

QUALITY INITIATIVES

Entries in the 20th Annual ACHS Quality Improvement Awards 2017

Quality Initiatives

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Category: Non-Clinical Service Delivery**Winner****North Eastern Community Hospital
First demonstration in an Australian healthcare setting of an
in-line electrochemical water treatment system for
optimising potable water quality***Scott Williams, Antony Amorico, Associate Professor Erica Donner***A. AIM**

The aim of the project is to implement and independently test an electrochemical Water Management System in Australia to address chronic Legionella counts within North Eastern Community Hospital (NECH).

B. SUMMARY ABSTRACT

Established in 1973, NECH is a not-for-profit community owned private hospital and aged care facility some 10 kilometres north-east of Adelaide's central business district. It currently comprises 60 hospital beds, eight day surgery beds, two operating theatres and a gastroenterology procedure room, along with an 84-bed residential aged care facility.

As the hospital and aged care facility covers a broad spectrum of patients and residents, from newborn babies to the elderly, the organisation is constantly on the lookout for ways to further improve patient and resident safety, particularly for those vulnerable groups.

Risk is, of course, always evident in healthcare, with water quality across the hospital an area of constant attention and efforts to mitigate and control the risk of Legionella and other waterborne bacteria a top priority.

Against this backdrop and with a Legionella issue identified in late 2013 when high counts of the bacteria were recorded in the aged care facility, NECH embarked on a program of rigorous monitoring and management in December 2013. The initial approach, from January 2014 to early 2016, saw the hospital conduct daily flushings of taps and shower heads while maintaining the heating of hot water at over 70 degrees Celsius.

Frequent water testing by an accredited commercial testing laboratory was also conducted.

In July 2014, the hospital began to explore options to install a continuous chlorine dosing system to

decrease waterborne bacteria – including Legionella – in the NECH water distribution systems. This approach posed a number of potential issues, though, among them the capital and operating costs, the uncertainty surrounding the potential residual risks of bacteria and Legionella, and the use of a potentially hazardous chemical for dosing.

Early in 2016, the hospital first met with Ecas4, a company specialising in water sanitisation and surface disinfection systems. Its patented Ecas4-Anolyte technology produces a highly effective, genuinely pH neutral, electrochemically active, metastable disinfectant without the use of toxic chemicals.

The technology is particularly suitable for water reticulation systems and infection protection in hospital environments, one of its major features being its ability to eliminate pathogens such as bacteria, fungi, viruses and mono-cell algae, from main and drinking water. Crucially, it also limits the biofilm – a thin layer of organic material where bacteria like Legionella can bind and develop – commonly found in the piping of any material. These characteristics make it especially suitable for controlling Legionella species and associated risks.

The Ecas4 technology dates back some 10 years when it was introduced to treat drinking water in complex structures that have to fight against the presence of waterborne pathogens. Despite its relative newness to market, it has already replaced many alternatives and is extensively used within European hospitals, most notably in Italy, Germany and Spain, and in Asian countries such as China, Myanmar and Taiwan, where it is considered the technology of choice.

In all locations, the technology has been 100 per cent successful in controlling waterborne pathogens while in the process saving the hospitals money by allowing them to reduce safe water heating temperatures from around 80 degrees Celsius to

less than 50 degrees Celsius – thereby dramatically cutting electricity cost.

Given its impressive international track record – and the fact that NECH had typically heated its hot water to about 80 degrees Celsius so as to be delivered at about 70 degrees Celsius, at high cost and considerable risk to infrastructure and without wholesale success since different exceedances in Legionella counts had been registered in recent years – NECH engaged Ecas4 to implement its Ecas4-Anolyte technology.

The installation went live in May 2016, making NECH Ecas4's first hospital application in Australia.

In order to acquire reliable and independent results and in addition to its own external laboratory monitoring program, NECH sought the collaboration of the University of South Australia (UniSA) as a super partes entity for data acquisition and analysis.

In particular, UniSA agreed to be involved with biofilm characterisation and the water sampling, as well as to carry out measurements of total carbon and total microbial charge, both in biofilm and water samples, together with dedicated Legionella testing (bacterial DNA analysis and qPCR quantification).

Monitoring data showed significantly reduced Legionella loads in NECH tap water within eight days of the Ecas4 installation and consistently thereafter.

This award submission, then, presents the independently verified results of Ecas4's first Australian hospital installation in treating both hot and cold water systems at NECH after a year of continuous operation.

C. REPORT

APPLICATION OF ACHS PRINCIPLES

1. Consumer Focus

NECH has long enjoyed a strong and distinguished consumer-centric ethos, as evidenced by the three most recent full accreditation and re-accreditation exercises awarding the hospital the highest possible 'Met with Merits' classification, for elements within Standard 2 Partnering with Consumers, National Safety and Quality Healthcare Standards.

In line with this ethos and in its efforts to constantly review and improve its policies, procedures and technologies and so provide the safest possible environment in Australian health and aged care, NECH had conducted rigorous internal monitoring

and management of its water supply and quality before engaging Ecas4 in 2016 to implement its Ecas4-Anolyte technology.

The hospital's primary considerations were to achieve safety, quality and reliability of its water supply for all patients, residents, visitors and staff at the hospital and aged care facility – and do so in a manner that, while being compliant with all industry standards, was cost-effective.

With the consumer – primarily the patients and residents – as the key focus, a high-level and dedicated Ecas4-Anolyte team was established to oversee the implementation program, with NECH chief executive officer Scott Williams and Ecas4 Australia director Antony Amorico at the helm. Furthermore and reflective of its focus on consumer health and wellness, both parties agreed that for the success of the implementation to enjoy authenticity and veracity, the outcomes needed to be independently monitored and the results professionally documented.

This saw the University of South Australia's Future Industries Institute contracted to monitor NECH's Ecas4-Anolyte technology program and conduct regular and ongoing analysis of the water quality.

Led by the University's Associate Professor of Environmental Science, Erica Donner, the UniSA team's water quality analysis used both standard plate count methods as well as more advanced quantitative DNA-based analysis to add a further layer of detail and a far greater level of surety..

2. Effective Leadership

The NECH project is a case study in effective leadership across a number of fronts, among them the installation of leading edge technology, the commitment to environmental best practice and, of course, the team dynamics between hospital staff, Ecas4 personnel and academics from the University of South Australia who combined to ensure its successful implementation and independent expert evaluation.

From a leading edge perspective, the NECH is the first hospital in Australia to introduce the Ecas4 technology that continually controls Legionella in its water pipelines, thus providing patients, residents, staff and visitors to the hospital with the safest and cleanest water in the country.

Given that Legionella is a real risk for hospitals, aged care facilities and all other buildings with reticulated water systems, NECH chose to display leadership by investing in the best possible – and arguably most

environmentally-friendly – system available. Not only does Ecas4 boast a 100 per cent effective track record in the control of Legionella and the elimination of pathogens such as bacteria, fungi, viruses and mono-cell algae from mains and drinking water, but it does so without the use of toxic chemicals.

Bacteria are naturally present in water and are able to form biofilm on the internal surface of pipes. Crucially, the Ecas4 system is able to kill bacteria being released from biofilms and also help prevent Legionella biofilms from building or forming in the pipes in the first place.

Furthermore and in another display of effective leadership, Ecas4 is perhaps the most environmentally friendly approach to water treatment in the world today – and testament to NECH being conscious of its role in helping to create a more environmentally-friendly world.

The Ecas4 solution is not only non-toxic but is an energy-efficient way to ensure optimal water quality. In NECH's case, all water was typically heated to 80 degrees Celsius so as to be delivered at about 70 degrees Celsius to control pathogens or bacteria that exist within its water system. This, of course, came at high cost, not to mention considerable risk to infrastructure.

With the new Ecas4 technology on board, NECH has been able to safely reduce its water heating temperatures to less than 60 degrees Celsius – thereby dramatically reducing energy consumption and cutting the hospital's gas bill by half.

In terms of team leadership and under NECH CEO Scott Williams' guidance, the hospital has a strong commitment to and embodies the community values which extend not only to the services provided but to corporate social responsibility leadership and innovation.

The team tasked with the successful implementation and subsequent evaluation comprised of individuals from NECH, Ecas4 and UniSA, each team member bringing a different strength and focus to the project.

Under Scott Williams' stewardship, the NECH team comprised of Maintenance Manager David Walker and Infection Control Nurse Sharon Piro, with Daniel's role to ensure there was no disruption to essential services throughout the installation and process, especially as, being a hospital, it runs 24 hours a day, seven days a week and 365 days a year and there couldn't afford to be any downtime.

Sharon, in turn, brought her infection control lens to the entire project to ensure that nothing implemented or applied would increase the risk of infection or infection-control issues across the organisation. She also made sure that NECH was compliant with all regulations at all times.

Ecas4, led by Director Antony Amorico with support from National Business Manager Simon Crabb, showed a real passion for and commitment to the project. As the first hospital of its kind in Australia to apply its technology, Antony and Simon adopted an exemplary collaborative approach to working with NECH on all aspects of the planning and installation.

And finally, the UniSA team under Associate Professor Erica Donner added valuable scientific and technological expertise and knowledge to the project and provided the vital independence component that ensured the validity of the system and offered the essential evidence base.

3. Continuous Improvement

NECH views accreditation as an opportunity to identify not only what the organisation is doing well but where there may be opportunities to do even better. As such, the accreditation process is to be embraced as it presents an opportunity to open one's mind to ideas from people outside the organisation and gain a better understanding of what is currently deemed best practice – and just as importantly, what needs to be done to achieve it.

The NECH philosophy centres on applying that lens to everything done within the organisation, which by definition means that all projects and initiatives are essentially about building on, fine-tuning and finessing the quality that already exists.

With regard to the Ecas4 initiative, the water at NECH was not bad. It was not an issue. But it also was not the very best it could be – and that is what drove the hospital to adopt something of a guinea pig approach and venture down a path no other Australian hospital had taken, buoyed by the knowledge that the product had delivered on its promise in other parts of the world.

When NECH's relentless commitment to continuous improvement identified Ecas4, it presented the hospital with an opportunity to enhance the water quality. And now that the water quality has been taken to the next level, NECH's commitment to continuous improvement will ensure that all within the organisation regularly reflect on where this

technology may be five years from now, even further into the future.

NECH knows that in the future there may well be a better product on the market, opening new opportunities to do things even better.

That's the crux of NECH's understanding of continuous improvement – it's about refining what you do and always aiming to do better. You never reach an end point in continuous improvement. It's a daily focus...and if you appreciate that you'll never reach the finish line, as NECH does, you will always be an ardent adherent to the concept of continuous improvement.

4. Evidence of Outcomes

The monitoring of NECH's Ecas4-Anolyte technology program was carried out by a team at the University of South Australia's Future Industries Institute led by the University's Associate Professor of Environmental Science, Erica Donner, from May 2016 to May 2017. Its primary purpose was to monitor the water quality at the point of delivery throughout the hospital, identify the varying needs of the different areas of the hospital, and facilitate the Ecas4 team to tailor treatment – in the form of dosage – for these specific areas, thus optimising the quality of the water throughout the hospital.

In her report, Associate Professor Donner notes that the initial conditions in the NECH water supply system before the Ecas4 installation showed a history of Legionella plate counts in some areas of the hospital, and significant build-up of biofilms in the flexi/plastic piping used at the point of supply across the hospital.

Furthermore, heating hot water to in excess of 70 degrees Celsius, along with increased flushing, had failed to satisfactorily control Legionella.

Another notable factor identified at the outset was that the mixing of hot and cold water took place several metres before the taps, understandably to prevent patient scalding accidents. This was identified as a likely problem zone for Legionella growth which could not be accessed for heat treatment. The Ecas4 solution with constant in-line disinfection was therefore confirmed to be one of the only suitable treatment approaches for this water supply.

The test parameters adopted for Ecas4 process monitoring and diagnostic analysis included:

- Water temperature
- pH

- Electrical conductivity
- Redox potential (Eh)
- Total chlorine
- Active chlorine
- Total DNA
- Heterotrophic colony counts (HCC)
- Legionella plate counts and serotyping
- Total bacteria quantification (16S rRNA gene counts)
- Legionella quantification (qPCR genomic units)

The Legionella plate counting method was employed as it used as the standard approach in current Legionella Regulations and guidelines. The method is relevant to all Legionella strands associated with serious human infections and death, such as *L.pneumophila*, *L.micdadei*, *L.longbeachae*, *L.feeleii*, and *L.dumoffii*. This approach has a number of challenges, among them the fact that a negative result does not necessarily indicate that Legionella bacteria is absent throughout the water system as bacteria are not evenly distributed in water samples and only a relatively small volume of water is used for plating. Furthermore, the presence of amoeba in the water, along with other bacterial species such as *Pseudomonas* spp. can confound plate count results.

Although variability and lack of sensitivity of results is a recognised issue with Legionella plate counts, plate counting is the standard regulatory method, and consistently negative results are meaningful as they indicate safe water quality at the point of use, with sinks and showers being the source of aerosols linked to human exposure by inhalation and ingestion.

To provide a higher level of detail on water quality at the point of delivery in patient rooms and facilitate more precisely tailored treatment, Associate Professor Donner and her team also conducted quantitative DNA-based analysis, which provides an added layer of detail and a far greater level of surety. Here, water is filtered through a membrane filter to collect the bacterial cells, and the total DNA is then extracted from the filter. DNA based analysis offers significant advantages over plating methods – firstly it is more specific than plating, thus allowing for more sensitive enumeration; secondly, it is more representative due to the larger volume of water sampled; and thirdly, the cost per sample is lower.

As successful treatment requires the taps at the point of use to be flushed regularly to ensure that the Ecas4 disinfection treatment reaches all outlets, nominated NECH staff members are required to

flush taps and showers each day as part of their normal duties. The highly sensitive DNA-based analysis then allowed the UniSA team to check and ensure that not only was the flushing adequate but that there was a high level of treatment efficiency in all monitored outlets.

By boosting the disinfection residual in the potable water as it enters the hospital supply network the Ecas4 technology helps ensure that all water in the hospital, wherever it occurs, is of the required standard. This is especially important in showers as Legionella is conveyed through inhalation, the steam given off by the hot water being a key source of inhalation risk. In addition, Ecas4 dosing decreases all other waterborne pathogen related risks as all cold water supplies – from toilets to ice machines – are being treated.

The conclusions drawn by Associate Professor Donner and her team were that:

- The data monitored, using both the plate count and DNA-based analysis, showed significantly reduced Legionella loads in the NECH tap water within just eight days of the May 2016 Ecas4 installation and consistently thereafter through to the latest results obtained in May 2017;
- The DNA-based qPRC analysis is a highly sensitive and cost-effective method for total bacterial community and Legionella monitoring in water supplies and facilitates point of use disinfection optimisation; and
- The Ecas4 treatment has clearly reduced Legionella-related risk at North Eastern Community Hospital and, in the process, has placed the hospital at the very forefront in water quality in the Australian healthcare sector.

The external assessment and validation of the Legionella and bacteria counts within the water are consistent with those achieved in the European and Asian hospitals that have implemented the technology, confirming that NECH has further improved the quality of its water.

At the same time and as further evidence of the outcomes, the hospital has been able to reduce its hot water heating from 80 degrees Celsius to 60 degrees Celsius, which has allowed it to halve its gas bill and save the organisation almost \$100,000 per annum.

In addition, a number of unexpected benefits have also resulted, most notably in relation to the filters in NECH's steriliser system, with the company

contracted to service the system noting that the filters are the cleanest they have ever seen in their many years in the business.

In the words of the hospital's CEO, Scott Williams, "with the Ecas4 implementation further enhancing water quality for patients and residents, saving the hospital money and allowing it to operate in a more environmentally-friendly manner, the outcomes for NECH are enormously positive and crystal clear."

5. Striving for Best Practice

It is fair to say that in becoming the first hospital in Australia to introduce the world-leading Ecas4 technology – and to take this a step further by employing both the industry standard Legionella plate counting method and complementing it with the DNA-based analysis which provides an added layer of detail and a far greater level of surety – NECH takes water quality very seriously and is constantly striving to achieve best practice in this area.

The project is also another example of the hospital's dedication to looking not just at what's going on in Australia but what's occurring elsewhere in the world as it aims for best practice.

And while there is always a degree of risk in being the first in anything you do, the fact that the Ecas4 system has proven its effectiveness in hospitals across Europe and Asia made the level of risk relatively low, added to which was another layer of risk mitigation in the form of an independent assessor, UniSA, on the project.

INNOVATION IN PRACTICE AND PROCESS

Being a small and independent community facility has never prevented NECH from being innovative or a leader in many areas of hospital and aged care endeavours.

On the contrary, the organisation has always harboured a mindset of innovation, as evidenced by its willingness to take on systems that are not necessarily prevalent in health. It also holds the view that for health to be innovative, health needs to look beyond health – and this is a perfect example of that type of novel thinking, especially given the system's history in Australia.

As a fascinating aside, the inventive thinking of Ecas4's Antony Amorico was particularly appealing to NECH as he initially imported the system from Italy to improve the water quality in his Australian florist business.

It was only when a family member contracted a bacterial infection while in hospital that he contemplated whether the technology could transcend across to other industries. After all, if it could improve the quality of water for his florist business, would it not be something that could be used to improve water quality in a healthcare setting?

APPLICABILITY TO OTHER SETTINGS

At NECH, the focus is very much on being more innovative with what you already have – and to do so, you need to look at how it can be used more broadly across the organisation. In Ecas4's case, that is to ensure that the technology and its solution does not remain solely in the hospital's cold water system, never to progress.

With the product already prepared in the hospital's system and perfectly mixed, it holds the potential to remove the use of chemicals from NECH's everyday cleaning operations.

Currently, the hospital is exploring ways to extend the application of the technology, with the area of food preparation gaining the most focus because, if NECH can get rid of chemicals in this area, it no longer needs to worry about concerns surrounding Personal Protective Equipment for Material Safety Data Sheets with chemicals.

And by eliminating the need to purchase chemicals, the Ecas4 system will also save NECH a considerable amount of money as the preparation is already present and in a ready-to-use state.

The long-term goal is also to use this technology to sterilise all NECH facilities, including waiting areas and hospital rooms post discharge.

F. REFERENCES

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G. APPENDICES

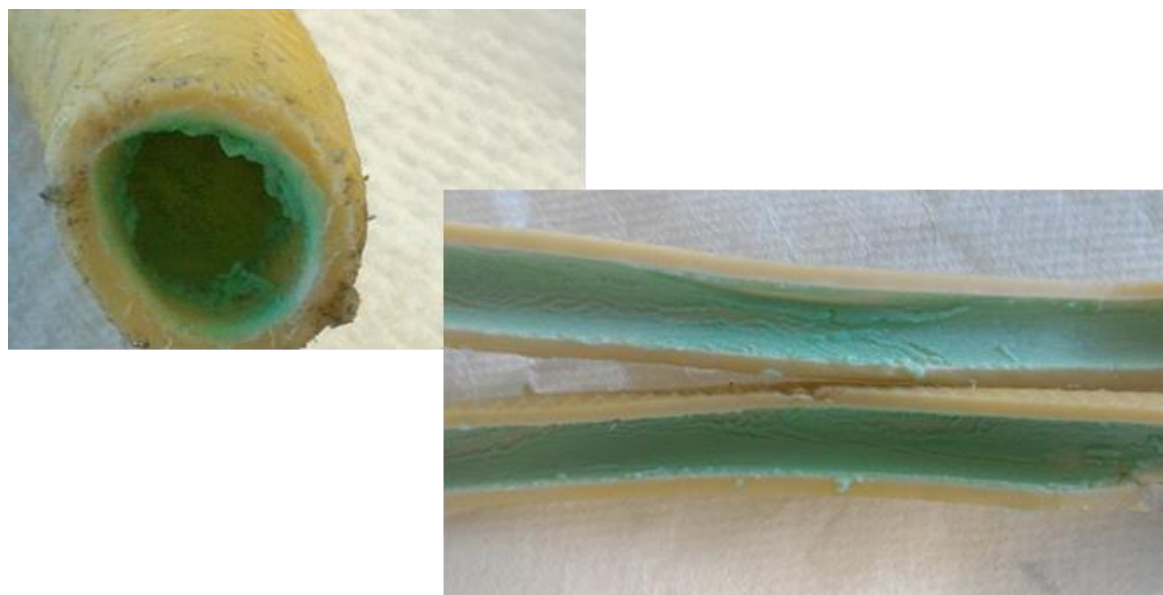


Figure 1: These images show an example of biofilm build-up on the inside of water distribution system supply pipes

Table 1: *Legionella* species colony counts (colony forming units per ml). These are standard plate counting method results from a NATA accredited commercial monitoring laboratory. Note that no positive *Legionella* plate counts have been reported since eight days after installation of the Ecas4 treatment system. *Legionella pneumophila* serogroup 1 and *Legionella pneumophila* serogroups 2-14 were not detected in any NECH tap water samples during baseline sampling or after installation of the Ecas4 disinfection system.

Legionella Spp. colony counts															
Sampling location	4th May	9th May	13th May	20th May	3rd June	17th June	1st July	29th July	12th Aug	29th Aug	12th Sep	26th Sep	25th Oct	26th Sep	26th Sep
	Baseline	Baseline	Day 1	Day 8	Day 22	Day 36	Day 50	Day 78	Day 92	Day 109	Day 123	Day 137	Day 166	Day 274	Day 376
Tank - upstairs	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room A	<10	100	500	600	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room B	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room C	100	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room D	<10	100	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room E	100	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room F	<10	<10	20	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room G	<10	200	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room H	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room I	<10	<10	<10	500	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room J	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Room K	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

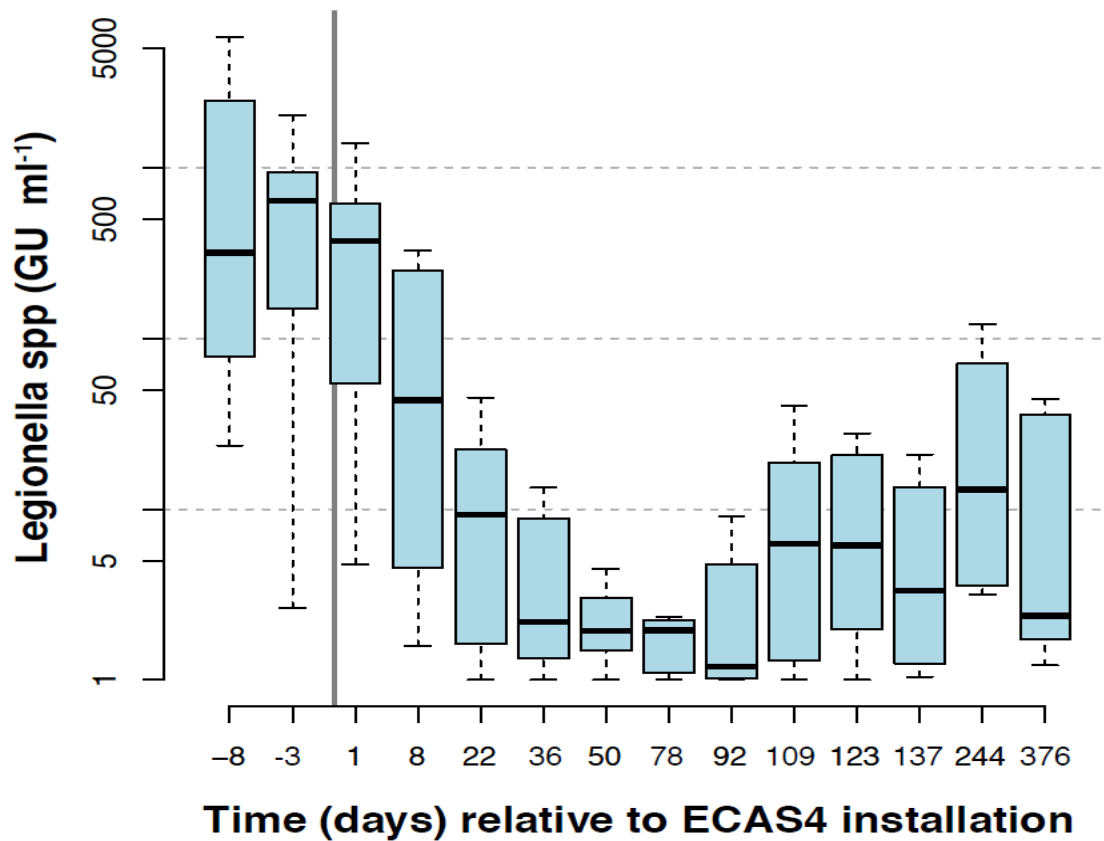


Figure 2: This graph shows the significant reduction in *Legionella* bacteria following installation and optimisation of the Ecas4 electrochemical water disinfection system at NECH. Data is presented as genomic units of *Legionella* per ml of tap water and was measured using DNA-based quantitative polymerase chain reaction analysis. Monitoring commenced eight days before installation to provide a baseline comparison point. The vertical line at Day 0 indicates the point of system installation. The data is graphed to show the median values and interquartile range of all monitored taps throughout the hospital. The heavy line within each box indicates the median number of *Legionella* from all sampling points within the hospital on that particular sampling date. Note that the graph has a logarithmic scale on the y-axis, indicating multiple log reductions in *Legionella* counts in response to the water treatment.

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