BEIPI BUILT ENVIRONMENT INFECTION PREVENTION INITIATIVE

BUILDING SAFER HOSPITALS

Building Infection Prevention into Hospital Design: Prospectus

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Healthcare Infection Society

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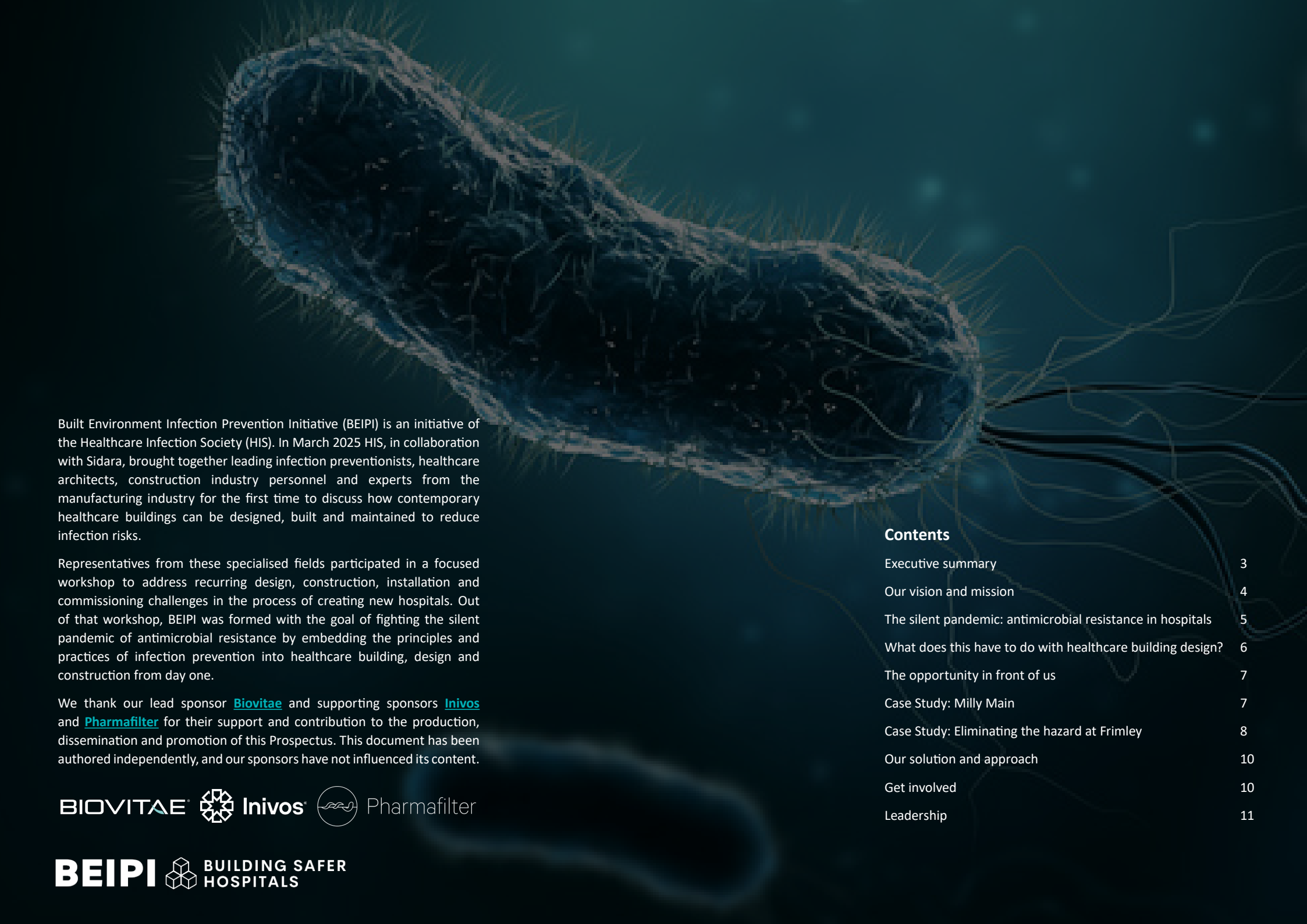

Built Environment Infection Prevention Initiative (BEIPI) is an initiative of the Healthcare Infection Society (HIS). In March 2025 HIS, in collaboration with Sidara, brought together leading infection preventionists, healthcare architects, construction industry personnel and experts from the manufacturing industry for the first time to discuss how contemporary healthcare buildings can be designed, built and maintained to reduce infection risks.

Representatives from these specialised fields participated in a focused workshop to address recurring design, construction, installation and commissioning challenges in the process of creating new hospitals. Out of that workshop, BEIPI was formed with the goal of fighting the silent pandemic of antimicrobial resistance by embedding the principles and practices of infection prevention into healthcare building, design and construction from day one.

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BEIPI BUILDING SAFER HOSPITALS

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Executive Summary

The Built Environment Infection Prevention Initiative (BEIPI) is an initiative of the Healthcare Infection Society (HIS). BEIPI aims to fight antimicrobial resistance (AMR) by building better hospitals.

With bodies from the United Nations to the World Health Organization recently highlighting the existential threat AMR poses to human health, the time for action is now. We know that elements of the hospital built environment can harbour and nourish AMR pathogens, and that not designing this out from day one can put patients and staff at immense risk, undermining the central tenet of occupant safety in all our hospitals.

We acknowledge that the evidence in this field contains gaps, but strongly believe that a risk-assessment approach is the best way to assist the New Hospital Programme (NHP) to build safer hospitals across England. We propose that instead of treating the guidance provided in Health Building Notes (HBNs) and Health Technical Manuals (HTMs) as immutable instructions, a case-by-case, risk-based approach would result in better hospitals, healthier patients and cut costs.

This prospectus makes the case for this approach. We are forming an expert panel of infection preventionists, construction professionals and hospital administrators to advise and support hospital building projects to build in infection prevention principles from day one. Our team will be able to consult on risk management, assess potential problems in your initial design, advise on derogations, and offer support and available evidence to underpin arguments for innovation and change.

To plug the gaps in our knowledge and ensure decisions are based on sound evidence, we will facilitate ongoing knowledge exchange and use the Healthcare Infection Society's (HIS) unique network of experts to build an evidence base, encouraging research to close knowledge gaps and underpin decision-making in hospital design.

The problem of AMR in hospitals is with us now. We cannot wait to start building the solution.

Our vision and mission

BEIPI was formed to fight the devastating pandemic of AMR by embedding the principles and practices of infection prevention into healthcare building, design and construction from day one.

We want every new hospital and healthcare facility to promote patient and staff health, and to centre occupant safety at every stage of design and use. Our goal is to eliminate deaths from avoidable infections acquired because of poor hospital design.

To fight infection through good hospital design, we aim to work with the NHP and other stakeholders to centre infection prevention and occupant safety into every stage of the concept, design, construction and maintenance of new hospitals. We believe that embedding the right principles from the start can save costs as well as lives.

We will facilitate continuous knowledge exchange between infection control and construction industry professionals, advocating for evidence-based risk assessments, and empowering teams to make decisions to create infection-safe hospitals.

The silent pandemic: antimicrobial resistance in hospitals

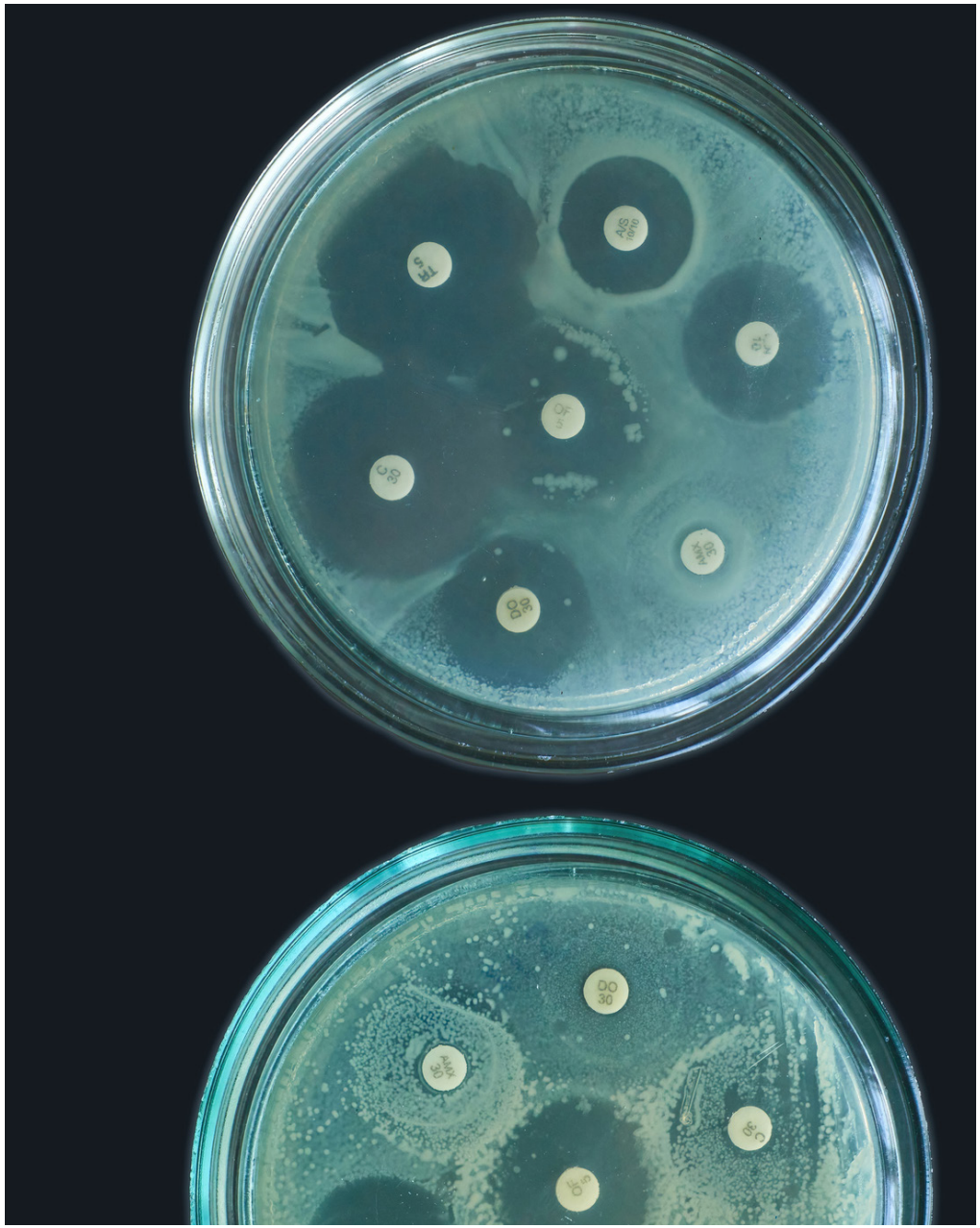
Imagine a world in which a common operation such as having an appendix removed or a C-section for giving birth is fraught with danger because the operation may be more hazardous than the condition it was intended to cure. Picture entering a hospital when you are at your most sick and vulnerable, only to find that this may make you sicker, not better.

This is the future of healthcare globally if we do not get 'antimicrobial resistance' in hospitals under control. We have become accustomed to relying on antibiotics, antivirals and other 'antimicrobial' drugs to heal us when we fall ill. But microbes fight back. Over time, they evolve to resist the effects of common drugs, and our antimicrobial treatments stop working as effectively as a result. We call this AMR.

AMR poses an existential threat to the practice of modern medicine, and to human health and wellbeing. It may rival climate change in its danger to us. The World Health Organization (WHO) estimates that in a year, bacterial AMR alone is directly responsible for 1.27 million global deaths and contributes to a further 4.95 million deaths.[1] A recent study of the key AMR pathogens found in hospitals worldwide concluded that hospital-associated infections they caused, doubled the risk of hospital death overall. In terms of cost, examples from US hospitals suggest an excess cost of $18,588 per AMR infection.[2] Closer to home, the Council for Science and Technology in 2024 stated that 'the annual cost of AMR to the NHS is already estimated to be £180 million, and urgent action is needed to reduce further burden on our public services'.[3]

These figures will only increase unless action is taken: AMR-related global deaths are predicted to rise to 10 million per year and cost the global economy $100 trillion by 2050.[4] These figures might, in fact, be significant underestimates because we are not currently detecting the true extent of the problem, its impact on patients or the costs to the NHS.

The problem is not one to consider after meeting new hospital building targets in 2040 but is with us here, now.



What does this have to do with hospital building and design?

AMR germs are found everywhere. Most of the time, our immune systems are strong enough to deal with them without help but in a healthcare context people are more vulnerable to infection by AMR germs as they are already unwell or may be immune-suppressed. In hospitals, cleaning, infection control teams and staff work hard to keep AMR germs away from patients, staff and visitors. When healthcare premises are designed and built without embedding infection control principles, they not only hinder these efforts, but actively harbour and help AMR bugs in their Darwinian struggle against antimicrobials and put hospital occupants at risk.

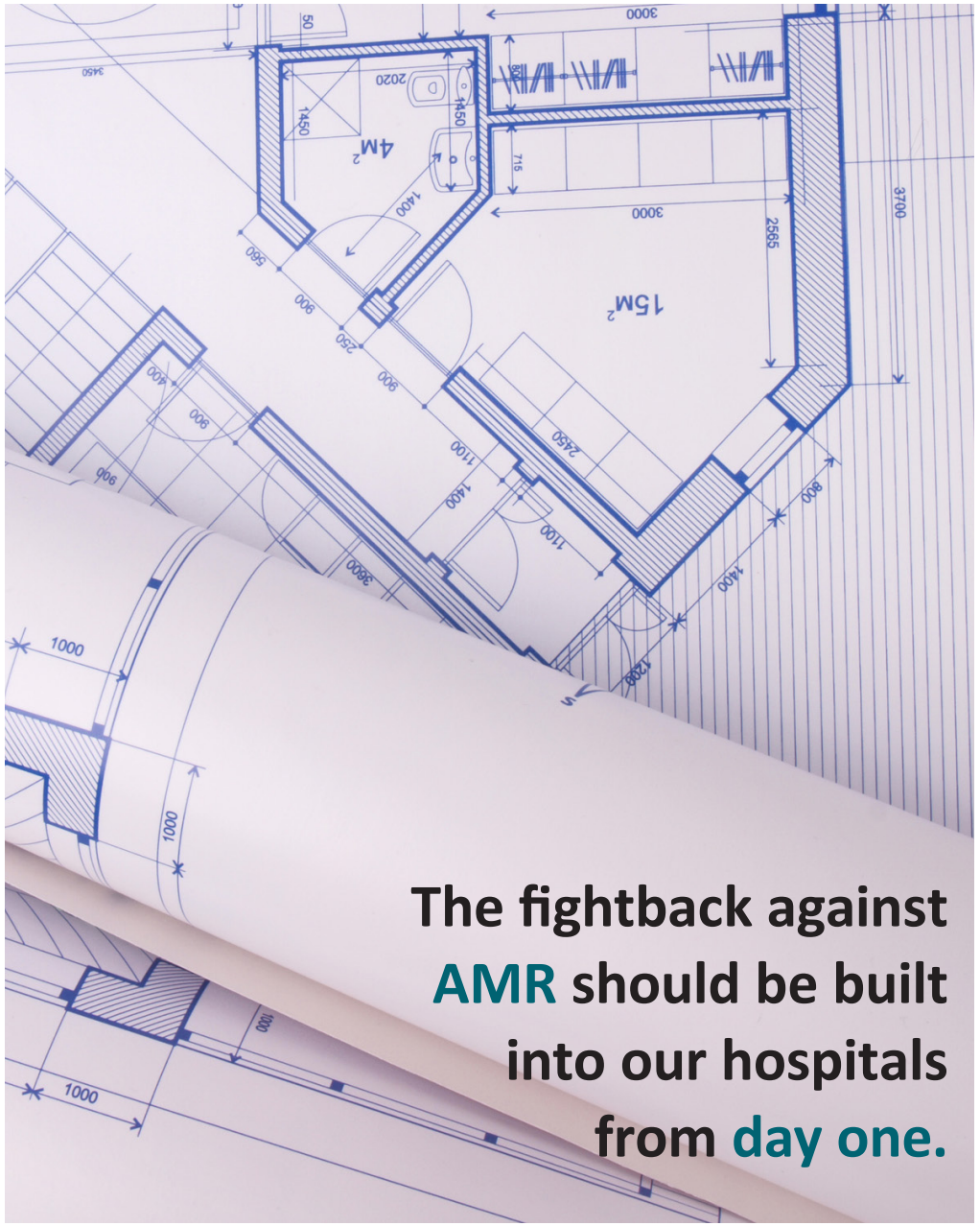
'Occupant safety' is central when building new hospitals. This is the principle that the safety of everyone who does, or will, ultimately occupy a building is the focus of every action or decision relating to that building. This requires everyone involved in a new hospital project, from its inception to occupation, to have the competency to perform their role. They must be able to understand the risks and consequences their decisions and actions may have upon the safety of the occupants. What a design looks like, how a pipe is transported and how the final vents are installed can potentially all cause harm to the occupants if there is not an understanding of AMR as a threat to occupant safety.

Consider the drainage system which is woven through a hospital building to remove waste. Every time a patient on antibiotics uses the toilet, they can excrete up to 90% of the medicine into the drains. Similarly, blood, sputum and other fluids containing infectious bacteria and viruses will find their way into the system. Wastewater pipes provide the perfect warm, moist environment for the drug-resistant microbes to fight and overpower the antimicrobials they encounter, becoming stronger.[5]

Evidence from the lab and from real-life outbreaks shows that these microbes can travel upwards and back out of drains into patient rooms due to changes of pressure in plumbing systems. A plume of AMR bacteria can spray invisibly from a toilet, sink or shower drain and infect those nearby. Drain blockages in hospitals are very frequent and have become accepted as the norm, while these emit dangerous pathogens. Despite government guidance existing in the form of the HTMs and HBNs, many of the experts consulted for this prospectus agreed that these often lag behind the rapidly evolving knowledge, innovation and practice in the field. The design of drainage systems, for instance, has not been reviewed for several decades. It is critical now that we revise and redesign such systems to function more effectively and safely.

Hospitals are some of the most complex buildings and the exacting safety needs of the occupants and the risks associated with the built environment compound this complexity.

AMR remains a persistent and growing threat within hospitals. Risks stem from water supply and wastewater management systems, ventilation systems, fixtures and fittings, surfaces, and the flow of people and equipment through the building. This prospectus focuses initially on the risk of water and wastewater, however each element of the hospital's design impacts the flow of patients and AMR bacteria through the environment, and each deserves close attention.



The opportunity in front of us

The NHP is one of the most ambitious programmes of healthcare building seen in the country. The programme has a clear plan that will deliver over 40 schemes through five-year waves of investment. Scotland is also building, with a modern 'digital hospital' in planning,[6] NHS Building for Wales has invested £4m to develop new construction and delivery frameworks for the future, and Stormont this year green-lit a brand new children's hospital for Northern Ireland at a cost of £671m.[7]

The NHP has the opportunity to improve occupant safety, not just in the hospitals it builds, but through all its designs, collaborations and driving a culture shift in safety processes and practices throughout health infrastructure projects. With huge investment across the UK in new hospitals, it is critically important to get this right, and to use this remarkable opportunity to deliver facilities which cure patients, help fight AMR and save the NHS money during construction processes and into the future.

The core group of expert Healthcare Architects, leading Infection Preventionists, Mechanical, Electrical and Plumbing Engineers (MEP) and other specialists in the construction and manufacturing industries assembled by BEIPI is passionate about building good infection prevention and control into our NHS hospitals. We want to offer this expertise to assist the team at the Department of Health and Social Care (DHSC), the NHP and other stakeholders to help ensure that infection prevention is embedded into every stage of the concept, design, construction and maintenance process of new hospitals, and to lead the world in innovation in this area. Not to do so will be an expensive and potentially deadly mistake.

Case Study: Milly Main

Milly Main was only ten years old when she died.

She had been diagnosed with leukaemia and received a bone-marrow transplant at the Royal Hospital for Children, part of the Queen Elizabeth University Hospital in Glasgow, where she stayed for nine months in a sterile environment. It was not the cancer which killed Milly: days away from coming home, she caught an infection from a tube inserted into a vein in her chest.[8]

The bacteria which infected Milly was *Stenotrophomonas maltophilia*, a relatively rare bug which thrives in the humid environment of medical implants. The infection turned into sepsis, caused multi-organ failure and Milly died within days. The Queen Elizabeth Hospital is one of the biggest hospitals in Europe, opening its doors in 2015 at a cost of £850m and boasting high-tech, modern amenities. Despite the cost, the infection which killed Milly is thought to have originated in mistakes made in the planning, design and construction of the hospital.[9]

Following water-safety reports leaked to the media in 2019, the Scottish Hospitals Inquiry was opened. A 2021 review found that 84 children, including Milly Main and Molly Cuddihy, who died recently of a hospital-acquired infection picked up at the hospital, had been infected with rare bacteria linked to the water and ventilation issues in the hospital environment.[10] The inquiry is ongoing, and has cost a further £27.5m.[11]

This case study is illustrative of only one type of bacteria transmitted through water systems.[12] There are other waterborne pathogens, and pathogens which are transmitted through other routes in the hospital built environment. Getting infection prevention in the built environment wrong is a deadly, expensive mistake which can create public fear around new hospitals, and mistrust in the NHS. These issues will only grow as our ability to treat hospital-acquired infections is diminished by AMR.

"The very first requirement in a hospital is that it should do the sick no harm."

Florence Nightingale, Notes on Hospitals, 1859

Case Study: Eliminating the hazard at Frimley

At Frimley Health NHS Foundation Trust, infection control teams were fighting an outbreak of an AMR germ called CPE (Carbapenemase producing *Enterobacterales*). CPE are bacteria which live quite harmlessly in our gut as part of a healthy microbiome, but can cause severe illness and death if they find their way into the blood, bladder or other parts of the body where they are not supposed to be. They are almost completely resistant to the strongest antibiotics we have.

The outbreak started in 2021 and despite infection control interventions the situation kept getting worse. When additional surveillance systems were introduced the real scale of the issue was revealed, with multiple cases coming to light. Each of these cases represents a vulnerable patient who was already in hospital with an illness, now burdened with a painful and potentially incurable infection – and with a mortality rate in excess of 50%. It was estimated that complex cases at Frimley Health NHS Hospitals cost in excess of a quarter of a million pounds in antimicrobial treatment alone, not including other care costs. In 2019, a study reported that a CPE outbreak across five hospitals in West London cost the NHS nearly £1m over the course of 10 months.[13] Extrapolate these figures to potential issues with over 40 new hospitals over the next few decades, and the idea that 'prevention is better than cure' seems a fitting truism.

Researchers linked the source of the CPE to the hospital's wastewater system and issues with existing hospital design;[14] issues which are very common in hospitals in the UK. The design of the basins and taps was older, encouraging greater splashes from the drains. There were blockages in pipework which allowed water to sit warm and stagnant – a perfect breeding ground for CPE. Taps designed to be elbow-operated were installed in positions which elbows could not reach. An excessive number of handwash basins had been installed in high-risk locations, and pressure variations in drainage systems caused plumes of bacteria to splash invisibly onto equipment, patients and staff.

Reading this, it would be easy to assume that Frimley had strayed from the guidance around hospital building. However, each sink and the plumbing behind it was installed with the best of intentions and followed the guidance provided by the HTMs and HBNs for the prevention and control of infection, but it is undeniable that these same sinks were causing deadly infections and increasing the spread of AMR microbes through the hospital.

Before: ICU hand wash basin on each bed

Before: Signalling hand wash basin are out of use

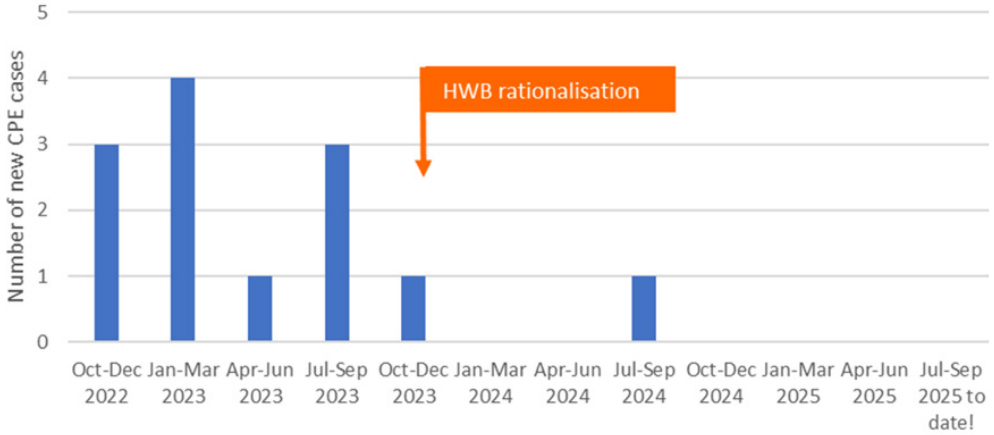


Figure 1. New CPE cases associated with a haematology/oncology ward. The orange arrow shows the point at which handwash basin rationalisation was introduced. Cases drop rapidly after this point.

Case Study: Eliminating the hazard at Frimley

In response, a cross-disciplinary team at the hospital pushed to introduce the first water-free hospital in the UK. Pioneered at the award-winning Radboud University Medical Centre in the Netherlands, water-free care removes the hazard of wastewater from patient care wherever possible. Principles used in the Netherlands were adapted and improvised to make it suitable for NHS settings – these included removing sinks in patient rooms, and objects being stored at least two metres away from any remaining sinks in other areas. Filtered water that is not contaminated by bacteria from drains is now used to wash patients, and innovations to improve tap design were implemented to eliminate drains. The use of disinfecting hand sanitiser by staff after every moment of contact with water in a sink is encouraged.

As simple as this sounds, it constitutes a huge mindset-shift for people on both the healthcare and construction sides of the divide – think back to the advice about handwashing with soap and water during the pandemic for example. Infection control teams worked with MEP engineers, estates teams, clinicians and others in the hospital to reach consensus around the proposed derogations from the standard guidelines, collectively adopting an evidence-based risk-assessment approach to make changes to suit the particular situation at Frimley.

The evidence, published by BEIPI member Dr Manjula Meda, speaks for itself:[15] the arrows on the figures below show the time at which handwash basins were removed from patient rooms and outpatient areas. The Frimley case study demonstrates that with a coordinated strategic approach, healthcare buildings in the NHS can be made to combat threats from AMR.

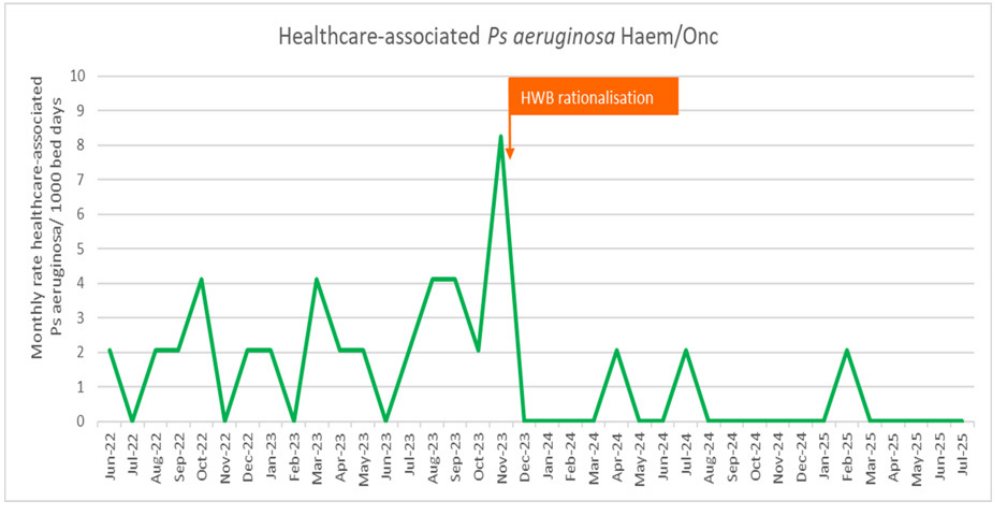


Figure 2. Healthcare-associated P. aeruginosa (another waterborne pathogen) cases on a haematology/oncology ward. The orange arrow marks where handwash basin rationalisation was introduced. Cases dropped quickly at this point.

After: "Drainless" outlet (Frimley faucet)

After: Improvised design of existing dirty utility

Official opening of waterless ICU at Frimley Health NHS Hospitals

Our solution and approach

BEIPI will collaborate with the leadership of the NHP and other stakeholders to build infection prevention policy into their strategy from day one. Two key pillars support our approach:

Expert advice

We are forming an expert panel, for the first time bringing together professionals from infection prevention, construction and hospital administration to advise and support hospital building projects on occupant safety and infection prevention principles from day one.

Our team will be able to consult on risk management, assess potential problems in your initial design, advise on derogations, and offer support and available evidence to underpin arguments for innovation and change.

Research and knowledge exchange

To ensure all decisions we make are based on sound evidence and to ensure that knowledge is shared rather than siloed, we support and will facilitate ongoing knowledge exchange and dialogue between those involved in infection prevention and in the physical construction of healthcare facilities.

We will encourage research to close knowledge gaps and underpin decision making in hospital design.

Notes on approach

We recognise that a range of factors are critical to preventing healthcare-associated infections, including areas such as ventilation. However, we have chosen to begin with water and wastewater, driven by our strong conviction in their significant role in reducing AMR and their broader impact on infection prevention and control.

Get involved

On 22 January 2026, we will hold a policy workshop to forge relationships and begin problem-solving with policymakers representing the DHSC and NHP. This will set the agenda to allow further work with policymakers to develop new protocols and tools to build infection prevention into our hospitals from day one.

To keep updated on BEIPI's next steps and for the chance to meet with our experts, sign up to our mailing list through the QR code or visit his.org.uk.

Leadership

BEIPI's core leadership team is composed of leading infection preventionists, healthcare architects, construction industry personnel and leading experts from the manufacturing industry, and is chaired by experienced campaigner Ron Finlay.

For the first time, these groups are working closely together to open lines of communication and ensure ongoing education on the principles of infection control, hospital design and ongoing healthcare management. We offer the expertise contained in this group to DHSC and the NHP to ensure we build the world-beating hospitals of the future.

Arup, Carlo Wilhelmina University of Technology Braunschweig, Currie & Brown, Frimley Health NHS Foundation Trust, Introba, Laing O'Rourke, New Hospitals Programme, Perkins+Will, P+HS Architects, Radboud Hospitals, Sisk, University College London Hospitals NHS Foundation Trust (UCLH).

Images from the first BEIPI workshop in March 2025.

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