirements under the *Public Health Act 2005*.
3. A memorandum of understanding be developed by relevant regulatory agencies—Department of Housing and Public Works, Department of Justice and Attorney General, Department of Energy and Water Supply and Department of Health—to clearly articulate the roles of each agency and coordination arrangements with respect to *Legionella* risks in hospitals and residential aged care facilities.
4. National collaboration be sought with regard to the following:
 - finalising as a priority the Australian Technical Standard for warm water systems and subsequently the updating of the Australian Standard (AS) 3500.4 to include standards for warm water systems
 - strengthening AS 3666.2 in relation to the operation and maintenance of heated water systems
 - specific requirements for the design, installation, replacement and commissioning of drinking water systems in hospital and residential aged care facilities
 - guidelines for the operation and maintenance of drinking water systems for hospital and residential aged care facilities
 - reviewing the *Legionellosis – National Guideline for Public Health Units*
 - reviewing accreditation processes for both hospital and residential aged care facilities to determine if aspects relating to the physical environment should be strengthened.
5. An immediate upgrade of the Notifiable Conditions System (NoCS) be progressed to provide enhanced prevention and control capabilities including:
 - a reliable and efficient system for the electronic notification of notifiable conditions
 - electronic clinical information management capacity in public health units, that supports public health action in responding to notifiable diseases and outbreaks and enhances statewide reporting of outcomes, quality and activity
 - enhanced disease surveillance, outbreak detection, enhanced surveillance and early warning of disease risks, including emerging infections and pandemics.
6. A review of information for the community be undertaken in collaboration with other agencies to ensure opportunities are maximised to increase awareness of the generally low, but potential risks of *Legionella* and how to minimise them.

2.0 Introduction

2.1 Background to the review

The review by the Chief Health Officer of the prevention and control of *Legionella pneumophila* (referred to as *L. pneumophila*) infection in Queensland was initiated at the request of the Honourable Lawrence Springborg MP, Minister for Health, on 6 June 2013. The purpose of the review was to:

- investigate the circumstances surrounding the notification of and response to Legionnaires' disease in two patients and the subsequent death of one of these patients, at The Wesley Hospital in Queensland in late May and early June 2013
- make recommendations regarding the future management of *L. pneumophila* in Queensland.

The terms of reference for the review, together with the key pieces of work undertaken to address them, are to:

- consider the circumstances surrounding the notification and management of cases of *L. pneumophila* infection at The Wesley Hospital
 - an investigation into the hospital's compliance with the *Private Health Facilities Act 1999* and associated regulations and standards, the *Coroners Act 2003*, and the National Safety and Quality Health Service Standards in relation to the circumstances of the legionellosis outbreak, and any broader implications relevant to the *Private Health Facilities Act 1999*
 - environmental investigations associated with the outbreak, including in relation to the water delivery systems and cooling water systems (which include cooling towers)
- consider the process undertaken by SNP for notification of *L. pneumophila* and any broader implications this may have for the management of these notifications by pathology laboratories and others under the *Public Health Act 2005*
 - an investigation into the reason for the failure to notify a positive *L. pneumophila* test result
- consider the risks of acquiring *L. pneumophila* infection in a Queensland hospital, and identify whether regulatory controls relating to water quality in hospitals, hospital refurbishment and rebuilding programs, and the associated testing and notification protocols for *L. pneumophila* in hospitals are adequate and appropriate
 - statewide testing of water samples project at public hospitals and licensed private facilities
 - review of the literature and preparation of a summary of data on legionellosis from the NoCS, including a review of available hospital separation and death registry data, and review of public and private laboratory *Legionella* positive test results for the past five years to determine if there have been any other notifiable results not recorded on the NoCS
 - a review of regulatory and other controls relevant to hospital settings
 - establishment of a technical advisory panel to evaluate how *Legionella* may become established at pathogenic levels in Queensland hospital and healthcare facility

drinking water infrastructure, and to identify best practices in responding to *Legionella* and other related waterborne microbial contamination

- commission an independent case review of the 2011 case of Legionnaires' disease at The Wesley Hospital and assess the implications for management of notifications of single cases of *L. pneumophila*, particularly in healthcare settings
- identify, in conjunction with other government agencies, the risk factors and appropriate control measures relating to exposure to *L. pneumophila* in the community setting, including homes, cooling towers, nursing homes and spas, including analysis of the impact the Climate Smart Program for Queensland homes has had on rates of *Legionella* with a focus on the reduced temperature of hot water systems as result of the program
 - review of current regulatory controls, including those administered by other agencies, specifically plumbing and drainage, and work health and safety
 - review of the literature and relevant government programs and policies.

This report provides a summary of the key findings and an analysis of the issues identified as a result of the review. The report also provides a summary of work the Department of Health has commenced or will commence, and recommendations for consideration by the Minister for Health, to respond to the issues identified.

3.0 *Legionella* and legionellosis

3.1 *Legionella* in the environment

Legionella, the bacteria that can cause legionellosis in people, are widely distributed in the environment and have been isolated from water sources, such as lakes, rivers, streams, groundwater, thermal lagoons and habitats, such as soils and mud. In natural water environments, they are usually present in low numbers and the conditions are rarely suitable to be of concern to human health. There are many different species and only some of these species are known to cause illness in people under the right conditions. The most common species to cause illness in Australia are *L. pneumophila* and *L. longbeachae*. *L. longbeachae* is found in soils and potting mix and is not discussed further in this report.

Legionella obtains nutrients from other microorganisms, such as algae, protozoa and other bacteria, and by using other organisms and inorganic substances.

Legionella multiply at temperatures ranging from 20 to 45 degrees Celsius, with maximum growth occurring between 32 and 43 degrees Celsius [1]. Other factors that are known to stimulate growth include:

- stagnation of water (i.e. being allowed to stand for periods of time)
- presence of biofilms (slimy material produced and colonised by bacteria, protozoa, algae and fungi which can adhere to surfaces, such as the inside of water pipework)
- nutrients and sediment, and other material in water
- inadequate concentration of disinfectants in manufactured water systems [1].

Legionella from natural sources can enter and, if the conditions are favourable, colonise manufactured water systems, such as:

- air handling systems incorporating cooling towers or evaporative condensers (collectively known as cooling water systems)
- water supplies
- cold, warm and hot water pipework
- spa pools, spa baths and hydrotherapy pools
- air-houses
- humidifiers and nebulisers
- decorative fountains.

These systems are commonly found in commercial, industrial, education, child care, aged care and healthcare facilities [2, 3].

If contaminated water is converted into an aerosol (small droplets of water in the air that contain the bacteria), and inhaled by humans, the bacteria can cause illness in susceptible individuals [1]. Environmental changes, such as a change in water pressure, in water delivery systems can also disrupt biofilm or dislodge portions of it and lead to a sudden and massive release of *Legionella* into the water system [1].

Large complex water delivery systems, such as those in healthcare settings, and warm water systems where the majority of water is circulating under 50 degrees Celsius, are at increased risk of problems with *Legionella* growth. The latter have become more popular in recent years and are common in residential aged care facilities as they require less extensive use of thermostatic mixing valves (TMVs). These valves mix hot and cold water, and supply the warm water at a predetermined temperature close to the outlet. These valves are important in the prevention of scalds, but they also require annual inspection and regular maintenance.

Domestic hot water supply pipework can be a source of *Legionella*, usually at low levels, to which most people will be exposed in their everyday life without incident. They are smaller, simpler systems, in which water is heated and stored at 60 degrees Celsius or higher (as required by law) and then distributed at 50 degrees Celsius or higher (via use of a valve), and where taps and showers are generally used regularly. Thus the risk from these systems is considered to be low. Domestic dwellings supplied with raw water (untreated, rain water or ground water supply) are more likely to be contaminated with *Legionella* than a treated drinking water supply that has been treated with chlorine or chloramines [4].

Whilst *Legionella* bacteria have strict requirements for growth, they can survive for long periods at low temperatures. *Legionella* can survive freezing, and can proliferate when the temperature increases if other conditions allow [5]. They are killed with increasing speed at temperature exceeding 45 degrees Celsius. Survival time decreases from hours at 50 degrees Celsius to minutes at 60 degrees Celsius while at 70 degrees Celsius the organism is killed almost immediately. Biofilm, sludge and scale, and amoebae² (within which *Legionella* can grow) can also protect *Legionella* from high temperatures, concentrations of biocides and other mechanisms of disinfecting water supplies that would otherwise kill or inhibit these organisms if they were freely suspended in the water [6, 7].

² An amoeba is a type of protozoa that can be found in rivers and ponds. They reproduce through cell division. They can change their shape constantly and are single-celled.

3.2 Reducing the risks of *Legionella* growth

3.2.1 Water systems generally

The most effective way of minimising the presence and growth of *Legionella*, and the generation and spread of contaminated aerosols in manufactured water systems is to keep systems clean. This generally involves minimising the formation of biofilms and deposition of scale and solids by effective water treatment, including the use of appropriate biocide programs and disinfection procedures. The development of biofilms and the effectiveness of disinfection are influenced by corrosion and the deposits of scale and solids. Degraded plumbing, such as decomposing gaskets and sealing washers, and corroded pipes provide sites for the development of biofilms. Some plumbing materials are known to contain nutrients that enhance the growth of biofilms. It is therefore important that fittings and components are corrosion-resistant and constructed with approved materials [2, 8].

The stagnation of water, including that which occurs when there are significant dead legs³ in pipework, should also be avoided. Maintaining the temperature of hot and cold water system within buildings, including through adequate insulation of pipework, is also an important control measure. Outlets that are used infrequently also create the same conditions as dead legs and should be flushed periodically when not in use [2, 6, 9].

Minimising the generation and spread of aerosols and compliance with relevant Australian and New Zealand Standards (AS/NZS), regulations and guidelines, which are discussed further below, are important in the management and effective control of *Legionella*.

3.2.2 Other specific manufactured water systems

Spa pools and hydrotherapy pools can produce aerosols and provide conditions suitable for *Legionella* growth. In 1994, Queensland reported one death related to *Legionella* infection associated with a private spa located in an apartment building [10]. Spa baths should comply with AS 3861. They should be designed and installed to ensure that all pipework and pumps are self draining to prevent stagnation of water. Spa and hydrotherapy pool operators are expected to be knowledgeable and competent in the operation and maintenance of public pool and spas in accordance with best practice.

Air-houses are industrial humidifiers used in paint, electroplating and finishing shops. Humidifiers can be found as part of an air handling plant, some manufacturing processes, fruit or vegetable storage and in homes. Nebulisers are commonly found in healthcare facilities and in homes. All of these systems include water reservoirs that produce aerosols and have the potential to transmit *Legionella*. It is important that these systems are properly managed and maintained in a clean state. Only sterile water should be used to fill a nebuliser reservoir or basin [2].

Aerosols may also be generated by water in a fountain. The recirculating water in such systems may be inadvertently heated (for example by submerged lighting) producing conditions that may favour the growth of *Legionella*. Design of fountains should take these factors into consideration.

Systems, such as ice machines and chilled water dispensers can also produce conditions that enable *Legionella* to survive and grow. As they don't produce aerosols, these devices are only considered to be a high risk to severely immunocompromised people through pulmonary aspiration (i.e. breathing in of liquid into the airways). Where extraordinary procedures, such as

³ A dead leg is a redundant length of pipe in a plumbing framework left in place or capped where is little or no flow.

air filtration and restricted food diets are used to protect high risk patients from infection, these procedures should extend to drinking water and ice machines. Ice machines should be inspected monthly and cleaned as necessary as per the manufacturer's instructions, and in any event at least once annually [2].

While the presence of *Legionella* in domestic water systems does not generally pose an unacceptable risk to occupants [11], domestic hot water systems have been implicated in sporadic cases of legionellosis (i.e. single cases not linked to an outbreak). While site inspections by public health staff are not routinely undertaken for sporadic cases, causes have included the water temperature of the hot water storage tank not being maintained at the required minimum of 60 degrees Celsius and where there have been flaws in the design of hot water systems or inadequate maintenance of devices, such as tempering valves.

3.3 *Legionella* and illness

3.3.1 What is legionellosis and Legionnaires' disease

Legionellosis is the collective name for acute bacterial infections caused by *Legionella* bacteria. There are two distinct types:

1. Legionnaires' disease, the more serious disease where pneumonia is present in all cases. It is the type of legionellosis which is the focus of this report.
2. Pontiac fever, a less severe flu-like illness that is not discussed further in this report.

Legionnaires' disease was first recognised in 1976, following an outbreak of pneumonia among delegates at the American Legion Convention in Philadelphia. The outbreak resulted in the deaths of 29 people and 182 were affected, with the previously unknown bacteria [12]. The bacteria was later named *Legionella pneumophila*, and resulted in the discovery of a range of species of *Legionella*, only some of which are known to cause disease [13].

The majority of cases of disease are due to *L. pneumophila* from contaminated water, the focus of this report, and *L. longbeachae* from contaminated soils and potting mix [14].

3.3.2 How it spreads

Legionellosis does not spread from person-to-person. *L. pneumophila* usually needs to be inhaled in an aerosol (small droplets of moisture that contain the bacteria) for Legionnaires' disease to occur. When aerosols are produced (such as, when water is being sprayed through cooling towers, through outlets such as shower heads and taps, high pressure car washes or through pumping and bubbling as in the case of spas) most or all of the water evaporated quickly leaving airborne particulate matter that is small enough to be inhaled [15, 16]. Aspiration of water contaminated with *Legionella* (i.e. water 'going down the wrong way') has also been described as a route of transmission, but is much less common and predominantly occurs in persons with swallowing disorders or in conjunction with nasogastric feeding [17].

3.3.3 Risk of acquiring legionellosis

The likelihood that a person who is exposed to *Legionella* develops illness is generally low. Most people who are exposed to aerosols containing *Legionella* do not become ill. This is because *Legionella* is an opportunistic pathogen. This means exposure to the bacteria does not cause disease in most healthy people as the body's immune system is able to successfully prevent infection. When the body's immune system is compromised, *Legionella* can reproduce, particularly within the lungs.

People at highest risk of acquiring legionellosis in the community or healthcare facilities are:

- severely immunocompromised patients—for example, haematopoietic stem cell transplant (HSCT) and organ transplant patients
- some patients receiving high doses of immunosuppressive medication.

Other people at greater risk of acquiring legionellosis than most people are:

- people with chronic underlying disease, such as chronic obstructive pulmonary disease, diabetes mellitus, congestive heart failure, chronic liver failure, chronic renal failure, HIV/AIDS and some forms of cancer
- smokers, people with excessive alcohol intake, and people over the age of 50 years

Additional risk factors for healthcare acquired infections include recent surgery, intubation (insertion of a tube into the trachea to assist breathing) and mechanical ventilation, aspiration (the inhalation of foreign matter into the trachea and lungs), and use of respiratory therapy equipment.

3.3.4 Incubation period, symptoms, infection rates and severity

The incubation period—the period from exposure to *Legionella* and onset of illness—is 2 to 10 days, most commonly 5 to 6 days.

Symptoms can vary, however loss of appetite, malaise (feeling unwell), myalgia (muscle pain), headache with a rapidly rising fever and associated chills, along with a non-productive cough, abdominal pain and diarrhoea are common. Legionellosis can usually be treated effectively with appropriate antibiotics if treatment is commenced early in the disease process, especially in those who are immunocompromised [18, 19].

Healthcare acquired infection rates and case fatality (death) rates⁴ vary between countries. Healthcare acquired (also known as nosocomial) infections usually make up a small proportion of reported cases of legionellosis. Two reports of a healthcare acquired outbreak in Australia were found in the published literature during this review:

- at a psychiatric hospital in Ballarat between 1979 and 1980 where five cases occurred over a long period of time and *L. pneumophila* was isolated from the shower water [20]
- at a haematology clinic in October 1999 (probably in Melbourne) where two cases occurred, along with one suspected case, although a microbiological source was not identified for the cluster, despite intensive testing of water from cooling towers, showers, drinking water and ice [21].

Internationally, the case fatality rate for Legionnaires' disease is thought to be approximately 15 per cent [18], although recent surveillance across Europe indicates case fatality rates of approximately eight to nine per cent [22, 23]. Early diagnosis also reduces case fatality, as seen in Spain in 2001 where 449 cases were confirmed with a case-fatality of one per cent [24]. The proportion of cases that are fatal tends to be much higher with healthcare acquired infections than with community acquired infections [25–28].

3.3.5 Outbreaks

Most cases of legionellosis are sporadic—single cases with no links to other cases in time or place, or to a common cause.

⁴ The percentage of people with the disease that die as a result of it.

As legionellosis is not spread from person-to-person, outbreaks (defined as two or more cases linked in time and place or to a common source) are the result of susceptible people having a common or shared exposure to an environmental source.

It has been estimated that only a small proportion (estimated at less than between one and five per cent) of those exposed in an outbreak develop the disease [1, 29]. Large community outbreaks are mostly associated with cooling towers. The process of cooling air involves extensive mixing of air with water droplets and sprays, creating aerosols that have the potential to travel long distances.

Outbreaks have also been identified in a range of other settings, including hospitals, hotels, nursing homes, retirement villages and commercial car washes. Systems involved include cooling towers, water delivery systems, respiratory equipment, spa pools and decorative fountains [18, 30–38].

Poorly maintained systems [24], lack of control measures [36] and failure of system equipment [39] have been shown to be significant contributing factors in outbreaks.

3.3.6 Gaps in knowledge in Australia

Much of the evidence linking *Legionella* found in water delivery systems to outbreaks of legionellosis is from overseas. For example, apart from an outbreak in Ballarat in 1979 in which five non-fatal cases associated with hospital shower water were reported [20], there appears to be little evidence in Australia of healthcare acquired outbreaks of legionellosis relating to water delivery systems [25, 40]. While anecdotal evidence of cases or outbreaks being linked to water delivery systems in hospitals and aged care facilities has been cited, a link can generally only be established if:

- the *Legionella* detected in clinical samples from patients and environmental samples from the water system are genetically indistinguishable
- no other possible sources of exposure were possible—given the widespread presence of *Legionella* bacteria in water systems, other possible sources may be difficult to rule out completely.

It is important to note that investigation may occur as late as two to three weeks after exposure. This allows for incubation, onset of illness, diagnosis and notification to authorities. In this period the system may have been treated prior to investigation, by routine maintenance or disinfection, or the ecology of *Legionella* in the system may have altered as part of a natural process. As a result, it is not surprising that the source is often not identified. It is also possible that disease outbreak investigations may not have considered warm water systems in the past when attempting to identify a source, as the focus in the past has typically been on cooling tower systems.

In Australia it has proven difficult to draw links between the environmental source of infection, hospitalisations and/or infections requiring intensive care admission. For example, a national review of legionellosis surveillance in Australia between 1991 and 2000 was unable to report data related to infection source (hospital or community) and differences between outbreak/non-outbreak related notifications [41].

Under-diagnosis and under-reporting are thought to lead to an under-estimation of incidence of legionellosis in many countries, but the extent to which this occurs in Australia is unknown. The reasons for under-diagnosis and under-reporting include the fact that clinical symptoms are common to other causes of pneumonia, that antibiotics are often used prior to pathology testing

which interferes with the isolation of *Legionella species*, and the lack of sensitivity and specificity of other diagnostic methods, particularly serology [4].

3.4 Diagnosis and notification criteria

A notifiable condition is a medical condition prescribed under regulation to be notifiable to a state or territory health department. Under the Queensland *Public Health Act 2005*, notifiable conditions are required to be reported by pathology laboratories and/or clinicians to Queensland Health for the purpose of preventing, controlling and reducing risks to the health of the public.

Legionellosis became notifiable in Queensland over 25 years ago, and *L. pneumophila* became notifiable as a discrete species in 1994. Pathology laboratories are required to immediately notify Queensland Health of laboratory results which provide definitive or suggestive evidence of legionellosis (*Public Health Regulations 2005* Schedule 2). In Australia, the definitive laboratory criteria for notification are:

- isolation of *Legionella* species
or
- seroconversion or significant increase in serum antibody level
or
- detection of *Legionella* antigen in urine.

Laboratory suggestive criteria are:

- single high antibody level to *L. pneumophila*
or
- detection of *Legionella* antigen in specimens by Direct Fluorescent Antigen (DFA)
or
- detection of *Legionella* specific target by Polymerase Chain Reaction (PCR).

For a person to be a valid or probable case of legionellosis, clinical evidence together with positive laboratory results is required. A valid or confirmed case requires laboratory definitive evidence and clinical evidence of fever or cough or pneumonia. A probable case requires laboratory suggestive evidence and clinical evidence of fever and cough, or pneumonia [42].

3.5 Legionellosis in Queensland

There were 886 valid and probable cases of legionellosis (relating to all *Legionella* species) notified in Queensland with an onset date from 1 January 1988 to 30 June 2013 (Figure 1).

Of these 886 cases, 352 were *L. pneumophila*, with illness onset dates between 1 January 1994 and 30 June 2013⁵. This represents 46 per cent of all notifications of legionellosis in Queensland during that period. Adults aged 50 years and over account for 66 per cent, with a greater proportion of notifications in males (61.9 per cent) compared to females.

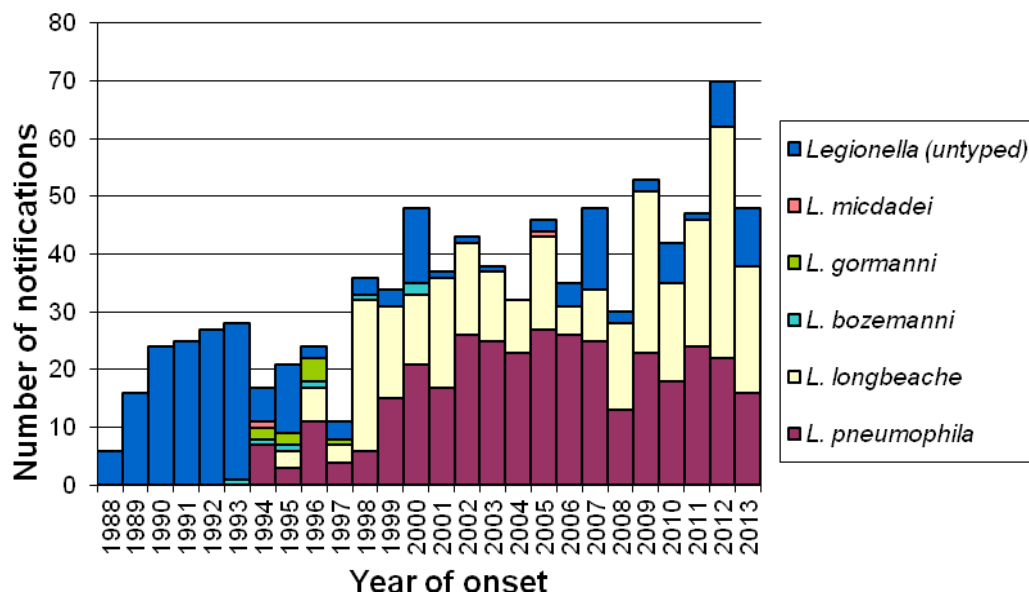
Of the remaining 534 cases, 39 per cent were *L. longbeachae* (the species commonly found in soil and potting mix), two per cent were other *Legionella* species (e.g. *gumanni* and *micdadei*) and 13 per cent were *Legionella* notifications of unspecified species.

⁵ *Legionella* became notifiable as a discrete species in 1994.

In Australia, the average notification rate for legionellosis over the past 10 years (2003–2012) was 1.54 cases per 100,000 population per year [43]. Queensland has fewer cases of legionellosis, with the average notification rate for Queensland for this period being 1.03 cases per 100,000 population per year.

Notification rates in Australia are consistent with international rates reported across the European Union (1.2 cases per 100,000 population) [23] and the United States (1.15 cases per 100,000 population) [44]. However the contributing species vary with *L. pneumophila* being the cause of a smaller percentage of legionellosis cases in Australia.

Figure 1: *Legionella* (by species) notifications in Queensland, 1 January 1988 to 30 June 2013



Four outbreaks—of two or three cases of legionellosis each—have been recorded on NoCS in Queensland since 2002, including the one linked to The Wesley Hospital in June 2013. The other three outbreaks were in the community. No outbreaks of hospital-acquired legionellosis had previously been identified in Queensland.

The previous three outbreaks are summarised as follows:

- 2002—two cases (one confirmed, one probable) of legionellosis due to *L. pneumophila* were diagnosed in a husband and wife couple managing a residential complex in South East Queensland. One case was admitted to hospital for treatment and the other was treated in the community—both recovered. Environmental health investigations revealed no detection of the organism within cooling tower, domestic shower roses, spa baths, heated swimming pool or hot water system within the residential complex. Investigation of potential sources at a recreational club attended by the couple once per week revealed significant presence of *L. pneumophila*. No further cases associated with this club were identified. A 44 year old male visitor from Tasmania who stayed at the residential complex in November 2003 subsequently developed *L. pneumonia*. This case is likely unrelated to the couple above. Remedial action was taken on the club utilities identified with *Legionella*.
- 2006—three confirmed cases of legionellosis due to *L. pneumophila* were identified in workers and contractors from a mine in Central Queensland. All three were admitted to hospital with pneumonia and responded well to treatment. A search for further cases in

workers associated with the mine was undertaken, but none were found. This process included assessing and testing 27 workers with current or recent acute respiratory infections. An environmental investigation of the mine identified a cooling tower as the likely source of the *L. pneumophila*. Although not conclusive, this assessment was supported by samples of water from the cooling tower testing positive for *L. pneumophila*. Water samples from the showers were negative. The mine undertook remediation measures, including safe recommissioning of the cooling tower and ongoing maintenance as required by the then Department of Mines and Energy, which was the regulator for health and safety on mine sites.

- 2012—two confirmed cases of legionellosis due to *L. pneumophila* were identified in residents of a retirement village in South East Queensland. One case was admitted to hospital for treatment and recovered. The other was treated in the community and recovered. A search for further cases at the facility was undertaken, but none were found. An environmental investigation of the facility was undertaken with water samples collected from the spa, pool and resident showers. The facility reported maintenance measures had been undertaken on the spa prior to water sampling. The water samples were negative for *L. pneumophila*. The cooling towers near the facility were reported by Workplace Health and Safety Queensland (WHSQ) to be satisfactory. Issues regarding maintenance of pool, spa and hot water boiler system were identified. Advice and recommendations were provided to resort management regarding suggested standards of maintenance for heated water facilities and records management. No source of the infections was identified.

4.0 Legionellosis outbreak at The Wesley Hospital

4.1 Background

On the afternoon of 5 June 2013, The Wesley Hospital, a private hospital owned and operated by the Uniting Church of Australia, advised the Chief Health Officer, Queensland Department of Health, of the death on 2 June 2013 of a 66 year old male patient from Legionnaires' disease. A positive *Legionella* urinary antigen test result had been advised by SNP to The Wesley Hospital on 27 May 2013.

Results of testing on cooling towers indicated no issues. As the patient had reportedly not left his room during the exposure period, further environmental testing was undertaken and the results, received by The Wesley Hospital on 5 June 2013, found *L. pneumophila* in water samples taken from the showerheads and hand basin taps of the room where the patient was staying⁶.

Following the advice by The Wesley Hospital to the Chief Health Officer of the first case it was identified that the required notification by SNP to Queensland Health had not occurred. Laboratories are required to notify the positive result to Queensland Health immediately on receipt, a requirement under the *Public Health Act 2005*. SNP notified Queensland Health on 5 June 2013. The notification occurred after Queensland Health officers contacted the laboratory following the hospital's advice to the Chief Health Officer.

⁶ First catch water (water on immediately turning on the tap) from the shower was 200 cfu/ml, then 40 cfu/ml after allowing the shower water to run. First catch from hand basin was 600 cfu/ml, then 100 cfu/ml. A level of <10 CFU/mL is considered satisfactory.

On the evening of 5 June 2013, The Wesley Hospital provided further advice to the Chief Health Officer that a 46 year old female patient had also been diagnosed with Legionnaires' disease, confirmed with a positive *Legionella* urinary antigen test, and had subsequently been transferred to the intensive care unit for treatment. She has since recovered from the infection following treatment. SNP notified Queensland Health of this additional case on 6 June 2013.

The Wesley Hospital ceased admitting further patients, and closed their Emergency Department until the source of *L. pneumophila* had been identified and controlled. The Chief Health Officer recommended that patients who may be exhibiting Legionnaires' disease type symptoms be identified and provided with antibiotics.

On 12 June 2013, Queensland Health was informed of a possible third case. An 81 year old male who had been hospitalised since March, returned a positive urine test for *L. pneumophila*. However, no positive results were returned on multiple serology and culture tests throughout admission. Additionally, the patient did not have a clinically compatible illness at the time of urinary antigen testing and therefore was determined not to be a case of legionellosis in accordance with the case definition.

On 12 June 2013, a review by SNP of previous positive test results identified an earlier case of legionellosis and a patient death at The Wesley Hospital in October 2011. The notification was received by the Metro North Public Health Unit at the time and public health staff undertook a follow-up which included the regulator responsible for regulating workplaces, WHSQ. At that time this case could not be classified as a definite healthcare acquired case, as it was reported that the patient had spent considerable periods of time outside the hospital, in the exposure period prior to diagnosis. Since that time up until the recent cases, there had been no other cases of legionellosis identified where a person's exposure period has been spent in The Wesley Hospital.

4.2 Investigations following notification

A number of investigations were initiated following the advice by The Wesley Hospital of the first case of Legionnaires' disease and on finding that the notification by SNP to Queensland Health had not occurred. These related to:

- compliance with relevant legislation and standards by The Wesley Hospital and SNP
- understanding the environmental situation to seek to identify the source of the *Legionella* and to ensure appropriate remedial action was being undertaken to prevent any continued risk
- the response to the case of Legionnaires' disease in a patient at The Wesley Hospital in 2011.

4.2.1 Clinical governance and compliance with relevant Acts and standards

This investigation focused on clinical governance and The Wesley Hospital's compliance with the following legislation, regulation, and national and state standards:

- *Private Health Facilities Act 1999*
- Private Health Facilities Regulation 2000
- *Private Health Facilities Act 1999 Standards* (the Act's standards)
- *Coroners Act 2003*
- National Safety and Quality Health Service Standards.

The investigation also considered whether:

- the circumstances surrounding the outbreak posed a further risk to patients, visitors, hospital staff and the greater community
- there were sufficient systems in place at the hospital to protect patients, visitors, hospital staff and the greater community from any outbreak of a notifiable condition.

Private Health Facilities Act 1999, regulations, standards and the National Safety and Quality Health Service Standards

Section 12 of the *Private Health Facilities Act 1999* empowers the Chief Health Officer to set standards for the protection of the health and wellbeing of patients receiving health services at private health facilities. There are 10 overarching standards which cover continuous quality improvement, credentials and clinical privileges, ethics, infection control, information management, management and staffing, minimum patient throughput, patient care, physical environment and specialty health services.

The introduction of the Australian Commission on Safety and Quality in Health Care (ACSQHC) in 2011 resulted in the development of 10 National Safety and Quality Health Service Standards (NSQHSS), which work in concert with the existing Queensland standards.

The 10 standards are:

1. Governance for safety and quality.
2. Partnering with consumers.
3. Preventing and controlling healthcare associated infections.
4. Medication safety.
5. Patient identification and procedure matching.
6. Clinical handover.
7. Blood and blood products.
8. Preventing and managing pressure injuries.
9. Recognising and responding to clinical deterioration in acute healthcare.
10. Preventing falls and harm from falls.

With regard to compliance with the *Private Health Facilities Act 1999 Standards* and the prescribed clinical governance standards set down in the NSQHSS, the investigation found that The Wesley Hospital had not achieved full compliance with regard to a number of the standards—specifically, continuous quality improvement, infection control, information management, management and staffing, patient care, and the physical environment.

Coroners Act 2003

Section 8(3) of the *Coroners Act 2003* requires all health facilities to submit details of any death which occurred in the facility that was not reasonably expected. The death of the patient with Legionnaires' disease would be regarded as an unexpected death. The investigation found that The Wesley Hospital had not reported the death to the Coroner, even though it was within the scope of its own policies regarding reportable deaths.

Sentinel event reporting to the Chief Health Officer

The main object of the *Private Health Facilities Act 1999 Section 3(1)* is to provide a framework for protecting the health and wellbeing of patients receiving health services at private health facilities. As per the intention of this object, licensees of private health facilities must submit details of any death which occurred in the facility that was not reasonably expected to be the outcome. Each facility is required to report incidences of serious harm to a person that occurs in the facility. These reports must be forwarded by email or facsimile within two working days (Monday to Friday) of a sentinel event. A review or a root cause analysis must be undertaken for each sentinel event.

It should be noted that the medical practitioner who signed the death certificate for the patient with Legionnaires' disease did not deem the death to be reportable to the Coroner until 5 June 2013, thus the requirement for provision of a sentinel event report was not triggered on 2 June 2013 when the patient died. Therefore, a sentinel event form was not required until the 7 June 2013 when it was subsequently provided.

Due to this delay, The Wesley Hospital did not comply with the Chief Health Officer's requirements, as this was a death that was healthcare related (the patient spent the entire exposure period for Legionnaires' disease in hospital) and should have been reported within two working days of the death. Further, the hospital did not comply with its own internal policy on the requirement to report sentinel events to the department, a policy applicable to all accredited medical practitioners, clinical nurse managers, registered nurses, directors of medical services, directors of nursing, nursing directors and after hours hospital nurse managers.

Discussion and action taken

The investigation identified a range of areas for improvement in internal processes and highlighted the need for further working towards compliance with selected national and Queensland standards. It is however, important to consider this in context. Healthcare institutions are complex organisations with people working in challenging situations. Quality improvement initiatives based around quality and safety standards are an ongoing issue and focus for all healthcare facilities. The individual standards have been identified and prioritised because they are areas that impact on a large number of patients, there is a known gap between the current situation and best practice outcomes across the health system, and improvement strategies exist that are achievable. They have been designed to drive the implementation and use of safety and quality systems and improve both quality and practice.

As a result of the investigation, it was determined that:

- with regard to compliance by The Wesley Hospital with the *Private Health Facilities Act 1999*, and in light of the absence of a requirement currently to test for *Legionella* in hospital water systems, although some administrative breaches of legislation were detected, none would warrant punitive action under the *Private Health Facilities Act 1999* based on information received at the time of the investigation
- there was no evidence indicating negligence or intent on the part of the hospital resulting in harm to visitors, patients, hospital staff and/or the greater community that would warrant punitive action based on information received at the time of the investigation
- the issues identified during the investigation were system and process type lapses affecting the administrative aspects of the hospital's management of, and response to, the outbreak of Legionnaires' disease—these mostly related to the fact that timely reporting of

an unexpected death of an inpatient to the Chief Health Officer and to the Coroner did not occur.

On receipt of the positive test results for the cases, The Wesley Hospital responded swiftly and comprehensively. This included, but was not limited to:

- engaging independent experts to provide advice on the response
- working cooperatively with relevant government agencies
- taking prompt action with regard to assessing cooling towers and water delivery systems, undertaking extensive water sampling, and implementing recommended actions
- implementing patient management activities to confirm there had not been and would not be further risk
- communication with patients, families, staff and the broader community.

The Department of Health's regulatory response to non-compliance with the Acts that it administers is guided by general principles of enforcement whereby the significance of the breach and the likelihood of voluntary compliance are considered. Options for an appropriate regulatory response may range from verbal or written warning to prosecution, depending on the individual circumstances.

Based on the routine audits and other regulatory activities undertaken by the Department of Health, it is considered that The Wesley Hospital has always maintained a high-level of compliance with the Act and that the hospital has engaged in a reasonable, appropriate, communicative and collaborative manner with the Department of Health. However, given the process lapses identified and outlined above, the hospital has been advised in writing of the non-compliance and advised to:

- undertake, as a matter of priority, a comprehensive review of all internal policies, procedures and guidelines, governance and operational documents to ascertain the currency, adequacy and validity of these documents in the context of compliance with both the *Private Health Facilities Act 1999 Standards* and the prescribed clinical governance standards set down in the NSQHSS
- review the adequacy and currency of the implementation, induction and in-house training and education provided to staff at the hospital with regard to operational policies and procedures, including those specifically relating to obligations relating to deaths reportable to the Coroner and sentinel events reportable to the Chief Health Officer
- complete the required process to achieve compliance with the mandatory NSQHSS for quality assurance certification in accordance with Section 48(1)(b)(c)(d) of the *Private Health Facilities Act 1999* as mandated by the Chief Health Officer as of 1 January 2013
- provide written advice and, where applicable, copies of any resulting documentation to the Chief Health Officer detailing the actions undertaken, the result of those actions and any outcomes, such as new or revised policies, procedures and guidelines.

The last issue investigated was with regard to the circumstances surrounding the outbreak, and whether:

- they posed a further risk to patients, visitors, hospital staff and the greater community
- there are sufficient systems in place at the hospital to protect patients, visitors, hospital staff and the greater community from any outbreak of a notifiable condition.

The investigation found that both patients who were diagnosed with Legionnaires' disease were significantly immunocompromised and at high risk for any infection, including *L. pneumophila*.

The Chief Health Officer is satisfied that the corrective and preventive actions undertaken by The Wesley Hospital immediately following and since the incident have formed a prompt and comprehensive response, and that sufficient systems are being explored, identified and implemented for the purpose of protecting patients, visitors, hospital staff and the greater community, as far as is practical, from future outbreaks of legionellosis.

The hospital continues to work cooperatively and collaboratively with the Department of Health, independent experts and specialists regarding activities, including but not limited to water management and testing, infrastructure assessment and enhancement and staff education.

4.2.2 Compliance by Sullivan Nicolaides Pathology with the *Public Health Act 2005*

Background

This investigation sought to assess compliance by SNP with the requirements to notify a positive *Legionella* result to Queensland Health under the *Public Health Act 2005* and to understand the circumstances that led to the failure that was identified.

Queensland Health has a notifiable conditions register (NoCS) as required under the Act. The Public Health Regulation 2005 prescribes which medical conditions are notifiable conditions and, of these, who is responsible for notifying which conditions to Queensland Health. The Act requires the director of a pathology laboratory to immediately notify the Chief Executive of the Queensland Department of Health or delegate following examination of a specimen from a person when the result indicates that the person has been, or is, suffering from a pathologically diagnosed notifiable condition. Legionellosis is one such condition. Hospitals and doctors are only required to notify provisionally and clinically diagnosed notifiable conditions. Legionellosis is not one of these conditions, and thus The Wesley Hospital was not required to notify it to Queensland Health⁷.

Pathology laboratories can make notifications to NoCS via a secure electronic file transfer and/or by fax or email to the relevant public health unit.

The Department of Health supports the notification requirements for notifiable conditions via a webpage. This webpage, among other things, provides a complete list of notifiable conditions and guidelines including the:

- *Queensland Notification Criteria Guidelines for Pathology Laboratories*. These guidelines detail pathology laboratory notification criteria, including those for legionellosis. It includes a positive *Legionella* urinary antigen test as a criterion for notification for legionellosis. *Legionella* urinary antigen tests were performed on specimens from both patients at The Wesley Hospital.
- *List of Pathological, Clinical and Provisional Diagnosis Notifiable Conditions* – Public Health Regulation 2005. This list indicates which notifiable conditions require immediate notification to the local public health unit after the pathological examination of a specimen. Legionellosis is one of these conditions.

⁷ Notifiable conditions are classified into various types – directors of pathology services are required to notify those defined as 'pathological diagnosis notifiable conditions', while hospitals and doctors are required to notify those that are diagnosed clinically (person has symptoms in line with those specified in the case definition for the condition, including those where laboratory results to confirm or otherwise are pending).

Findings

The investigation found that SNP received positive results for *L. pneumophila* infection on Monday 27 May 2013 (10.14 pm) and Wednesday 5 June 2013 (8.14 pm) respectively, after examining specimens obtained from the two patients from The Wesley Hospital.

Notification to Queensland Health occurred:

- for case 1—on Wednesday 5 June 2013 at 4.48 pm (following telephone contact with SNP by Queensland Health)
- for case 2—on Thursday 6 June 2013 at 9.30 am by phone to the local public health unit by electronic transfer to NoCS at 12.55 pm and by fax to the local public health unit at 5.18 pm.

Given the requirement for immediate notification, SNP did not comply with the requirements of the Act on both occasions.

The investigation found that the failure to notify the first case was due to deficiencies in the laboratory information system and supporting procedure document within SNP. An automated system of notification following a positive test result for notifiable conditions normally exists. However, following the introduction of the *Legionella* urinary antigen test in August 2008, the test set used for entering urinary antigen test results into the laboratory information system did not have the notification code set up to be automatically added when a result was positive. It is this code that is required for the notification to be sent automatically to Queensland Health's notifiable conditions register.

This meant that the person recording the positive result required the experience to know that a positive result was notifiable to Queensland Health and required the notification code to be entered manually. If the code was not entered manually, the test result was not notified. A deficiency was also identified in the bench top procedure document used by SNP staff as it did not alert staff of the need for this manual entry.

Once these issues were identified, SNP made amendments to the laboratory information system to allow for automatic notification of positive *Legionella* urinary antigen test results. The procedure document was also updated accordingly.

The positive test result for the second case was notified the morning after SNP received the positive test result. This also represented a breach of the *Public Health Act 2005* as legionellosis requires immediate notification to Queensland Health. After hours contact arrangements exist.

Discussion and actions taken

SNP has demonstrated a proactive approach to implementing corrective action in a timely manner to ensure future voluntary compliance with the Act. SNP is considered a leader in working with health jurisdictions in complying with notification requirements, and is a participant in Queensland Health's Communicable Diseases Laboratory Reference Group. There is also a strong history of compliance and cooperation.

The appropriate regulatory response involved consideration of the following:

- this was the first identified offence by SNP in relation to Section 72(1) of the Act
- SNP quickly acknowledged that there had been a failure to comply with the Act and promptly undertook investigatory and remedial action

- the breach, on this occasion, did not result in further cases of Legionnaires' disease and therefore had no impact on human health, due to the prompt action taken by The Wesley Hospital under its own initiative following receipt of the positive test results from SNP.

In light of these considerations, SNP has been issued with a formal written warning by the Department of Health. The written warning requires a formal response from SNP which includes details of actions taken to prevent future notification failures and assure future compliance with the Act. This includes quality assurance actions to prevent similar issues which may otherwise arise with new testing regimes and/or changes in technology, and the associated updating of procedures, systems and staff training.

4.2.3 Analyses of notifications for *Legionella pneumophila* on the Notifiable Conditions System (NoCS) compared to laboratory data

Purpose and results

Following the identification of the system and process issues at SNP, the Chief Health Officer requested the re-provision of all positive test results for *Legionella* by four major Queensland pathology laboratories for the period June 2008 to June 2013, including culture, urinary antigen and serology tests. The purpose of the request was to enable a cross-check between the *L. pneumophila* pathology test results held on NoCS and data which the laboratories were required to notify under the *Public Health Act 2005*. The findings were as follows:

- All nine culture positive results for *L. pneumophila* were recorded in NoCS.
- 80 of 87 (92 per cent) positive urinary antigen tests (specific for *L. pneumophila* type 1) were recorded in NoCS.
- Seven positive urinary antigen tests were not recorded on NoCS. Of these:
 - four tests were for persons who had a *L. pneumophila* notification already as a result of concurrent serology testing and thus follow-up by the relevant public health unit occurred at the time
 - the remaining three tests (corresponding to three persons) were not recorded on NoCS. These three tests were performed in 2008, 2009 and 2011. The 2008 and 2011 cases, who recovered from their illness, have subsequently been followed-up by the relevant public health units and the infections deemed not to be hospital acquired. The 2009 case presented to their local hospital with a four day history of illness consistent with pneumonia, and left lower lobe pneumonia confirmed on x-ray. He was admitted, continued to deteriorate, and was transferred to The Wesley Hospital three days later. Respiratory deterioration continued and the patient passed away at The Wesley Hospital on day 25 of his admission. The clinical picture and timing and results from laboratory testing were considered consistent with community acquired legionellosis prior to being admitted to their local hospital.
- 163 *L. pneumophila* serology test results were provided by the laboratories with a single high antibody titre of 512 or greater. Whilst a single high titre can be dependent on the type of test conducted by the laboratories, all antibody titres of 512 or over should be notified as laboratory suggestive evidence. While some laboratories may choose to notify a lower titre based on their test kits, an antibody titre of 512 or over was used for this analysis. Ninety (55 per cent) of these tests were recorded on NoCS. A further 30 tests related to a notification where other legionellosis testing had been recorded on NoCS. This means the people who had these results would have been appropriately followed-up at the time.

- The 163 serology test results related to 99 persons being tested, of which 73 persons (74 per cent) had a *L. pneumophila* notification on NoCS. Further investigation of data sets revealed that for the 26 persons who had single high titre serology results, but were not recorded on NoCS, no hospitalisations or deaths from legionellosis were recorded, apart from the case mentioned above that also had a urinary antigen result not recorded on NoCS.

Discussion

The cross-check of laboratory results did not identify the reason why some of the notifiable test results were not recorded in NoCS. Further investigation into the notification process is being undertaken in collaboration with notifying laboratories. This will inform any future action required by the relevant organisation/s to help ensure that all notifiable results are received and recorded on NoCS and are able to be followed-up by the relevant public health unit.

With regard to the serology results, a single high antibody titre for *Legionella* is only suggestive evidence for a legionellosis diagnosis. There are a number of reasons why a single high titre may not be notified by laboratories. These reasons include the clinical microbiologist comparing the result with clinical symptoms noted on the test form, or testing earlier blood samples from the same patient to determine that the result is not indicative of recent *Legionella* infection. These practices are consistent with the case definition for legionellosis, but are not consistent with the laboratory notification requirements.

Following the laboratory data review, single high titre serology results (suggestive of legionellosis) that had not previously been recorded on NoCS were not referred to the relevant public health unit for retrospective follow-up. A review of hospital and death data was undertaken and none of these potential cases had resulted in hospitalisation or death. A review of the notification criteria is being undertaken to ensure consistency in laboratory reporting.

4.2.4 Environmental site inspections and investigations

Environmental site inspections and related investigations were undertaken by:

- the Metro North Public Health Unit within the Metro North Hospital and Health Service—to attempt to determine the source of the *Legionella* bacteria and to ensure appropriate remedial action was undertaken to prevent any continued or future risk
- WHSQ, Department of Justice and Attorney General—involving an audit of cooling tower management and compliance with the *Work Health and Safety Act 2011*
- Brisbane City Council (BCC) plumbing compliance officers jointly with advisors/ investigators from Building Codes Queensland (BCQ), Department of Housing and Public Works—in relation to compliance of their water storage and delivery systems with the *Plumbing and Drainage Act 2002*.

The purpose and findings of each are summarised below.

It should be noted that at the time of these investigations, the hospital management had already instigated its own investigations in response to notification by SNP of the positive *L. pneumophila* test results.

Investigation by the Metro North Public Health Unit

The public health unit investigation commenced on 5 June 2013 and included gaining an understanding of the systems on-site and the work being undertaken by The Wesley Hospital.

The response by the hospital was considered comprehensive and involved a multidisciplinary team, including external expert advisers.

Independent water sampling of the reticulated water supply, additional to the samples organised by the hospital, was taken from east and west wings by public health unit staff and from various air conditioning cooling towers on-site in collaboration with WHSQ. Of 14 reticulated water supply samples, one result from a shower indicated a level >10 cfu/mL (the level of detection used by most laboratories) for *L. pneumophila* (15 cfu/mL). No *L. pneumophila* was detected in the cooling tower samples. Following remedial action in the form of alkaline and chlorine flushing of the heated water system in the east wing, further validation sampling was undertaken. No detections were found in the 17 samples taken. Ongoing sampling is being undertaken by the hospital.

No significant issues were identified and more specific inspections were undertaken by WHSQ and BCC/BCQ, relative to their regulatory requirements.

In addition to the standard microbiological testing of water samples from the hospital, the Department of Health's Public Health Microbiology Section, part of Forensic and Scientific Services, undertook further testing. This testing involved molecular genotyping of the *L. pneumophila* serogroup (sg) 1 isolates. This included bacterial isolates sourced from patients and also from a range of water samples collected across the hospital site. In an attempt to further differentiate the hospital isolates from other South East Queensland isolates, the laboratory also performed whole genome sequencing. Results from this molecular analysis indicated that the isolates sourced from the two patients and the sample from the patient shower showed a high degree of genetic relatedness.

Given the information available, the most probable source of infection appears to be *L. pneumophila* contamination of the heated water system. The genome sequencing work showed that the isolates from the heated water were more genetically similar to those from the patients than to other environmental and clinical isolates from South East Queensland that were analysed. Contributory factors to the harbourage and growth of the *Legionella* bacteria within the system could include the identified presence of 'dead legs' and the lack of awareness regarding the need for regular and on-going maintenance of plumbing fittings, such as taps and shower heads.

Inspection and audit by Workplace Health and Safety Queensland

An audit of the cooling towers was carried out by WHSQ on 7 June 2013. It was concluded that a satisfactory *Legionella* risk management system was in place for the 10 cooling towers on-site, however a series of recommendations for improvements were made. These related to plant upgrades, operations and maintenance, and included:

- upgrading water treatment systems, installing side stream filtration to all towers and scheduling replacement of two old towers
- labelling water sampling points and signage relating to wearing of P2 respirators
- daily activation of offline or standby condenser pumps to ensure circulation of treated water, repositioning of a drift eliminator, and addressing water leaks in two towers
- investigating and actioning elevated bacterial (HPC) counts in two towers and documentation of prioritised time plans for action recommendations following the review of risk management plans.

Inspection by Brisbane City Council and Building Codes Queensland

The site inspection of hot and cold water systems by BCC compliance officers and BCQ investigators was also undertaken on 7 June 2013. BCC also reviewed its records and confirmed

that it appeared all new works conducted at The Wesley Hospital had undergone the required compliance assessment process. The inspection found that:

- recent hot water heater installations appear to comply with relevant AS 3500.4, flow and return pumps were operational, the temperature of all water heaters were above the required minimum of 60 degrees Celsius, and digital temperature recording was accurate
- water temperature from showers and hand basins within rooms was 45 degrees Celsius as is required by AS 3500.4 for selected facilities, including hospitals, aged care and child care facilities
- hot water pipework located within wall spaces servicing the mixing valves had adequate pipe lagging for thermal insulation, however in many cases the hot and cold water piping were in close proximity to each other which can cause radiant heat transfer between the hot and cold water supplies to the rooms within the wards—the Australian Standards require 100 mm separation from hot water service and observations indicated that this may not have been adhered to
- inspection of the TMVs indicated they were operational and records indicated they were tested annually as required by AS 4031.2
- while the delivery of the domestic supply is fed from the two supply tanks during normal operation, the existing mains water connection to the water service provider's infrastructure is still operational and can be used if required (i.e. it guarantees continued water supply if a failure should occur), however it poses a significant risk of a 'dead leg' (i.e. an unused/redundant pipe branch within a water supply system).

The report recommendations related to:

- confirming maintenance, testing and design requirements have been met—for example:
 - there was no evidence that the temperature of hot water systems was reduced at any time
 - there was adequate testing of TMVs and temperature compliance
 - there was adequate testing of backflow prevention devices and that all are operational
 - all fixtures, including showers and tapware have the appropriate WaterMark certification
 - there was an adequate cleaning program in place for shower heads and hoses
- reducing the risk of shower hoses that were not self draining and could hold onto water, posing a possible risk of bacterial growth if the shower is not used for a long period of time
- confirming a cleaning program is in place for shower heads and hoses and considering options to treat this potential risk
- confirming whether there is any heat transfer between the hot and cold water piping and if additional lagging may be required
- confirming or excluding the likelihood of unused water supply piping (dead legs) which may have possible health and safety implications

- testing of the water within the combined water supply tanks to determine chlorine levels of the water supply to the hospital and a full investigation of the system to minimise the possible risk of *Legionella* contamination⁸.

These recommendations were provided to The Wesley Hospital for review and action if required.

It was also recommended that consideration be given to the benefits of mandatory testing of water delivery systems within all healthcare facilities within Queensland.

4.2.5 Independent review of the 2011 case of Legionnaires' disease

This independent review was commissioned to review the 2011 case of Legionnaires' disease at the Wesley Hospital and assess the implications for management of notifications of single cases of *L. pneumophila*, particularly in healthcare settings and recommend any improvements to such practices, if required. In summary it was found that the patient was severely immunocompromised and subsequently died due to his underlying disease.

The Brisbane North Public Health Unit investigated the case in accordance with the *Queensland Communicable Disease Control Manual*. The public health unit staff asked the correct questions of infection control at the hospital. However, the public health unit considered the case a sporadic infection that may have acquired their infection outside of the hospital. As a consequence, there was no search for related cases or related environmental testing. At the time of the investigation, neither the hospital or the public health unit identified that the hospital water supply was the likely source of the patient's infection. The reviewer's recommendations were as follows:

- Improve the Communicable Disease Manual guidance for public health units to investigate cases of Legionnaires' disease, which should include:
 - modification of the case report form to include more details about case-patient demographics, clinical disease, laboratory testing information, and potential exposures for legionellosis
 - clarification of roles and responsibilities of public health units and institutions, such as hospitals—possibly in legislation
 - clearer guidance regarding investigation of sporadic cases of legionellosis based on a simple risk assessment of nosocomial and environmental transmission
 - triggers for establishment of an incident control team in instances of potential nosocomial transmission—the exact nature and composition of this team will depend on Queensland legislative and institutional circumstances, but may be most appropriately managed by the hospital in sporadic nosocomial cases.
- Ensure Queensland public health staff members are adequately resourced and trained in investigative procedures for legionellosis and other infectious diseases.
- Consider developing an online critical incident management system to keep investigation team members and Queensland Health informed and provide a record of investigation. Senior staff in Queensland Health should be rapidly informed of all cases of legionellosis where they have occurred in an institutional setting.

⁸ Later confirmed that the Queensland Urban Utilities water supply is chloraminated, not chlorinated, so the measured chlorine residual is not relevant.

4.2.6 Water testing results for public and private hospitals across Queensland

Background

Following advice about the first case from The Wesley Hospital on 5 June 2013, the Minister of Health directed the precautionary testing of all public hospital water supplies in Queensland the following day. The purpose of testing was to identify if similar issues were being experienced in hospitals elsewhere and to ensure appropriate action was taken where required. The Chief Health Officer wrote to all private hospitals requesting that they undertake the same actions. Guidance was provided to all HHSs on 7 June 2013 and subsequently to private facilities.

Flexibility was built in to the implementation of the project to enable HHSs to incorporate local knowledge of their facilities, and other specific regional requirements. It was acknowledged that resources were available to HHSs, in the expertise of their public health units, workplace health and safety teams and infection control and infectious diseases teams. While this flexibility was important to allow knowledge of local factors to direct the selection the sampling locations, it does limit the opportunity to draw conclusions from the data, particularly in regard to comparisons between facilities or facility categories.

Further advice on the selection of sampling sites to include areas likely to house the most vulnerable patients, selection of sites most distant from hot water storages, and on determining the appropriate number of samples for each facility was provided in subsequent correspondence to facilities on 14 June 2013. Guidelines for responses to positive test results, for both water management and the management of vulnerable patients, were also issued.

Key findings

Due to the rapid initiation by facilities of sampling and testing following the notification at The Wesley Hospital, there was some variation in the approach taken by different facilities. This resulted in limitations with regard to the analysis and interpretation of results, however the key findings were that:

- of the 267 facilities (172 Commonwealth and state public and 95 private) which reported results, 83 public (49.7 per cent) and 76 private facilities (80 per cent) had no positive detections of *L. pneumophila* or *Legionella spp* (not pneumophila)
- positive results in one or more samples were reported by 106 facilities, or just under 40 per cent of all facilities, either *L. pneumophila*, *Legionella spp* (not pneumophila) or both as shown in Table 1.

Table 1: Facilities reporting positive results for *L. pneumophila* and *Legionella spp* (not pneumophila)

Facility type	Positive no. (row %)	No positives no. (row %)	Total facilities no. (column %)
Public (Commonwealth)	3 (60.00)	2 (40.00)	5 (1.87)
Private	19 (20.00)	76 (80.00)	95 (35.58)
Public (HHS)	84 (50.30)	83 (49.7)	167 (62.55)
Total	106 (39.7)	161 (60.30)	267 (100)

It should be noted that although the average number of samples per facility is similar for public and private hospitals (approximately 20 per facility), 62 per cent of the sample results from private facilities were from The Wesley Hospital ($n=1177$). If the hospital results are excluded, the average number of samples from private facilities was about 15. Only summary data is available for private facilities. Public hospitals reported 3299 sample results with accompanying data on

sample collection. Therefore, information on sampling locations and actual bacterial counts were only available for HHS and Commonwealth facilities.

Overall, just under 10 per cent of sample results were positive for *L. pneumophila* (8.91 per cent) or *Legionella spp* (not pneumophila) (6.67 per cent) as shown in Table 2.

Table 2: Summary of sample results for *L. pneumophila* and *Legionella spp* (not pneumophila) for all sampling in public and Commonwealth facilities, categorised by the number of colony forming units reported

Species	cfu/mL	Number	Per cent	Cumulative per cent
<i>L. pneumophila</i>	<10	3005	91.09	91.09
	≥10 and <100	164	4.97	96.06
	≥100 and <1000	114	3.46	99.52
	≥1000 and <10000	14	0.42	99.94
	>10000	2	0.06	100.00
	Total	3299	100.00	
<i>Legionella spp</i> (not pneumophila)	<10	3079	93.33	93.33
	≥10 and <100	51	1.55	94.88
	≥100 and <1000	141	4.27	99.15
	≥1000 and <10000	25	0.76	99.91
	>10000	3	0.09	100.00
	Total	3299	100.00	

Only a very small number of samples returned very high counts, with less than one per cent of samples exceeding 1000 cfu/mL of either *L. pneumophila* or *Legionella spp* (not pneumophila). The significance of *Legionella spp* (not pneumophila) is that while the *L. pneumophila* was not detected in the sample, other species were, indicating the environment is also suitable for *L. pneumophila* (which tends to be more virulent) to grow and may be present elsewhere in the system.

The response to positive detections protocol required that re-sampling be undertaken following remedial action. Not all re-sampling data had been received at the time of writing of the report and limitations associated with data collection do not allow for detailed interpretation of data to make strong conclusions on the efficacy of follow-up treatment. Although the numbers are small, and not all remediation and re-sampling has been completed, there appears to be significant improvement in subsequent rounds of re-sampling, with 50 per cent of facilities undertaking remedial action reporting no detections of *Legionella* (Table 3).

Table 3: Summary of sample results for *L. pneumophila* and *Legionella spp* (not pneumophila) in public and Commonwealth facilities for initial sampling and re-sampling

Species	cfu/mL	Initial sampling n (column %)	Re-sample 1 n (column %)	Re-sample 2 n (column %)
<i>L. pneumophila</i>	<10	2,381 (90.88)	488 (90.54)	136 (97.14)
	≥10 and <100	134 (5.11)	27 (5.01)	3 (2.14)
	≥100 and <1000	90 (3.44)	24 (4.45)	-
	≥1000 and <10000	13 (0.5)	-	1 (0.71)
	>10000	2 (0.08)	-	-
	Total	2,620 (100)	539 (100)	140 (100)
<i>Legionella spp</i> (not pneumophila)	<10	2,381 (90.88)	488 (90.54)	136 (97.14)
	≥10 and <100	134 (5.11)	27 (5.01)	3 (2.14)
	≥100 and <1000	90 (3.44)	24 (4.45)	-
	≥1000 and <10000	13 (0.5)	-	1 (0.71)

	>10000	2 (0.08)	-	-
	Total	2,620 (100)	539 (100)	140 (100)

There was no correlation between the size of facility (as number of beds) and positive results. There were no correlations between positive detections and water temperature, free chlorine, pH or heterotrophic plate count. This should be interpreted with caution given limitations associated with different approaches to data collection and reporting.

Of note, approximately 30 per cent of samples were identified as cold water samples and around 10 per cent of samples identified as having temperatures below 20 degrees Celsius were positive for either *L. pneumophila* or *Legionella spp* (not pneumophila).

There were significantly more positive detections in first draw samples (i.e. samples taken when the tap is first turned on, indicating the source was localised) than flushed samples (i.e. after allowing the water to run before taking the sample). Results were 59.26 and 40.47 per cent for *L. pneumophila* and 76.78 and 22.27 per cent for *Legionella spp* (not pneumophila) respectively. There was no pattern identified when facilities were assessed as major regional, rural or South East Queensland.

Of the facility types, public residential aged care facilities and public psychiatric health facilities had significantly higher than average positive results (21.51 and 39.74 per cent respectively). This increased occurrence was largely *L. pneumophila* (20.32 and 29.8 per cent). This increased occurrence was largely due to just two facilities, both of which have taken appropriate remedial action, some of which is ongoing.

Discussion

The results from the statewide water testing program of hospitals has shown *Legionella* is present to varying extents in a significant proportion of the water systems of public and private health facilities in Queensland. The data is still incomplete, and is somewhat difficult to interpret, however the result of 10 per cent positives from 50 per cent of public facilities provides a baseline for future monitoring and control.

Although the results of the project represent only a snapshot, taken in the season when the incidence of legionellosis tends to be lowest, it is probably a reasonable indicator of the unmanaged risk in Queensland healthcare facilities. It is notable that several facilities were identified in which the risk level could be considered to be somewhat elevated, either due to high counts of *Legionella*, or inadequate response to remediation. However, results of the response so far indicate that control of *Legionella* and management of the risk is possible.

The lack of comparable data from other Australian jurisdictions makes it difficult to comment on whether this situation is unique, although overseas studies have found that hospital water systems are commonly contaminated with *Legionella* [9]. For example, more than two-thirds of institutions in one study [45] and 63 per cent in another [46] had *Legionella* contamination. Cases have also been sourced back to cold, warm and hot water systems of hospitals many times [46]. However, presence of *Legionella* in the water systems is often not associated with cases, which makes interpretation of results and assessment of risks difficult.

There are differing views in the literature on the issue of routine testing of hospital water supplies. For example, in a 2011 mini-review the authors noted that 'knowledge of *Legionella* positivity in hospital drinking water is the only factor known with certainty to be predictive of risk' [47]. Conversely, advocates for control measures in the event of clinical cases only, argue that *Legionella* is ubiquitous in hospital water systems and positive environmental cultures do not correlate with risk of infection [48].

Few studies have been published around risk and risk mitigation in residential aged care facilities. However, there is agreement that this population is at higher risk than the general population and evidence suggests that legionellosis may be an important, but under-recognised cause of pneumonia in this population [49]. One recent study reported a case fatality rate of 4.7 per cent in an outbreak of Legionnaires disease related to the potable water system [50]. This study identified the potential for outbreaks in this population and recommended that facilities should consider control measures, such as annual sampling of potable water and the development of more comprehensive multi-disciplinary risk management plans.

Given the greater vulnerability of significant numbers of patients in hospitals and residential aged care facilities, there is a common theme in guidelines generally in Australia and elsewhere, including those issued by the World Health Organization (WHO) in 2007 [9]. Appropriate management of water systems is required to control microbial growth and prevent elevated counts, to monitor those aspects of the system that are known to contribute to growth, to assess the effectiveness of controls through periodic testing, and to respond accordingly.

The WHO has developed a framework for safe drinking water [8], which is consistent with the drinking water framework in the *Australian Drinking Water Guidelines* [51]. This combines health-based targets, risk assessment and water safety plans (or the term more commonly used in Australia, risk management plans) and surveillance into a single framework, and underpins its approach to risk mitigation and the prevention of legionellosis. An overview of the key steps in the development of a risk management plan for *Legionella* control in water systems is provided in Appendix 1 [9].

The benefit of risk management plans is evidenced by an overseas study that found *Legionella* were less likely to be detected in cooling towers where risk management plans had been implemented [36]. It has been reported that early adopters of the *US Guidelines for Legionella detection and control*, saw cases of hospital acquired legionellosis decline from 33 to 3 per cent [52].

A risk management approach is also supported by the work of the technical advisory panel, established by the Department of Health to evaluate how *Legionella* could become established at pathogenic levels in Queensland healthcare facility drinking water infrastructure, and to identify best practices in responding to *Legionella* and other related waterborne microbial contamination. The work completed to date has been a high-level assessment and is considered the first-step toward establishing a robust program of drinking water system risk management for Queensland healthcare facilities. However, the key points in the panel's assessment are:

- If it is not managed effectively, water quality in healthcare infrastructure can easily and rapidly degrade, posing a risk to patients of those facilities. The most significant risk exposure, as indicated elsewhere, is to immunocompromised persons, but over time, risk to persons of average health may increase.
- Management of the supply of drinking water in Australia follows recommendations from the *Australian Drinking Water Guidelines* (ADWG), but these guidelines do not specify that drinking water should contain a minimum level of residual disinfectant at each delivery point to protect against microbial colonisation of healthcare facilities.
- In Queensland, drinking water quality can be variable due to climate, impaired source water quality (a small number of reticulation systems are not potable), and complex supply arrangements. Therefore, it cannot be assumed that even if the incoming water quality complies with the ADWG that it will necessarily have an effective chlorine residual. Consequently, water delivered to healthcare facilities that house vulnerable patients may not be fit for purpose without additional treatment.

- There are a number of healthcare facilities not equipped with specialist water treatment equipment or processes to meet the needs of vulnerable patients.
- It is likely that there are a significant number of Queensland hospital facilities that have complex potable water systems which can also contribute to risk.
- There are no specific Australian Standards that advise in detail how to control microbial quality in hot or warm water systems in healthcare infrastructure. This hampers development of uniform construction and maintenance practices. The current *Capital Infrastructure Requirements* provides a consistent and standardised approach to health capital infrastructure planning and design in Queensland and promotes the application of contemporary and evidenced-based standards. However it does not deal specifically with issues relevant to *Legionella* control.

These issues are the basis for recommendations one and two (on page 44) and part of four (on page 44). The findings of the investigation into the cases at The Wesley Hospital, and of the statewide water testing program, together with the issues summarised above, point to areas for action more broadly. Work has commenced with regard to some of these and recommendations are made for others. These are discussed further in the following sections.

5.0 Regulation and other approaches to prevention

5.1 Scope of approaches

This section summarises the review of approaches that are important to the prevention of legionellosis, and the current arrangements in Queensland and other jurisdictions. This section also discusses actions that can make for a more robust system for prevention and control in Queensland.

A range of approaches exist to help prevent the growth of *Legionella*, to identify and respond to positive cases of disease, and to take action to reduce future cases. These include:

- Regulation—legislation which can be supported by codes of practice, guidelines and protocols which may further articulate required or recommended practice.
- Standards—published documents setting out specifications and procedures designed to ensure products, services and systems are safe, reliable and consistently perform the way they were intended. They establish a common language which defines quality and safety criteria. Standards are voluntary consensus documents that are developed by agreement and their application is by choice unless their use is mandated by government or called up in a contract.
- Accreditation—health and aged care facilities are required to be accredited against national standards.
- Guidelines and related advice—these are generally advisory documents that provide more detailed guidance to practice and, when referenced in legislation, to assist with compliance.

5.2 Approaches to the control of *Legionella*

5.2.1 Current arrangements

Regulation and associated standards

Regulation relevant to the control of *Legionella* in water systems includes regulation relating to plumbing and drainage, work health and safety, and public health risks generally, but also to *Legionella* control specifically.

All Australian jurisdictions have legislation associated with work health and safety and plumbing and drainage. These are areas where there has been significant reform to support consistency across jurisdictions.

Plumbing and drainage regulation provides for the design and installation of systems that are effective and safe. It calls up the Plumbing Code of Australia (PCA) which, among other things:

- sets out the requirements for the design, construction, installation, replacement, repair, alteration and maintenance of water services
- contains materials and product certification procedures, such as the WaterMark Certification Scheme, which certifies plumbing and drainage materials and products so that they may be authorised for use in a plumbing or drainage installation—this is relevant to *Legionella* control as the type of materials used can contribute to its survival and growth.

The PCA also references a range of AS/NZS which specify minimum requirements for various aspects of manufactured water systems. These include standards for water services, including heated water services, TMVs and other temperature control valves, backflow prevention devices and for the design, commissioning, operation and maintenance of air handling and water systems in buildings for microbiological control. They are the principal reference point for practice and regulatory compliance activity in relation to the design, installation, commissioning, operation and maintenance of such systems.

In particular, the PCA calls up *AS/NZS 3500.4 Heated Water Services* as the performance requirements to ensure that 'heated water storage to be stored and delivered under conditions to avoid the likelihood of the growth of *Legionella* bacteria', including the requirement to store heated water above 60 degrees Celsius. AS/NZS 3500.4 in turn references other standards including the *AS/NZS 3666 series: Air handling and water systems of buildings – Microbial Control*.

Work health and safety legislation places a duty of care on persons conducting a business or undertaking to ensure, so far as is reasonably practicable, that the health and safety of workers and other persons is not put at risk from work carried out as part of the conduct of the business or undertaking. This includes through:

- the provision and maintenance of a working environment that is safe and without risks to health and safety
- the provision and maintenance of plant, structure and systems of work that are safe and do not pose risks to health and safety
- the provision of information, instruction, training or supervision to workers needed for them to work without risks to their health and safety and that of others around them
- that the health and safety of workers and the conditions of the workplace are monitored to prevent injury or illness arising from the conduct of the business or undertaking.

This general duty is broad and thus inclusive of manufactured water systems, however there are no further specific requirements relevant to manufactured water systems.

All public health legislation across Australia has general provisions providing powers for authorised officers to respond to public health risks and for the making of regulations and guidelines and/or codes of practice to assist in the prevention and management of public health risks.

With regard to legionellosis specifically, two complementary types of regulatory approaches are relevant:

1. Preventing risk from systems that can support the growth and dissemination of *Legionella*.
2. Disease notification—discussed further in Section 5.3.

Many countries have developed regulations specific to the control of *Legionella* in water systems for the prevention of legionellosis. In Australia, all jurisdictions, with the exception of Queensland and the Northern Territory, have requirements in their public health legislation for responsible persons in regard to the cooling and water delivery systems in buildings in non-domestic settings, although the scope of the systems and the settings in which they apply varies.

The primary reference document used to facilitate this legislative process is the *AS/NZS 3666 series: Air handling and water systems of buildings – Microbial Control with references to Parts 1, 2 and 3⁹*:

- Part 1—covers the design, installation and commissioning of these systems
- Part 2—covers operation and maintenance
- Part 3—performance based document for maintenance of cooling water systems.

While the requirements vary across jurisdictions that regulate (i.e. not including Queensland and the Northern Territory), elements common to the majority of jurisdictions include:

- registration of cooling water systems (in all jurisdictions other than Western Australia)
- registration of warm water systems in all or selected non-domestic settings (in all, but South Australia and Western Australia)
- requirements for the installation, operation and maintenance of these systems as per AS 3666, with or without additional requirements
- water sampling and testing, and remedial action on detection of specified levels for *Legionella* and heterotrophic plate counts in the regulated water systems
- requirements for water systems suspected or implicated as an infection source (in all, but South Australia and Western Australia)
- documentation and record keeping relating to plans, operating and maintenance manuals, and maintenance records.

Three of the six jurisdictions also require:

- some form of certification or third party auditing or inspection of cooling water systems (Victoria, Tasmania and the Australian Capital Territory)
- mandatory reporting of results exceeding specified levels of *Legionella* in cooling water systems (Victoria, South Australia and the Australian Capital Territory).

⁹ This series also includes a Part 4 relating to microbial control in air handling systems.

A number of jurisdictions have regulations relating to swimming pools and spas and/or mandatory codes of practice. These are designed to promote high standards of microbial quality in water, generally, but are relevant to *Legionella* control in spa pools particularly. The requirements covered generally include maintenance of facilities, cleaning, treatment of water, filtration, maintenance of microbial quality within defined parameters, responses required when water sample test results don't comply, chemical testing, requirements when a facility is suspected or implicated as the source of infection, record keeping, and water replacement. These issues are dealt with through the issuing of guidelines in other jurisdictions, including Queensland.

Guidelines and similar tools

Guidelines and other resources often exist to support regulatory requirements. In addition, in places where there is no specific regulation, an advisory and supportive approach exists through guidelines, fact sheets and associated tools, either developed by government agencies or by professional and/or industry bodies.

In Queensland, guidelines developed by WHSQ, exist for the design, installation, commissioning, operation and maintenance of water cooling systems, including cooling towers and for control strategies for the presence of *Legionella* and other heterotrophic microorganisms¹⁰ [53]. However, no such guidelines exist for manufactured water systems in non-domestic situations, unlike in most other jurisdictions.

As indicated above, guidelines also exist for the operation and maintenance of swimming pools and spas (the latter being of relevance to legionellosis), developed by the Department of Health. These guidelines [54] set out recommended water quality and operational standards for swimming and spa pools to ensure safe bathing water is provided for users. The guidelines apply to pools that are open to the public and include pools located at municipal and commercial sites, schools, hospitals, hotels and motels, leisure centres, health resorts, gymnasiums, clubs and resorts, camps, caravan parks, community health centres, retirement villages and unit developments, such as strata title or cluster title units.

There are also a range of other guidelines covering the design, selection and safe pool operation for swimming pools and spas, including a number of Australian Standards and related handbooks relating to water management for public swimming pools and spas, hydrotherapy pools and private swimming pools, and residential spa pools.

Fact sheets are also available to the general public to assist them in understanding the risks and action they can take to minimise these in domestic settings.

5.2.2 Discussion

Regulation

Regulatory and associated approaches in other Australian jurisdictions have, in part, been prompted by their experiences with large outbreaks. This has not been experienced in Queensland. The reasons for these differences are not clear. However it is appropriate that regulation of high risk manufactured water systems (i.e. cooling water systems and water delivery systems), specifically as it relates to microbial control, be reconsidered now given the:

- review of approaches elsewhere

¹⁰ Heterotrophic microorganisms are bacteria, moulds and yeasts that use organic carbon sources to grow and can be found in all types of water.

- recent health system reforms (whereby HHSs are now independent statutory authorities, separate from the Department of Health, whose role is now that of system manager)
- findings of this review.

Regulation specific to microbial control in cooling water systems is included in public health legislation in all Australian jurisdictions except Queensland and the Northern Territory. In Queensland, regulation falls under general duties, including those specific to plant in general, under work health and safety legislation.

Given the vulnerability of people in healthcare and residential aged care facilities, and despite the lack of evidence of links between cooling tower contamination and healthcare acquired cases in Queensland, the risk remains and consideration should be given to regulating cooling water systems in these settings under the *Public Health Act 2005*.

Regulation with regard to water delivery systems varies in the type of systems and the settings in which they are regulated. This ranges from all water delivery systems (cold, warm and hot), all heated systems, or warm water systems only, and from all non-domestic settings¹¹ to health and residential aged care settings only.

There are pros and cons associated with different regulatory options. This should be the subject to further analysis, consultation and consideration. However, given the key risk settings are health and residential aged care, a focus on regulating both cooling and water delivery systems in these settings is recommended.

It is also recommended that the key reform should be a requirement for each hospital and residential aged care facility to have a water quality risk management plan, similar to the way that risk management plans are required for cooling water systems. There should also be a minimum requirement for the frequency of testing for heterotrophic colony count and *Legionella*, with more frequent testing as indicated based on a stratified risk assessment and documented in risk management plans. A *stratified* risk assessment would focus on exposures with the highest risk exposures being those undergoing HSCT or solid organ transplants, oncology patients and other high-risk patients.

With regard to the scope of healthcare settings covered, more specific definition of facility types to be captured under regulation would be required. The intent would be to focus on hospital and hospital type facilities that provide acute healthcare with admitted patients, with consideration also given to any other key features that make particular facilities at significantly higher risk with regard to water quality control and the risk profile of patients. This issue forms the basis for recommendation two (on page 44).

Regulation of cooling water and water delivery systems in other risk settings could remain the responsibility of WHSQ under its general duty of care and plant provisions. Consideration should be given to the development of guidelines for water delivery systems, similar to those that exist for cooling water systems.

Standards and guidelines

As discussed in Section 4.3, there is no specific Australian or Queensland standard that advises in detail how to control microbial quality in hot or warm water systems in healthcare facilities.

¹¹ Definitions vary slightly between jurisdictions but generally domestic includes Class 1, Class 2 or Class 10 buildings as classified in Part A3.2 of the Building Code of Australia (domestic residences and non-habitable out-buildings).

There are heated or warm water guidelines for the control of *Legionella* relevant to healthcare facilities in all Australian states except for Queensland and the Northern Territory. These guidelines are usually linked to legislation.

All guidelines reviewed by the technical advisory panel recommend an engineering maintenance approach of regular examination of TMVs. Hot water pasteurisation¹² is recommended if *Legionella* is detected, but its effectiveness is often short-term. Further guidelines in some states recommend disinfection of shower heads and TMVs with consumer-grade chlorine bleach. Existing guidelines do not offer further actions that may be required if these approaches are not effective in controlling *Legionella*. State guidelines focus on *Legionella* only and do not follow the broad approach of international guidelines, which often recognise the need for total microbial control in plumbing systems.

The panel found none of the guidelines provide follow-up support when a facility is unable to provide ≥ 65 degrees Celsius at the far-reaching areas of healthcare infrastructure which may be contaminated. Furthermore, no guidelines exist for removal of accumulation of biofilm or sediment (which are known to promote ongoing and further contamination) in healthcare infrastructure. Pasteurisation is not expected to remediate these accumulations and continuing pasteurisation becomes more difficult as these deposits build up.

There are two Australian Standards which impact the capability to install and manage drinking water systems, namely AS 3500 (mainly about installation) and AS 3666 (design, installation, operation and maintenance). These deemed-to-satisfy provisions¹³ are used in Queensland.

AS 3500.4 Heated Water Services, last updated in 2003, has a section, Section 9 Heated Water below 60 degrees Celsius, which is identified as being under development. It is intended to set out requirements for heated water systems that distribute and deliver heated water below 60 degrees Celsius, and to provide installation solutions and appropriate maintenance standards for the designer, installer and maintenance plumber. This work has not been completed at this time.

The lack of specific standards that advise in detail how to control microbial quality in hot or warm water systems in healthcare facilities hampers development of uniform construction and maintenance practices. AS 3500 generally prescribes disinfection of systems prior to commissioning, but does not cover maintenance and remediation except for reference to AS 3666. Furthermore, procedures for commissioning do not include specification of when they should be conducted with respect to time before use of the system.

AS 3500 is a deemed-to-satisfy provision for plumbing installations that deals primarily with acceptable hydraulic design and only deals minimally with providing a disinfected pipe system. There is also the AS 3666 series, but beyond the requirement to keep operating and maintenance manuals and records, it deals mainly with the control of *Legionella* in cooling towers. It is limited with regard to heated water systems, focusing only on:

- servicing and maintenance of heated water to be in accordance with the suppliers published requirements and best practice and be undertaken by competent personnel

¹² Involves sending hot water through all affected warm/cold water pipes to obtain a temperature no less than 70 degrees Celsius at the furthest point and maintaining that continuously at a reasonable flow rate for not less than 10 minutes.

¹³ These are provisions which meet the performance requirements set down in the PCA.

- inspection and management to be in accordance with the requirements of the regulatory authority, including requirements with regard to the retention of records—a gap because Queensland does not regulate.

Comprehensive guidelines exist in a number of other countries and regions, including the United Kingdom, Europe, North America, New Zealand, and Japan. These guidelines address design, fittings, maintenance and disinfection. The most recent guidelines stress the need for general control of microbial water quality, including both *Legionella* species and *Pseudomonas*¹⁴.

In conclusion, the review of the above arrangements and the experience gained in responding to the recent cases of legionellosis has highlighted the following:

- There are a range of agencies involved in the regulation of practice in regard to manufactured water systems. While communication and collaboration between agencies occurred from early on in The Wesley Hospital incident, clear articulation of the respective roles and coordination arrangements between agencies is warranted to ensure that the most effective approach is in place in Queensland. This forms the basis for recommendation three (on page 45)
- Greater national collaboration is warranted, to harness the collective knowledge and expertise available across jurisdictions. Collaboration could focus on, but not be limited to addressing the gaps in standards, guidelines and associated tools identified as part of this review, and to developing a single national guideline for manufactured water systems, to be reviewed periodically as new knowledge emerges. This would benefit all jurisdictions by avoiding duplication of effort and reducing pressure on already stretched specialist expertise. It would also benefit owners/managers of water delivery systems that operate across jurisdictional boundaries, reducing the regulatory burden and the need to consult different documents. This forms the basis for some aspects of recommendation four (on page 44).

5.3 Approaches to detection of disease and associated public health responses

5.3.1 Current arrangements

The second type of regulation relevant to legionellosis is disease notification. This involves a requirement under all state and territory public health Acts, for certain individuals, mainly doctors and directors of pathology services, to formally notify the relevant Department of Health of the diagnosis of conditions specified as notifiable conditions under regulation. Legionellosis is one such condition. The Department of Health is also required to maintain a notifiable conditions register and officers are authorised to take action as required in response to such notifications.

These requirements provide a basis for initiating investigations, identifying potential outbreaks, identifying common sources of infection, taking appropriate action to prevent further cases, and issuing public advice. It also enables monitoring of the epidemiology of legionellosis and other notifiable diseases to better understand it and to inform prevention strategies.

In emerging situations, Queensland Health may undertake additional surveillance, including active case finding and increased communication with key stakeholders, such as alerts to clinicians and media alerts. Active case finding could include using broader clinical screening

¹⁴ *Pseudomonas* are a group of bacteria found commonly in soil and other natural environments. Generally, people who are at most risk of getting *pseudomonas* infections and becoming seriously ill are those who have a weak immune system.

criteria for testing, and encouraging clinical notification by general practitioners (GPs) and emergency departments, and reporting of possible cases to the 13 HEALTH phone line by members of the public.

Notification requirements for legionellosis are outlined in guidance documents for pathology laboratories as outlined in Section 4.2.2 above.

The public health response to notifications of *Legionella* positive patient test results by pathology laboratories is nationally consistent and outlined in the *Series of National Guidelines* (SoNG) for legionellosis, developed under the auspices of Communicable Disease Network of Australia¹⁵.

5.3.2 Discussion

Individual jurisdictions may add additional guidance to the SoNG for communicable diseases in the form of state based guidelines, which build on the SoNG. Beyond this, responding to individual cases, clusters or outbreaks is at the clinical discretion of the relevant public health physician. It should be noted that neither the SoNG nor the Queensland Health guidelines for legionellosis provide detailed advice on the public health responses to possible healthcare acquired cases, in particular in relation to active case finding, and in relation to environmental testing and responses to positive environmental test results. This issue is the basis for aspects of recommendation four (on page 44).

The Notifiable Conditions System (NoCS) database was developed in 1996. Since that time, as issues have been identified, enhancements have been made. These modifications have generally addressed an immediate or urgent problem without a systematic review of global system issues. For example, there is only limited capacity to interrogate the database, which is now technically outdated. There is currently no available electronic clinical information management capacity in public health units, including limited capacity for electronic transfer of enhanced surveillance data to NoCS. This capacity is important to:

- support public health action in responding to notifiable diseases and outbreaks
- enhance statewide reporting of outcomes, quality and activity
- reduce data entry and transcription errors.

Issues have also been identified with the robustness of the electronic transfer features for notifications from pathology laboratories. This has required the addition of a back up system whereby the laboratories also send notification lists daily by fax or mail and/or email to the Department of Health and the relevant local public health unit, creating an additional burden on both pathology laboratories and public health staff. Work is underway to scope the requirements and assess the best option for the future. Funding approval will then be required. This issue forms the basis for recommendation five (on page 44).

6.0 *Legionella pneumophila* infection in the community

The ways in which legionellosis can be contracted in community settings have been discussed in Section 3. Despite *Legionella* being widespread in community water supplies the risk of acquiring Legionnaires' disease is low. Routine and effective maintenance of cooling towers, heated water systems and other water systems in both commercial and domestic settings remain the most

¹⁵ A national interjurisdictional committee which includes senior officers from all states and territories and the Commonwealth which functions under the National Health Protection Principal Committee, a committee under the Australian Health Ministers Advisory Committee (AHMAC).

important measure of prevention. The special responsibilities of residential aged care facilities have been discussed previously in Section 5.2.6.

At the time of the notification of Legionnaires' disease in the two patients at The Wesley Hospital, the issue of whether other policies and programs had the potential to inadvertently contribute to the risk of legionellosis was raised. This was in the context of recent initiatives relating specifically to energy efficiency, including the former Climate Smart Program. In reviewing the scope of these programs, no issues of concern were identified. The basis for this assessment is summarised below.

The Climate Smart Program included the Climate Smart Home Service—a residential energy efficiency program which ran from 2009 until mid-2012. It was specifically designed to help Queensland households save money, energy and contribute to a cleaner environment. The service included a visit from a licensed electrician who conducted a household power assessment, installed a range of energy saving devices and a water efficient showerhead, and where indicated, adjusted the hot water system thermostat.

The electrician tested electric hot water systems to determine whether the temperature could be safely reduced and, if so, offered to adjust the temperature of the storage tank to 65 degrees Celsius where the test recorded a temperature above this. This temperature was chosen to assist customers to avoid wasting electricity while remaining above the minimum temperature for the storage of hot water (in regulation) to avoid the growth of *Legionella*. The minimum of 65 degrees Celsius provided a safety margin, allowing for potential variances in manufacturing tolerances.

Two other programs were reviewed. The Smart Energy Saving Program was a program under the *Clean Energy Act 2008*, which has since been discontinued to reduce the regulatory burden on Queensland businesses. Under the program, relevant businesses were required to report on their energy use, undertake audits and prepare a report on an energy savings plan. EcoBiz is a program designed to help Queensland companies measure their current energy, water and waste use, identify opportunities and plan and implement efficient business practices. This program included working with a range of businesses, including hospitals, health services and residential aged care facilities. The focus in these settings was in the areas of lighting, water consumption, waste and transitioning from electric hot water systems to solar and heat pump systems. Neither program makes reference to water storage tank temperatures below the minimum 60 degrees Celsius.

It is also worthwhile to comment on the issue of the requirements to deliver heated water at outlets used primarily for personal hygiene purposes at temperatures not exceeding 45 degrees Celsius (in selected settings, such as schools and child care, healthcare, aged care and disability care facilities) and not exceeding 50 degrees Celsius (in domestic settings), introduced into AS 3500.4 Heated Water Services in 1994. This requirement is complementary to the requirement for hot water to be stored at a temperature of at least 60 degrees Celsius. This is achieved by the inclusion of tempering or TMV/s in pipework between the hot water storage tank and outlets, which mixes hot water from the storage tank with cold water to achieve the lower temperature at the tap or shower fixture. The aim of these requirements, in combination, is to reduce the incidence and severity of scalding injuries particularly in children and older people, while at the same time minimising the risk of legionellosis.

Despite the low risk to the community more broadly, there are opportunities to increase awareness of the potential risks associated with *Legionella* in manufactured water systems. This is the basis for recommendation six (on page 44).

7.0 Responses to issues identified as part of the review

In addition to the work undertaken in response to, and following, the case of Legionnaires' disease at The Wesley Hospital, the Department of Health has commenced or will commence following the release of this report, a number of pieces of work to progress the issues identified as part of the review and provide a more robust system-wide approach to the management of risks associated with *L. pneumophila*.

In relation to water infrastructure and water quality management these are:

- a guideline for the water supply response if *Legionella* is detected in healthcare and residential aged care water supply. Interim guidelines have been released for healthcare facilities and these are being further developed based on feedback
- a guideline for the management of microbial water quality in Queensland healthcare and residential aged care drinking water systems will be developed over the medium-term, building on the current interim guidance document and also addressing the gap identified in guidelines elsewhere in relation to strategies required if initial efforts are unsuccessful—further research into the efficacy and implementation of these guidelines will also be progressed
- a robust, detailed water quality risk management plan guidance document to support the above requirements and, in time, be incorporated into the guidelines recommended above. Work completed to date has developed a high-level plan structure—this will include guidance with regard to testing for *Legionella*
- progression of practical education, training and skills-based development for relevant health service managers in order to better inform Queensland Health efforts in characterising and managing hospital and healthcare infrastructure water quality
- development of additions to the *Capital Infrastructure Requirements* to address the infrastructure improvements that should be implemented, including the detail of how healthcare drinking water infrastructure is disinfected prior to handover from building contractors to building owners—the *Capital Infrastructure Requirements* applies only to public sector health facilities, these requirements will be extended to private health facilities through an amendment to the *Private Health Facilities Act 1999 Standards*
- an investigation into the role that incoming water quality may have on the risk of *Legionella* growth within hospital water systems—this will include consideration of the following factors in service provider water supplies: water temperature, water age, disinfectant residual, organic carbon and any other factor that could promote *Legionella* proliferation in the water systems of healthcare facilities
- final analysis of the statewide hospital water testing data, once all re-sampling results have been obtained, to inform future work.

In relation to patient management when *Legionella* is detected in a hospital facility:

- a guideline to assist hospitals in ensuring they were undertaking best practice management of patients in the event of positive detections in water systems or potentially hospital acquired cases—interim guidelines issued as part of the response to the two cases at The Wesley Hospital are being peer reviewed prior to finalisation.

In relation to notification, surveillance and follow-up of potential cases:

- further investigation into the notification process in collaboration with notifying laboratories to identify the reasons why some positive legionellosis test results were not recorded on the NoCS
- review of the laboratory notification criteria for legionellosis under the *Public Health Act 2005*, in consultation with the Department of Health's Laboratory Reference Group
- requesting all laboratories review their systems, processes and quality assurance, and training mechanisms as they relate to notification requirements—this is particularly with regard to occasions when new tests are introduced or other changes are made which affect the work procedures, and/or which have the potential to impact on information system functioning and ultimately notifications being received by Queensland Health
- review of processes to improve collection, analysis and reporting of both routine and enhanced surveillance data
- review of quality improvement processes for monitoring data quality and completeness in NoCS
- review of the *Legionellosis – Queensland Health Guidelines for Public Health Units* to determine if more specific guidance is warranted in relation to public health management in cases where it is possible the exposure occurred in a hospital or residential aged care facility.

In relation to *Legionella* risk in community settings:

- review and update, as required, current Queensland Health fact sheets, web content and guidelines for businesses and the public, including advice regarding hot water systems and spas.

8.0 Conclusions and recommendations

8.1 Conclusions

The investigations undertaken in relation to the cases of Legionnaires' disease and death of a patient at The Wesley Hospital found that:

- with regard to compliance by The Wesley Hospital with the *Private Health Facilities Act 1999*, and in light of the absence of a requirement currently to test for *Legionella* in hospital water systems, although some administrative breaches of legislation were detected, none would warrant punitive action under the *Private Health Facilities Act 1999* based on information received at the time of the investigation
- there was no evidence indicating negligence or intent on the part of the hospital resulting in harm to visitors, patients, hospital staff and/or the greater community that would warrant punitive action based on information received at the time of the investigation
- the majority of issues identified during the investigation were system and process type lapses related to the administrative aspects of the hospital's management of, and response to, the outbreak of Legionnaires' disease—these mostly related to the fact that timely reporting of an unexpected death of an inpatient to the Chief Health Officer and to the Coroner did not occur
- the failure by SNP to notify the first positive *Legionella* test results was due to deficiencies in the laboratory information system and supporting procedure document—in this case,

this failure had no impact on future risks to other patients given the prompt action undertaken by The Wesley Hospital.

It is the view of the Chief Health Officer that:

- The Wesley Hospital responded promptly and comprehensively to the notification of positive results in two of its patients, including extensive investigatory work and enhancements to its water infrastructure to help further reduce any future risk to patients, and active case finding to determine if any other patients had developed the infection
- SNP responded promptly on being advised by Queensland Health that the notification of the first case had not been received, identifying how and why the failure had occurred, and making the necessary modifications to its information system and supporting bench top procedures
- public and private hospitals have responded to the detection of *Legionella* in water samples from within their facilities following the statewide water testing program, informed by guidelines issued by the Department of Health—action is continuing where required
- there is no evidence that current and past government climate change and energy efficiency policies and programs have promoted unsafe practices or contributed to any increase in risk of contracting legionellosis.

The findings of the broader review, however, include:

- the results of the hospital water testing program
- the assessment by the technical advisory panel of the risks associated with drinking water systems in healthcare facilities
- the review of current arrangements for prevention and control.

These point to a number of areas for improvement that would make for a more robust system-wide approach to prevention and control of *Legionella* and legionellosis. These relate to:

- regulation
- water supply to health and residential aged care facilities
- water infrastructure and water quality management, including periodic testing
- electronic data management, notification and follow-up of cases of legionellosis
- national collaboration and consistency
- information for the community.

8.2 Recommendations

In addition to the work that is being progressed by the Department of Health in relation to these issues as outlined in Section 7.0, the following recommendations are made to the Minister for Health.

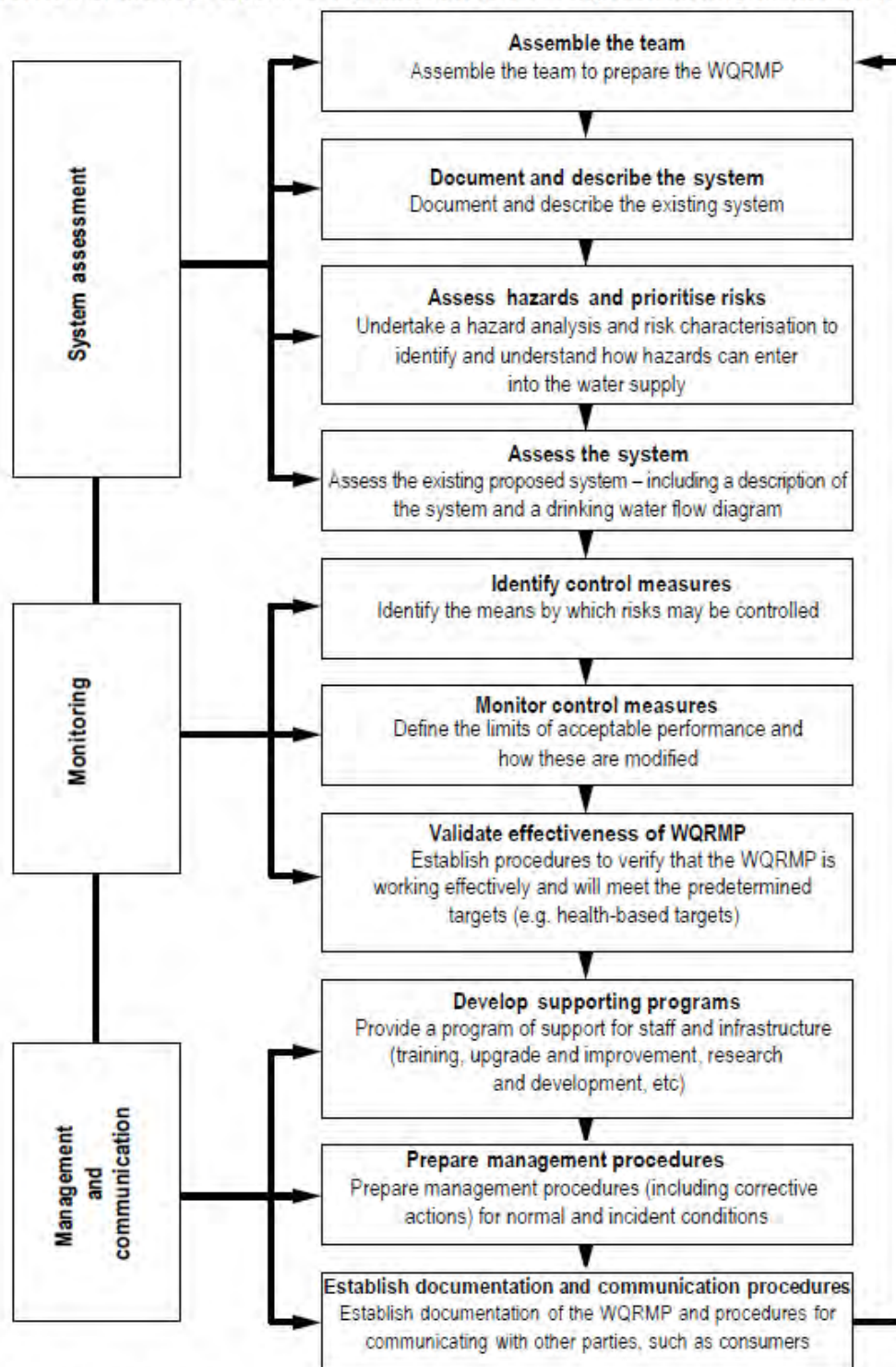
It is recommended that:

1. In the short-term, public and private hospitals and all public residential aged care facilities be required, and private residential aged care facilities be requested, to develop water quality risk management plans which will include periodic testing of their water supplies for *Legionella* and heterotrophic plate count, based on risk. This can be achieved through:
 - a directive applicable to all public hospitals and residential aged care facilities

- modification to the Physical Environment Standard within the *Private Health Facilities Act 1999 Standards*
 - a letter issued by the Chief Health Officer to all private residential aged care facilities strongly encouraging the adoption of such plans.
2. In the medium-term, legislation be strengthened relating to the design, commissioning, installation, operation and maintenance of cooling water and water delivery systems in hospitals and residential aged care facilities, through inclusion of requirements under the *Public Health Act 2005*. This would include as a minimum the requirement for facilities to have a water quality risk management plan which include requirements for periodic testing for *Legionella* and heterotrophic plate count, based on risk.
 3. A memorandum of understanding be developed by relevant regulatory agencies—Department of Housing and Public Works, Department of Justice and Attorney General, Department of Energy and Water Supply and Department of Health—to clearly articulate the roles of each agency and coordination arrangements with respect to *Legionella* risks in hospitals and residential aged care facilities.
 4. National collaboration be sought with regard to the following:
 - finalising as a priority the Australian Technical Standard for warm water systems and subsequently, the updating of AS 3500.4 to include standards for warm water systems
 - strengthening AS 3666.2 in relation to the operation and maintenance of heated water systems
 - specific requirements for the design, installation, replacement and commissioning of drinking water systems in hospital and residential aged care facilities
 - guidelines for the operation and maintenance of drinking water systems for hospital and residential aged care facilities
 - reviewing the national guideline for the public health response to legionellosis
 - reviewing accreditation processes for both hospital and residential aged care facilities to determine if aspects relating to the physical environment should be strengthened.
 5. An immediate upgrade of the Notifiable Conditions System (NoCS) be progressed to provide enhanced prevention and control capabilities including:
 - a reliable and efficient system for the electronic notification of notifiable conditions
 - electronic clinical information management capacity in public health units, that supports public health action in responding to notifiable diseases and enhances statewide reporting of outcomes, quality and activity
 - enhanced disease surveillance, outbreak detection, enhanced surveillance and early warning of disease risks, including emerging infections and pandemics.
 6. A review of information for the community be undertaken in collaboration with other agencies to ensure opportunities are maximised to increase awareness of the generally low, but potential risks of *Legionella* and how to minimise them.

Appendix 1

Overview of the key steps in developing a Water Quality Risk Management Plan (WQRMP)



Adapted from WHO (2007)

Abbreviations

ACSQHC	Australian Commission on Safety and Quality in Health Care
ADWG	Australian Drinking Water Guidelines 2011
AS	Australian Standard
AS/NZS	Australia and New Zealand Standard
BCC	Brisbane City Council
BCQ	Building Codes Queensland, Department of Housing and Public Works
cfu/mL	Colony forming units per millilitre
DFA	Direct Fluorescent Antigen
GPs	General practitioners
HPC	Heterotrophic plate count
HSCT	Haematopoietic Stem Cell Transplant
HHS	Hospital and Health Service
NoCS	Notifiable Conditions System
NSQHSS	National Safety and Quality Health Service Standards
PCA	Plumbing Code of Australia
PCR	Polymerase Chain Reaction
SNP	Sullivan Nicolaides Pathology
SoNG	Series of National Guidelines
TMV	Thermostatic mixing valve
WHO	World Health Organization
WHSQ	Workplace Health and Safety Queensland, Department of Justice and Attorney General

Glossary

Aged care	Aged care means care of one or more of the following types: • residential care • home care • flexible care.
Antibody	A protein produced by the body's immune system that recognises and help fight infections and other foreign substances in the body.
Antigen	A foreign substance that stimulates the production of antibodies by the immune system.
Biofilm	A slippery matrix produced and inhabited by bacteria, which enables the bacteria to adhere to a surface.
Clinical diagnosis notifiable condition	A notifiable condition: diagnosis of which can be made on the basis of clinical evidence, including clinical history, signs and symptoms prescribed under a regulation as a clinical diagnosis notifiable condition.
Cluster	An aggregation of cases of a disease, injury, or other health condition (particularly cancer and birth defects) in a circumscribed area during a particular period without regard to whether the number of cases is more than expected (often the expected number is not known).
Community acquired pneumonia	An acute infection of the lower respiratory tract occurring in a patient who has not resided in a hospital or healthcare facility in the previous 14 days ¹⁶ .
Cooling tower	Heat removal devices used to transfer process waste heat to the atmosphere.
Culture	The propagation of microorganisms or of living tissue cells in media conducive to their growth.
Dead leg	A redundant length of pipe in a plumbing pipework left in place or capped where there is little or no flow.
Department of Health	When referring to the department only.
Communicable Disease Network of Australia	A subcommittee, including senior officers from state and territory health departments, under the Australian Health Protection Principal Committee, a principal committee of the Australian Health Ministers' Advisory Council.
Ecology	The relationship between an organism and its environment.
Epidemiology	The study of the distribution and determinants of health conditions or events among populations and the application of that study to control health problems.
Enhanced surveillance	A process where the scale and timeliness of surveillance is increased to address issues of greater short or long-term importance. This may include active case finding and increased communication with key stakeholders, such as alerts to clinicians and media alerts. Active

¹⁶ Bartlett JG, Dowell SF, Mandell LA, et al. Practice guidelines for the management of community-acquired pneumonia in adults. Clin Infect Dis 2000; 31: 347-382

	case finding can include using broader clinical screening criteria for testing, and encouraging clinical notification by GPs and emergency departments and reporting of possible cases by members of the public.
Genotyping	The process of comparing the DNA of an organism using molecular testing to determine the relationship with other organisms or potential disease sources.
Healthcare acquired	Condition acquired in a healthcare setting (also known as nosocomial).
Healthcare facility	Means a facility at which a declared health service is provided and includes: mobile premises associated with the facility other premises or places at which persons employed or otherwise engaged at the facility provide declared health services for the facility.
Heterotrophic plate count	A test used to estimate the total number of all types of bacteria in an environmental sample, usually water. The lower the HPC the better the biological water quality. HPC is an indicator of how favourable the water environment in plumbing pipework, fixtures or storage areas is for the growth of microorganisms, such as bacteria, yeasts and moulds. It can also be used to help verify the effectiveness of disinfection processes such as chlorination.
Hospital acquired pneumonia	Pneumonia that occurs more than 48–72 hours after hospital admission, but that was not incubating at the time of admission.
Hospital and Health Service	17 statutory bodies each governed by a Hospital and Health Board.
Immunocompromised	A change or alteration of the immune system that normally serves to fight off infections and other illnesses.
Incubation period	The time interval between initial exposure to infection and appearance of the first symptom or sign of disease.
<i>Legionella</i> bacteria	The bacteria that can cause legionellosis in people. They are widely distributed in the environment in natural water sources and habitats, such as soils and mud. There are many different species. Only some are known to cause illness in people under the right conditions. The most common species to cause illness in Australia are <i>L. pneumophila</i> and <i>L. longbeachae</i> .
<i>L. pneumophila</i> serogroup 1	The group of bacteria most commonly associated with Legionnaires' disease.
Nebulisers	A machine that converts liquid medication into a fine mist that can then be inhaled.
Healthcare acquired infection (also known as nosocomial infection)	A localised or systemic condition that results from adverse reaction to the presence of an infectious agent(s) or its toxin(s) and was not present or incubating at the time of admission to the hospital ¹⁷ .
Notifiable condition	A medical condition prescribed under a regulation as a notifiable condition and which requires certain persons to notify the relevant state health department under prescribed conditions.
Opportunistic bacteria	Bacteria that take advantage of certain conditions (e.g. a host's lowered immunity) to cause disease.

¹⁷ Maynall, 2004

Outbreak	The occurrence of two or more confirmed cases of legionellosis linked by common time and place or to a common cause.
Pathogen	Organism capable of causing disease.
Pathological diagnosis notifiable condition	A notifiable condition: a diagnosis of which can be made on the basis of a pathological examination of a specimen of human origin prescribed under a regulation as a pathological diagnosis notifiable condition.
Private health facility	A private hospital or a private day hospital.
Private hospital	A facility at which health services are provided to persons who are discharged from the facility on a day other than the day on which the persons were admitted to the facility.
Pseudomonas	A group of bacteria found commonly in soil and other natural environments.
Pulmonary aspiration	Entry of material into the larynx (voice box) and lower respiratory tract to the lungs.
Queensland Department of Health	The Queensland public sector health department comprising three divisions, two commercialised business units and the Office of the Director-General. Since the national and Queensland health reforms, the service delivery arm of the former department is now made up of 17 Hospital and Health Services which are statutory bodies with Hospital and Health Boards that are accountable to the local community and the Queensland Government.
Queensland Health	Term used to describe the public sector health system i.e. the Queensland Department of Health and the 17 Hospital and Health Services collectively.
Risk management plan	A strategy for assessing, managing, monitoring, responding to, and communicating about risks specific to the business.
Sentinel event	Any unanticipated event in a healthcare setting resulting in death or serious physical or psychological injury to a patient or patients, not related to the natural course of the patient's illness.
Serogroup (sg)	A group of bacteria containing a common antigen, possibly, including more than one serotype, species or genus.
Serology	Scientific study or diagnostic examination of blood serum, especially with regard to the response of the immune system to pathogens.
Series of national guidelines	A series of guidelines developed nationally that provide consistent advice and guidance to public health units in responding to individual notifiable diseases.
Sporadic case	An individual case of disease with no links to other cases in time or place or to a common cause.
Surveillance	The process of systematic collection, orderly consolidation and analysis of data, with prompt dissemination and feedback of the results to those who need to know, particularly those who are in a position to take action.
Thermostatic mixing valves	A valve that blends hot water with cold water to ensure constant, safe shower and bath outlet temperatures, preventing scalding.
Titre	The quantity of antibody present in an organism.

Urinary antigen test	A test used to identify the presence of <i>L. pneumophila type 1</i> in a patient.
WaterMark Certification Scheme	Provides the means of demonstrating that plumbing and drainage products comply with the applicable standard(s) through the WaterMark Certificate of Conformity.

References

1. Mandell, G., J. Bennett, and R. Dolin, eds. *Legionella*. Mandell, Douglas, and Bennett's principles and practice of infectious diseases. 2005, Elsevier Inc: Philadelphia. 2711-2724.
2. South Australian Department of Health and Ageing, *Guidelines for the Control of Legionella in Manufactured Water Systems in South Australia*. 2013, Department of Health and Ageing: South Australia.
3. Swanson, M. and B. Hammer, *Legionella pneumophila pathogenesis: a fateful journey from amoebae to macrophages*. Annual Reviews in Microbiology, 2000. 54(1): p. 567-613.
4. Ministry of Health, *The Prevention of Legionellosis in New Zealand, Guidelines for the Control of Legionella Bacteria*. Revised October 2012, Ministry of Health: Wellington.
5. Soderberg, M.A., O. Rossier, and N.P. Cianciotto, *The type II protein secretion system of Legionella pneumophila promotes growth at low temperatures*. J Bacteriol, 2004. 186(12): p. 3712-20.
6. The Chartered Institute of Building Services Engineers, *Minimising the risk of Legionnaires' disease*. 2013, TM13.
7. Kilvington, S. and P. J., *Survival of Legionella pneumophila within cysts of Acanthamoeba polyphaga following chlorine exposure*. Journal of Applied Bacteriology, 1990. 68 (5): p. 519-525.
8. World Health Organisation, *Guidelines for Drinking-Water Quality*. 2011, World Health Organisation: Geneva, Switzerland.
9. Bartram, J., et al., eds. *Legionella and the prevention of legionellosis*. 2007, World Health Organisation: Geneva, Switzerland.
10. Cowell, N. and L. Selvey, *Heated Spa Associated with Legionella Pneumophila Deaths*. CDI, 1995. 19(5): p. 116-17.
11. *National Guidelines for the Control of Legionellosis in Ireland, 2009*. Report of Legionnaires' Disease Subcommittee of the Scientific Advisory Committee, Health Protection and Surveillance Centre Dublin.
12. Fraser, D.W., et al., *Legionnaires' disease: description of an epidemic of pneumonia*. N Engl J Med, 1977. 297(22): p. 1189-97.
13. McDade, J.E., et al., *Legionnaires' disease: isolation of a bacterium and demonstration of its role in other respiratory disease*. N Engl J Med, 1977. 297(22): p. 1197-203.
14. Muder, R.R. and V.L. Yu, *Infection Due to Legionella Species Other Than L. pneumophila*. Clinical infectious diseases, 2002. 35: p. 990-8.
15. Schaechter, M., et al., *Schaechter's mechanisms of microbial disease*. 2012: Wolters Kluwer Health.
16. Fitzgeorg, R., *Aerosol infection of animals with strains of Legionella pneumophila of different virulence: comparison with intraperitoneal and intranasal routes of infection*. Journal of Hygiene, 1983. 90(1): p. 81-89.
17. Johnson, J.T., et al., *Nosocomial legionellosis in surgical patients with head-and-neck cancer: implications for epidemiological reservoir and mode of transmission*. Lancet, 1985. 2(8450): p. 298-300.
18. Heyman, D.L., ed. *Control of communicable diseases manual*. 19th ed. 2008, American Public Health Association: Washington DC.
19. Australian Government Department of Health and Ageing. *Australian national notifiable diseases case definitions: Legionella case definition*. [cited 30 August 2013]; Available from: http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-surveil-nndss-casedefs-cd_legion.htm.
20. Makela, T.M., et al., *Isolation of Legionella pneumophila (serogroup one) from shower-water in Ballarat*. Med J Aust, 1981. 1(6): p. 293-4.
21. Ratcliff, R.M., et al., *Legionella pneumophila mip gene sequencing to investigate a cluster of pneumonia cases*. Pathology, 2003. 35(1): p. 65-9.
22. Amato-Gauci, A., et al., *Legionnaires' disease in Europe 2011*, in *Legionnaires' disease in Europe 2011*. 2013, European Centre for Disease Prevention and Control: Stockholm.
23. Beate, J., P. Zucs, and B. de Jong, *Legionnaires disease in Europe, 2009-2010*. Euro Surveill, 2013. 18(10): p. 20417.
24. Garcia-Fulgueiras, A., et al., *Legionnaires' disease outbreak in Murcia, Spain*. Emerg Infect Dis, 2003. 9(8): p. 915-21.

25. Benin, A.L., et al., *An outbreak of travel-associated Legionnaires disease and Pontiac fever: the need for enhanced surveillance of travel-associated legionellosis in the United States*. J Infect Dis, 2002. 185(2): p. 237-43.
26. Howden, B.P., et al., *Treatment and outcome of 104 hospitalized patients with legionnaires' disease*. Intern Med J, 2003. 33(11): p. 484-8.
27. Jespersen, S., et al., *Clinical features and predictors of mortality in admitted patients with community- and hospital-acquired legionellosis: a Danish historical cohort study*. BMC Infect Dis, 2010. 10: p. 124.
28. Dominguez, A., et al., *Factors influencing the case-fatality rate of Legionnaires' disease*. Int J Tuberc Lung Dis, 2009. 13(3): p. 407-12.
29. Hawker, J., et al., *Legionellosis, Communicable Disease Control Handbook*. Second ed. 2005, Oxford: Blackwell Publishing Ltd.
30. *Legionellosis - United States, 2000-2009*, in *Morbidity and Mortality Weekly Report*. 2011, Centres for Disease Control and Prevention. p. 1083-86.
31. Baron, P. *Generation and Behavior of Airborne Particles (Aerosols)*. 2013 [cited 2013 18 July]; Available from: http://www.cdc.gov/niosh/topics/aerosols/pdfs/aerosol_101.pdf.
32. Baron, P. and K. Willeke, *Respirable droplets from whirlpools: Measurements of size distribution and estimation of disease potential*. Environmental research, 1986. 39(1): p. 8-18.
33. Brousseau, N., et al., *Contamination of public whirlpool spas: factors associated with the presence of Legionella spp., Pseudomonas aeruginosa and Escherichia coli*. Int J Environ Health Res, 2013. 23(1): p. 1-15.
34. Coetsee, N., et al., *An outbreak of Legionnaires' disease associated with a display spa pool in retail premises, Stoke-on-Trent, United Kingdom, July 2012*. Euro Surveill, 2012. 17(37).
35. Fields, B.S., R.F. Benson, and R.E. Besser, *Legionella and Legionnaires' disease: 25 years of investigation*. Clin Microbiol Rev, 2002. 15(3): p. 506-26.
36. Mouchtouri, V.A., et al., *Legionella species colonization in cooling towers: risk factors and assessment of control measures*. Am J Infect Control, 2010. 38(1): p. 50-5.
37. Nguyen, T.M.N., et al., *A community-wide outbreak of legionnaires disease linked to industrial cooling towers—how far can contaminated aerosols spread?* Journal of Infectious Diseases, 2006. 193(1): p. 102-111.
38. Nygård, K., et al., *An Outbreak of Legionnaires Disease Caused by Long-Distance Spread from an Industrial Air Scrubber in Sarpsborg, Norway*. Clinical infectious diseases, 2008. 46(1): p. 61-69.
39. Greig, J.E., et al., *An outbreak of Legionnaires' disease at the Melbourne Aquarium, April 2000: investigation and case-control studies*. Med J Aust, 2004. 180(11): p. 566-572.
40. Victorian Department of Health, *Controlling Legionella in warm water systems*. 2010 (draft), Victorian Government Department of Health: Melbourne.
41. Li, J.S., E.D. O'Brien, and C. Guest, *A review of national legionellosis surveillance in Australia, 1991 to 2000*. Commun Dis Intell Q Rep, 2002. 26(3): p. 461-8.
42. Public Health Laboratory Network, *Legionella Laboratory Case Definition*. 2007, Department of Health and Ageing: Canberra.
43. Australian Government Department of Health and Ageing, *National notifiable diseases surveillance system*. 2013, Australian Government Canberra.
44. Centres for Disease Control and Prevention, *Legionellosis - United States, 2000-2009*, in *Morbidity and Mortality Weekly Report*. 2011, CDC. p. 1083-86.
45. Napoli, C., et al., *Legionella spp. and legionellosis in southeastern Italy: disease epidemiology and environmental surveillance in community and health care facilities*. BMC Public Health, 2010. 10: p. 660.
46. Sabria, M. and V.L. Yu, *Hospital-acquired legionellosis: solutions for a preventable infection*. Lancet Infect Dis, 2002. 2(6): p. 368-73.
47. Lin, Y.E., J.E. Stout, and V.L. Yu, *Prevention of hospital-acquired legionellosis*. Curr Opin Infect Dis, 2011. 24(4): p. 350-6.
48. Levin, A.S., *Nosocomial legionellosis: prevention and management*. Expert Rev Anti Infect Ther, 2009. 7(1): p. 57-68.
49. Seenivasan, M.H., V.L. Yu, and R.R. Muder, *Legionnaires' disease in long-term care facilities: overview and proposed solutions*. J Am Geriatr Soc, 2005. 53(5): p. 875-80.

50. Silk, B., et al., *Legionnaires' disease case-finding algorithm, attack rates, and risk factors during a residential outbreak among older adults: an environmental and cohort study*. BMC Infectious Diseases, 2013. 13(1): p. 291.
51. National Health and Medical Research Council, *Australian Drinking Water Guidelines Paper 6 National Quality Management Strategy*. 2011, NHMRC, National Resource Management Ministerial Council, Commonwealth of Australia: Canberra.
52. Goetz, A., et al. *Guidelines*. [cited 9 September 2013]; Available from: <http://legionella.org/guidelines/>.
53. Department of Justice and Attorney-General, *Guide to Legionella control in cooling water systems, including cooling towers*. 2013, Workplace Health and Safety Queensland.
54. Queensland Health, *Swimming and Spa Pool Water Quality and Operational Guidelines*. 2004, Communicable Disease Unit Public Health Services.

