ID Number	Name of Poster	Presenter
3	Integrating NETB 2024/3 into Risk-Structured Design Decision-Making: A Hierarchical Task Analysis for Water Safety in an NHS Capital Project	Daniel Mziray
5	BioEffective Surfaces for Transport (BEST) Network – Callout for Collaborators	Jo Flint
6	Future-Proofing Hospital Design Through Vacuum Drainage: The Buckinghamshire Healthcare NHS Trust Wycombe Hospital Case Study	Kris Wojick
7	Carry on Commissioning: Lessons from Healthcare Water Projects	Mark Conway
8	Operational Neuropathy: An Evidence-Chain Assurance Method for NHS PAM Domains and Built-Environment Infection Prevention Risk	Allen Howe
9	Wastewater as Hidden IPC Infrastructure: Mapping Drainage, Biofilm and AMR-Relevant Risk in Healthcare Buildings	Allen Howe
10	Internal Positioning Systems and the EFM Flight Deck: Real-Time Traceability for Safer Healthcare Buildings	Allen Howe
11	Backlog Maintenance as Built-Environment IPC and AMR Exposure: A Board Assurance Translation Method	Allen Howe
13	Healthcare Waste Water Treatment Unit: Translating Oxwash Closed-Loop Process Control into Hospital Water, AMR and Pharmaceutical-Residue Risk Reduction	Allen Howe
14	'Lifting the curtain on ensuite showers'.	Breda O'Brien
15	Should the "Frimley Faucet" become a standard design principle for safer healthcare water and wastewater systems?	Vicky Gentry
16	Infection prevention and control in healthcare design: a rapid scoping analysis for high-risk clinical areas to inform evidence-based guidance	Catherine Ho
17	Expanding on U.K's first water and wastewater safe environment (WAWE) hospital's experience from adult intensive care to Neonatal Unit	Vicky Gentry
18	Building bridges: Improving liaison between IPCT and Estates	Chris Lynch
19	Animate to Educate: How using animation can inform IPC risks in healthcare construction	Mark Clark
20	From First Fill to Handover: Monochloramine Dosing as a Strategy to Prevent Waterborne Pathogen Related Delays in New-Build Hospital Water Systems	Hari Singh

21	Making Older NHS Estates Safer Through the Implementation of Water and Wastewater Safe Environment (WAWE) Principles in Existing Older People's Wards	Carmen Nagy
23	Defining "Safe" Hospitals: Proposing the Foundations for Healthcare Buildings of the Future	Shanom Ali
24	Designing for Safety: Translating the NHS Scotland National Infection Prevention and Control Manual (NIPCM) Chapter 4.1 (Water) into Practice through Governance, Risk Assessment and Organisational Assurance Processes	Christina Coulombe
25	Improved Healthcare Dirty Utility Design	Mark Conway
26	Hospital sewer systems: from passive drainage infrastructure to an integral component of infection prevention	Mariëtte Lokate

Integrating NETB 2024/3 into Risk-Structured Design Decision-Making:

A Hierarchical Task Analysis for Water Safety and Infection Risk in an NHS Capital Project

York and Scarborough Teaching Hospitals NHS Foundation Trust

Daniel J. Mziray

Capital Project Manager, York and Scarborough Teaching Hospitals NHS Foundation Trust,
Doctoral Researcher in Estates Management, Leeds Beckett University

Using HTA and NETB 2024/3, we reduced water outlets from 37 to 15, improving patient safety, simplifying the water and wastewater systems and supporting a water-lite clinical environment.

Why This Study Matters

Background

- Water and wastewater systems are reservoirs for waterborne pathogens such as Pseudomonas aeruginosa and Legionella.
- NETB 2024/3 strengthens expectations for water and wastewater services and patient safety in NHS capital projects.
- Capital projects often struggle to balance clinical need, infection prevention and engineering requirements.
- There is limited guidance on how design teams should make structured risk-based decisions.

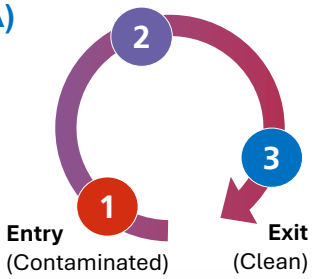
Aim

Demonstrate how NETB 2024/3 can be imbedded into NHS Capital Project risk assessment and decision making using Hierarchical Task Analysis (HTA).

Methodology

Focus on Project Water Safety Group, competence, Site Visit, Clinical Team engagement to understand water uses and users, risk assessment respecting wastewater interfaces/splash zones /processes, PWSG & Clinical Team design review and approval for a waterlite approach, endorsed by Strategic WSG governance

Hierarchical Task Analysis (HTA)

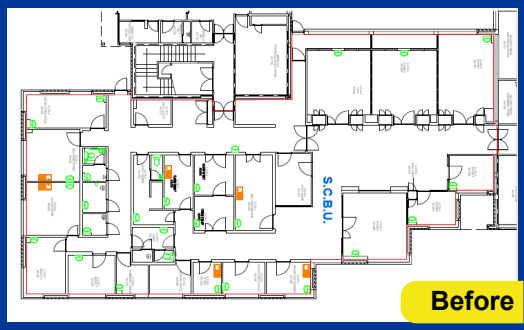


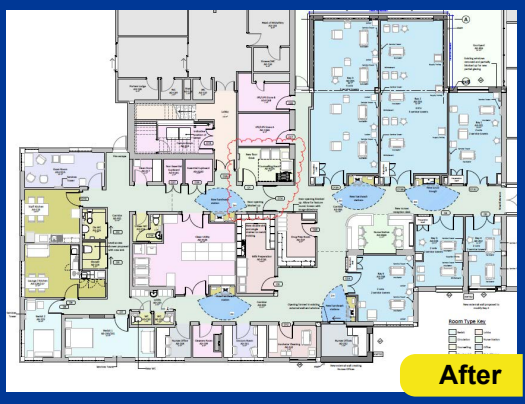


Tasks identified as bringing risk from water/wastewater interface

- Cot cleaning
- Bottle cleaning
- poor drain/slow drainage and sewer smells
- Handwashing
- Splash zones

Key Findings





Patient Safety

- Reduced pathogen exposure risk
- Estates Management
- Simpler system
- Easier monitoring
- Capital Delivery
- Lower installation cost
- Reduced lifecycle burden

Major Outcome

Water Outlets:

Before - 37 outlets

After - 15 outlets

60% Optimisation

Not just the reduction in number of outlets but the position of water /wastewater interfaces outside of patient care areas - removing risk of splash and aerosolisation from the patient care areas

This aligns with "win-win-win" conclusion

Cultural Change

Beyond Compliance: Creating a Risk-Informed Culture

Key points:

- Multidisciplinary collaboration
- Challenging traditional design assumptions
- Leadership-driven decision-making
- Shared ownership of patient safety
- Evidence replacing historical practice

Recommendations

- Use HTA during RIBA Stages 0-3
- Establish a Project Water Safety Group early
- Challenge unnecessary outlet provision
- Adopt risk-structured design principles throughout NHS projects

Conclusion

HTA enabled NETB 2024/3 to be translated into practical, evidence-based design decisions. The project achieved a 60% reduction in water outlets while maintaining clinical functionality and improving water quality and patient safety outcomes.

Acknowledgements With thanks to Gail Lindley (Special Care Baby Unit Ward Manager), Dr Catherine Whapham (Harper Water), and Dr Mike Weinbren (NHP, NHS England) for their expert guidance and support throughout this work.

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BEST NETWORK

Antimicrobial Surfaces for Transport and the Built Environment

WHO WE ARE

The BEST Network is a multi-disciplinary community of UK scientists, engineers, manufacturers, transport industry and built environment representatives and policy influencers, funded for 3 years by UK Government (EPSRC) and led by Manchester Metropolitan University.



PURPOSE OF THE NETWORK

We engage, connect, discuss, inform and develop solutions for **antimicrobial material** usage in transport and the built environment, including healthcare.

We collaborate and aim to:

- Progress manufacture, design, testing & deployment.
- Strengthen hygiene strategy with effective, evidence-based antimicrobial surface treatments and materials.

Potential IMPACTS include research collaborations, policy and working practice guidance, grant applications, testing standards and publications, but we are guided by the needs of the network.

CURRENT PRIORITIES

In the network's final year, we're continuing to engage all disciplines and also focusing on understanding the challenges and solutions for industry stakeholders. **Connect to be involved**!

We are setting up a long term legacy of resources to inform people from all disciplines, including policy, who may be interested in this area in the future. **Connect to be informed!**

TRAVEL AND KNOWLEDGE EXCHANGE FUND

Awards for up to £500 are available until 31st March 2027

We invite applications for awards to support collaboration, knowledge exchange, capacity building and impact, relating to advancing the use of antimicrobial materials in the built environment and transport sectors.

Eligible costs may include travel, accommodation, registration fees and more.

Scan QR code for info and to apply

HOW TO GET INVOLVED

Register for the network

Follow us on LinkedIn

Email: best@mmu.ac.uk

Web: thebestnetwork.org

DESIGNING FOR THE FUTURE

NEW WYCOMBE HOSPITAL - ADAPTABLE DRAINAGE

A DESIG CASE STUDY

DESIGNING ADAPTABLE HOSPITAL INFRASTRUCTURE FOR FUTURE CLINICAL FUNCTION CHANGE

The new Wycombe Hospital facility for Buckinghamshire Healthcare NHS Trust has been designed as a multi-storey healthcare building to support future expansion, including cardiology, stroke care, operating theatres and critical care services.

While the ground and first floors are to be fitted-out in the initial phase, the functions and layouts of the upper floors will be determined in future phases.

Challenge:

Uncertainty about future level and room functions created a significant challenge for the drainage strategy, as a conventional gravity drainage system would require fixed drainage stack locations during the first construction phase, limiting future flexibility and increasing construction costs.

A design review, prompted by NHS Estates Technical Bulletin () No. 2024/3, explored alternative drainage solutions that could remove internal underground drainage/manholes from within the building envelope while providing unrestricted flexibility for future clinical layouts.

The project team evaluated a transition from gravity drainage to a vacuum drainage system during the RIBA Stages 3 to Stage 4 design period.



Image source: reproduced from "Wycombe Hospital work due to start on new £20m building" BBC News

> "Vacuum drainage can provide an adaptable infrastructure strategy to meet current requirements while accommodating future changes in clinical needs and building use"

1 THE CHALLENGE

How do you design drainage for a hospital when you don't yet know what the **future departments and functions** will be?

GRAVITY DRAINAGE APPROACH

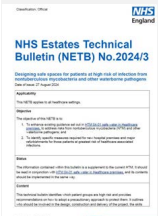
DESIGN STAGE → IN USE



- *Gravity drainage locations - future-proofing design*
- *Actual use*

Gravity drainage vertical stack positions and underground infrastructure decisions are required BEFORE future clinical layouts are known.

2 DESIGN OPTIONS



NHS England

NHS Estates Technical Bulletin (NETB) No.2024/3

DESIGN REVIEW

NHS Estates Technical Bulletin () No.2024/3

OPTIMAL DRAINAGE STRATEGY FOR PATIENT-CARE AND CONSTRUCTION

Option A Conventional Gravity Drainage

Option B Vacuum Drainage

OPTIMAL DECISION WINDOW BETWEEN **RIBA STAGES 2 - 4**

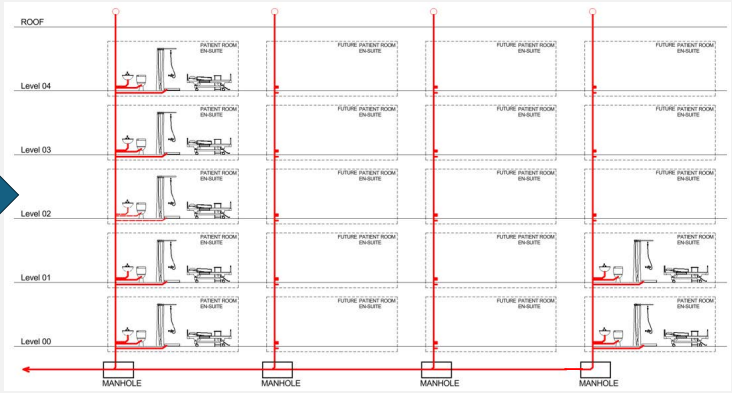
3 WHY GRAVITY DRAINAGE IS A CONSTRAINT

Option A
Conventional Gravity Drainage

- Internal underground drainage with internal manholes
- Fixed position of drainage stacks and associated connection points
- Gravity falls required
- Large diameter pipework
- Infrastructure becomes fixed before future layouts are known

IMPACT		
DESIGN COORDINATION COMPLEXITY	ADAPTABILITY ALTERATION COST	INFECTION RISK
HIGH	HIGH	HIGH

GRAVITY DRAINAGE SCHEMATIC [1]



1) Conceptual gravity drainage schematic inspired by the Wycombe Hospital project, illustrating a representative section of the system

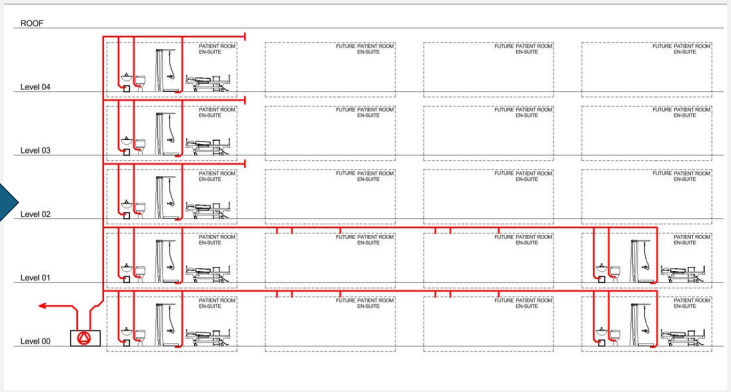
4 FIXED → ADAPTABLE INFRASTRUCTURE

Option B
Vacuum Drainage

- No internal underground drainage and no internal manholes
- Small diameter vacuum drainage distribution pipework, with **zonal isolation**
- Appliances of future departments can be positioned anywhere
- Infrastructure supports changing clinical requirements

IMPACT		
DESIGN COORDINATION COMPLEXITY	ADAPTABILITY ALTERATION COST	INFECTION RISK
LOW	REDUCED	REDUCED

VACUUM DRAINAGE SCHEMATIC [2]



2) Conceptual vacuum drainage schematic inspired by the Wycombe Hospital project, illustrating a representative section of the system

5 ENGINEERING/ CONSTRUCTION & COMMERCIAL CONSIDERATIONS

NUMBER OF PIPES: 50 INITIAL → 3 FINAL

KEY FACTOR: Unlike conventional gravity drainage, vacuum pipework can be routed at high level within ceiling voids and offset to remote locations, allowing vertical collection stacks to be positioned remotely from the sanitary appliances.

In the Wycombe design comparison, this reduces the number of required vertical drainage stacks from approximately **50 to just 3.**

ENGINEERING/ CONSTRUCTION

- Flexible pipe routing
- Reduced dependence on gravity falls
- Simplified coordination with structure & services
- Simplified adaptation for future clinical fit-out

COMMERCIAL

- **Reduced programme** and **cost** thanks for elimination of underground drainage
- **Flexibility** with minimum work required for future clinical fit-out options
- Less structural disruption and structural penetrations/firestopping

6 INFECTION PREVENTION AND CONTROL

- Zonal/system design
- Zonal isolation for disinfection
- Vertical and horizontal compartmentation of pipework to separate different risk area
- Infrastructure can adapt to change (sanitary appliances can be added / removed
- Removal of internal underground drainage

7 KEY CONCLUSIONS

DESIGN FOR CHANGE
Hospital buildings evolve throughout their operational life.

SEPARATE INFRASTRUCTURE FROM ROOM LAYOUT
Critical infrastructure should not unnecessarily constrain future clinical planning.

ADAPTABILITY HAS VALUE
Designing for future change can reduce the constraints and disruption associated with later alteration.

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ID7: Carry on Commissioning Lessons from Healthcare Water Projects

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Mark Conway, Stephen Flatman, Matthew Stenning, Alison Thomas, Catherine Whapham, David Harper

Introduction

Commissioning is a systematic quality-assurance process using engineering methods to verify that facility systems meet design specifications. Water and wastewater networks are vulnerable to colonisation by opportunistic waterborne pathogens, including Legionella spp., Pseudomonas aeruginosa, Stenotrophomonas maltophilia, and non-tuberculous mycobacteria. Risks increase with deficiencies in design, procurement, installation, commissioning, and operation. Poor commissioning may cause persistent water quality issues, threatening occupant health and safety. We outline common commissioning failures in UK healthcare facility projects, across the RIBA stages, to improve risk recognition, prevent problems, and protect occupants.

Handover

Unclear monitoring parameters and acceptance criteria lead to misinterpretation by third-party contractors and frequently delay commissioning. **Monitoring and acceptance criteria must be defined at the Design Brief stage.**

Commissioning often **over-relies on microbiological culture data** rather than verifying fundamental operational metrics: continuous hot- and cold-water temperature control, rapid drainage, and evidenced daily "building-volume" water turnover. This reliance is compounded by **sampling performed by personnel lacking necessary competency** or analysis by laboratories without appropriate UKAS accreditation. Common sampling bad practices include:

- **Invalid Pre-flush Sampling:** Sampling immediately after daily system flushing, or intentionally flushing outlets to achieve target temperatures prior to "pre-flush" sample collection.
- **Multi-sampling:** Drawing consecutive samples (e.g., Legionella and Total Viable Counts and NTM) from the same outlet on the same day. Authentic pre-flush samples require several hours of stagnation, necessitating sampling across separate days.
- **Poor sampling technique:** lack of competence to undertake sampling procedure.



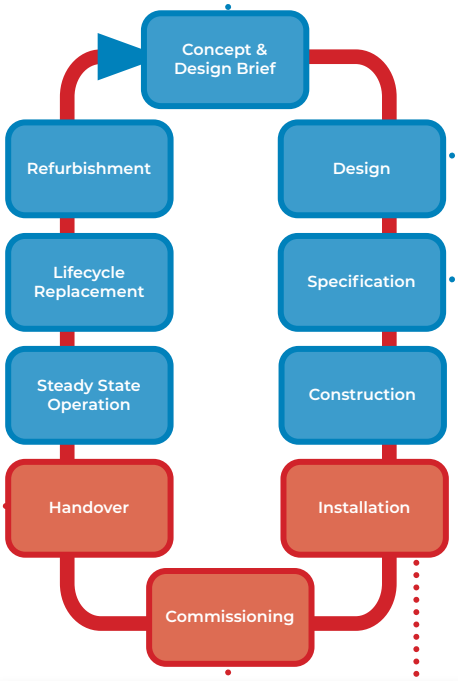




- No aseptic technique
- Dirty gloves in contact with sampling bottles and outlet
- Bottle lip in contact with outlet
- Bottle lid not replaced immediately; lid stored on dirty surface
- No inversion of bottle to mix with sodium thiosulphate
- Sequential sample rather than a "post flush" sample taken
- No controlled storage or transport conditions prior to laboratory receipt

Concept and Design Brief

- Connecting new-build water systems to existing infrastructure introduces risk, particularly where baseline temperature and microbial monitoring, hydraulic imbalances, and resources to investigate foreseeable issues are inadequately addressed.
- Failure to conduct **Hierarchical Task Analysis** (HTA) during early planning can produce designs that neglect end-user needs and workflows while incorporating redundant services. Designs must support safe patient hydration, food preparation, patient ablutions and staff hand hygiene, environmental cleaning, and asset maintenance.



Design

- **Water storage and demand calculations** often rely on outdated parameters that do not reflect current needs. Limited ward-level consumption data and installation of predictably low-use outlets (e.g., showers, slop hoppers) exacerbate over-storage. Steady-state monitoring typically identifies demand 30–50% below design estimates, e.g. **a recently opened (2025) Emergency and Urgent Care Unit used 11 m³/day to support clinical activities vs design of 24 m³/day.** Cold-water tank volumes require dynamic adjustment to operational demand and multiple daily turnovers. Variable, delayed-action float valves should enable rapid dump fills and minimise thermal gain. Stored hot water requires equivalent risk mitigation.
- **Air Source Heat Pumps** (ASHPs) pose patient safety risks by failing to consistently maintain required water temperatures during low-load commissioning and steady-state operation. Immersion backup is necessary, compromising environmental benefits, while pump sizing, positioning, and hydraulic balance often require remedial adjustment. **ASHPs currently lack sufficient robustness for healthcare settings**, although decentralised, multi-unit configurations may offer greater stability than centralised systems.
- Optimal water-service placement requires early clinical engagement through Hierarchical Task Analysis (HTA), before architectural layouts are finalised or **generic room designs** adopted. Spatial constraints, including corridors and fixed centralised utilities (e.g., Dirty Sluice, Clean Utility, Equipment Stores), **must not compromise user workflows or critical asset placement**, such as clinical wash-hand basins, macerators, and patient drinking-water outlets.

Specification

- **Thermostatic Mixing Valves and Taps** (TMV/T) should only be installed where **justified by site-specific scalding risk assessments**. Their plastic and rubber components support microbial colonisation and biofilm formation, while residual and non-sterile water from factory wet-testing increases colonisation risk. Thorough disassembly, physical cleaning, and disinfection are therefore required before installation.
- Sectional **cold-water storage tanks** are typically filled immediately after on-site assembly to verify structural integrity for warranty purposes. To minimise stagnation and biofilm growth before commissioning and handover, **"filling" should be scheduled for the final construction phase,** immediately prior to system wetting.
- Certain assets, including **point-of-use boilers, chilled drinking-water dispensers, ice machines, tea boilers, and vending machines,** pose elevated microbial risks due to factory wet-testing and complex internal materials and designs. These devices require **risk assessment before installation** or consideration for use with patients.







Installation & Commissioning

Poor installation practices in healthcare construction are endemic and multifactorial, driven by fragmented third-party subcontracting, inadequate competency, lack of Project Water Safety Plans, and limited prevention of microbial ingress pathways. These systemic failures exceed the inspection capacity of the Clerk of Works.

Critical observations include:

- **Poor Material Handling:** Pipework stored without endcaps on unclean floors; components, materials, or waste fluids placed in newly installed basins.
- **Inadequate Decontamination:** Factory wet-tested components installed without validated cleaning and disinfection; failure to maintain dirty-to-clean workflows when servicing thermostatic mixing valves following system disinfection.
- **Cross-Contamination:** Repeated use of contaminated tools, cloths, and containers; reuse of hoses and connectors for biocide injection; unhygienic "builders' clean" during handover.
- **Flushing Deficiencies:** Inconsistent or inadequate flushing protocols; outlet attachments used to reduce splash causing cross-contamination; simultaneous outlet flushing disrupting ASHP temperature control; inadequate flushing records; flooding risks from outlets inadvertently left on. Wet commissioning must be deferred until all assets are installed, enabling immediate and efficacious daily flushing of every outlet.





Conclusions

Healthcare facility commissioning experiences highlight critical deficiencies, including:

- Reliance on guidance and compliance rather than evidence-based safe practices.
- Competency and capability gaps.
- Inadequate risk recognition and assessment.
- Poor stakeholder collaboration.
- Insufficient learning and application of Hierarchical Task Analysis (HTA).
- Neglect of wastewater system risks.
- Overreliance on systemic disinfection to compensate for poor installation and commissioning.
- Failings during "builders' clean" which cross-contaminate plumbing assets, whereas housekeeping teams are trained decontamination experts.
- Overreliance on microbiological data, with limited focus on patient safety and long-term operational resilience.

Poor decisions can compromise project delivery, water and wastewater quality, patient safety, and overall costs. Occupant safety requires a competent, accountable Water and Wastewater Safety Group (WWSG).

Further Reading

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OPERATIONAL NEUROPATHY

An Evidence-Chain Assurance Method for NHS PAM Domains and Built-Environment Infection Prevention Risk



Allen Howe
The Healthcare Recode Bureau Ltd
Spilsby UK

THE PROBLEM

Operational neuropathy describes an organisation losing sensitivity to unresolved risk while its reporting continues to look satisfactory.

In estates and facilities management (EFM), that failure can occur between a ward observation, an asset record, a contractor return and the board assurance statement.

Water, drainage, ventilation and cleaning controls may be reported as complete without evidence that they protect the intended patients under actual operating conditions.

Antimicrobial resistance (AMR) adds a clinical dimension: persistent environmental reservoirs require coordinated engineering and clinical interpretation.

A green dashboard becomes unreliable when exceptions, uncertainty or ineffective controls disappear during aggregation.

THE AIM

The purpose is to test whether assurance can be traced from the clinical environment to the board and back to corrective action.

The method connects NHS Premises Assurance Model domains with operational evidence, named responsibility and competent verification.

It asks what the control should achieve, where it applies, who can authorise action and what demonstrates continuing effectiveness.

Within this proposed method, unknown and not assured describe evidence states; neither automatically establishes noncompliance.

Positive assurance requires sufficient current evidence for the specified control.

Material safety concerns require immediate escalation rather than waiting for a complete evidence pack.

THE METHOD

Each record links the care area, room, bed space and asset to patient vulnerability, hazard, required control, owner and technical requirement.

Monitoring, sampling rationale, exceptions, clinical interpretation, mitigation, remedial work and verification follow the same identifier.

Proposed failure flags include an untraceable control, missing or stale required evidence, uncontrolled material exceptions and closure without competent verification.

Aggregate scores cannot override these failures.
Minimum evidence packs include scope, justified exclusions, dated observations, authorised decisions, commissioning or maintenance records and review dates.

Implementation and demonstrated effectiveness are verified separately before closure. Changes in use or infrastructure trigger reassessment. Assurance for affected controls requires competent verification before reinstatement.

THE WORKED EXAMPLE

In an illustrative augmented care setting, repeated basin drainage problems coexist with satisfactory maintenance reporting.

Estates checks the installation and defect history; infection prevention and control (IPC) assesses basin use, splash exposure and nearby equipment; microbiology advises whether targeted environmental investigation is justified.

The Water Safety Group coordinates water safety actions through the Water Safety Plan, with drainage interfaces assessed jointly.

Immediate restrictions must preserve safe hand hygiene and patient care.

A contractor completion note cannot close the concern if drainage performance, exposure controls or recurrent defects remain unverified.
Material unresolved control failures, interim arrangements and decision authority must remain visible at board level.

IMPLICATIONS AND LIMITATIONS

The HRB evidence-chain test complements NHS PAM; its proposed scores are neither NHS ratings nor independently validated measures. It supports built environment stewardship while retaining clinical interpretation within microbiology and IPC.

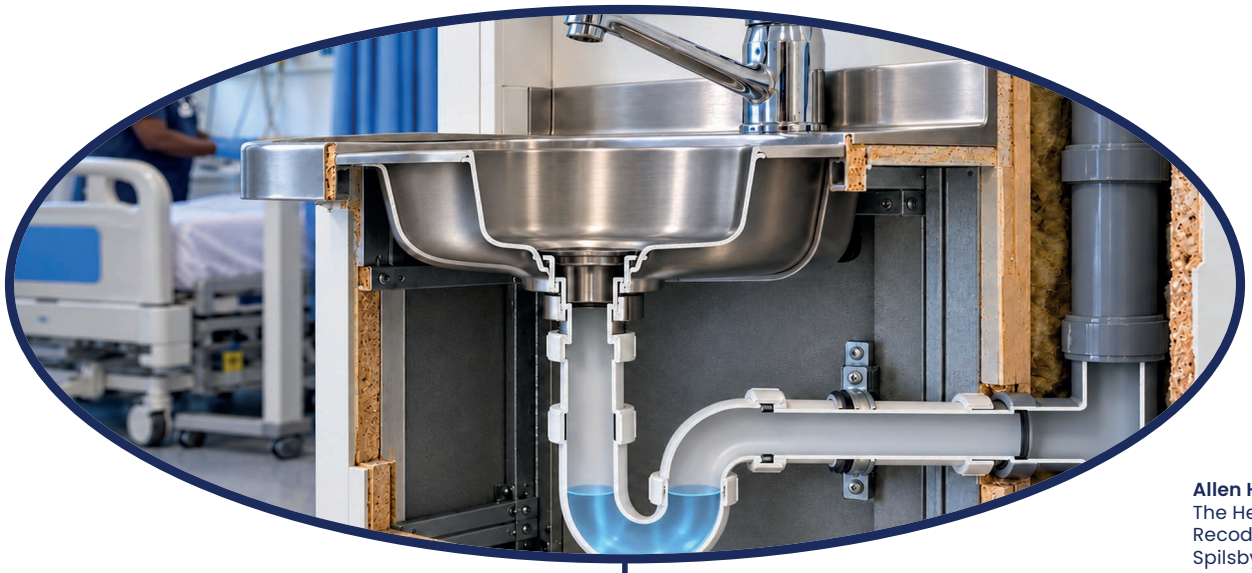
HTM 04-01 provides the water safety framework. Evaluation should use a defined record sample, independent duplicate reviews and adjudication to examine agreement, missed exceptions, escalation timeliness and sustained closure.

An open defect with effective authorised mitigation is distinguished from an uncontrolled failure.

Infection outcomes require separate study. Digitisation contributes only where evidence, authority and response arrangements remain dependable and frontline teams receive confirmation that their concerns have been addressed.

WASTEWATER – HIDDEN IPC

Translating Closed-Loop Process Control into Hospital Water, AMR and Pharmaceutical-Residue Risk Reduction



Allen Howe
The Healthcare Recode Bureau Ltd
Spilsby UK

THE PROBLEM

Hospital wastewater can support microbial reservoirs within drains, traps and associated biofilms.

At the near-patient interface, splashing, contaminated surrounds, inappropriate basin use and equipment placement can create plausible exposure routes.

The presence of resistant organisms in drainage does not, by itself, demonstrate patient transmission or infection.

Clinical significance depends on the organism, patient susceptibility, exposure pathway and epidemiological evidence.

Operational Neuropathy describes the assurance failure when drainage drawings, repeat faults, clinical observations and microbiological findings remain disconnected, leaving antimicrobial resistance (AMR) risk without a coordinated investigation or accountable response.

THE METHOD

Each mapped point records clinical function, patient vulnerability, outlet alignment, splash potential, drainage behaviour, adjacent equipment and maintenance access.

Drawings, modifications, repeated blockages, cleaning and disposal practices are checked against site observations.

Each plausible pathway needs a control, residual exposure assessment, named action owner, deadline, escalation route and closure evidence. HTM 04-01 and the National Infection Prevention and Control Manual inform operational practice; NETB 2024/3 adds specific design measures for high-risk new premises and major refurbishments.

Clinical handwash basins are reserved for handwashing. Sampling plans specify purpose, sites, timing, methods and interpretation; genomic comparisons require clinical, environmental and temporal context.

THE AIM

The proposed method makes drainage visible as infection prevention infrastructure, where vulnerable patients are exposed to wet environments.

It maps the route from source & reservoir to potential exposure, then identifies the control, supporting evidence and escalation decision.

The objective is proportionate joint action, with clear implementation responsibility, by infection prevention and control (IPC), microbiology, estates, operational and capital teams.

Drain sampling should answer a defined investigation question; it does not replace required water monitoring or assessment of design, use and maintenance.

The investigation plan specifies how positive, negative and inconclusive findings will affect clinical or engineering action. The board needs visibility of material unresolved risks, rather than an inventory of every drain.

THE WORKED EXAMPLE

In an illustrative high dependency area, splash reaches equipment beside a basin with recurrent slow drainage.

The immediate response assesses patient exposure, protects clean supplies and establishes safe alternative arrangements where necessary.

Estates investigates the obstruction and installation; IPC reviews clinical practice and cleaning; microbiology considers targeted sampling against the incident context.

An organism recovered from a drain is recorded as an environmental finding, with patient colonisation or infection considered separately.

Similar isolates may support investigation but do not establish transmission direction alone.

Repairs are followed by functional checks, review of splash and use, and confirmation that mitigation remains effective.

IMPLICATIONS AND LIMITATIONS

Drainage assurance should influence design briefs, commissioning, maintenance access and operational practice across the New Hospital Programme and existing buildings. It applies built environment stewardship to AMR risk. For relevant high-risk spaces, NETB 2024/3 recommends a two-metre clear splash zone, with screens considered where this is not possible; applicability requires assessment.

Basin removal and chemical treatment require specialist agreement and safe alternatives. Disturbing reservoirs may alter exposure. Negative samples cannot establish permanent absence, and environmental contamination is not an outbreak.

Evaluation should examine map completeness, control effectiveness, recurrence and verified closure. Reduced transmission requires appropriately designed clinical evaluation.

FLIGHT DECK TRACEABILITY HERO

Real-Time Traceability for Safer Healthcare Buildings



Allen Howe
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Spilsby UK

THE PROBLEM

Hospitals depend on continuous movement of equipment, linen, waste, supplies, staff and patients, yet task records may lack reliable location evidence.

This weakens investigation of shared equipment, delayed response and clean or dirty route crossover.

Internal Positioning Systems could improve visibility, but location data have limits. A tag beside a bed does not establish infectious contact, and a cleaner's attendance does not demonstrate effective decontamination.

Antimicrobial resistance (AMR) investigation requires the evidence chain to preserve those distinctions so that an operational display does not become unsupported clinical assurance.

THE AIM

The estates and facilities management (EFM) Flight Deck is proposed as an operational coordination and assurance model connecting location events with asset identity, task records, room status and authorised action.

It supports finding equipment, reconstructing movements and investigating exceptions while retaining uncertainty.

Lessons from the New Hospital Programme (NHP) linen and laundry work are applicable: traceability supports stock control, custody and timely replenishment, while validated decontamination remains a separate requirement.

The aim is an operational record that assists infection prevention and control (IPC) decisions, with a defined use case and measurable benefit before implementation is expanded.

THE METHOD

The design distinguishes passive RFID identification at readers from active tracking using powered tags or Bluetooth.

NHS guidance on real-time location systems (RTLS) informs implementation. Events require asset identifiers, timestamps, location estimates and quality status.

Acceptance limits for accuracy, coverage, delay and false boundary alerts are specified for each task and tested, including tag-to-asset association and historical room occupancy.

Maps, clocks and interfaces require controlled maintenance, cybersecurity and audit trails. Alerts have named response owners.

Battery condition, missing-event rates and alarm acknowledgement are monitored against predefined acceptance thresholds. Identifiable data require a lawful basis, any necessary special-category condition, role-based access and retention, and a data protection impact assessment where required. Assess DCB0129 and DCB0160 applicability and complete clinical safety assurance where required.

THE WORKED EXAMPLE

In an illustrative investigation, shared medical equipment appears in several rooms before its next recorded decontamination.

The Flight Deck retrieves movement events, verified identity, historical patient room occupancy and cleaning records.

IPC establishes whether the sequence represents relevant exposure; microbiology interprets findings. Missing scans, stale tags and uncertain associations remain visible as gaps.

Location events may prompt recovery or cleaning; completion requires an attributable, time-stamped record identifying the equipment, approved procedure, operator and relevant checks.

Linen movements support segregation and custody without certifying microbiological quality. Safety-critical uses need visible signal loss, escalation and tested fallback arrangements.

IMPLICATIONS AND LIMITATIONS

Location intelligence can strengthen logistics and outbreak investigation when its uncertainty and operational dependencies are explicit. It cannot independently prove transmission, cleaning effectiveness, compliance or successful evacuation.

Fire response and missing person procedures require established human checks and tested fallback arrangements. Staff monitoring must be necessary, transparent and proportionate to the stated purpose. Evaluation should compare baseline and implementation performance for retrieval time, missed events, false alerts, response completion and data quality, alongside staff experience. Clinical benefit and AMR reduction require separate evidence. The model links location to competent interpretation and verified action before contributing to board assurance.

BACKLOG MAINTENANCE

Built-Environment IPC and AMR Exposure: A Board Assurance Translation Method



Allen Howe
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THE PROBLEM

Backlog maintenance is usually reported as cost, condition and capital liability. Those measures alone do not explain how a defect affects controls supporting safe care.

Damaged finishes can impede cleaning; water and drainage failures can alter exposure; ventilation defects can compromise specified performance; unavailable rooms can force unsuitable decant arrangements.

The relationship must be assessed rather than assumed. Neither the value of backlog nor the presence of an ageing asset establishes infection or antimicrobial resistance (AMR) transmission.

Operational Neuropathy becomes relevant when repeated defects and temporary workarounds are absorbed into routine reporting without their clinical consequences remaining visible.

THE AIM

The translation method brings material infrastructure concerns into patient safety assurance through five questions: who is exposed, which controls depend on the asset, what mitigation operates, what evidence demonstrates control, and when temporary tolerance has become unsafe normalisation.

It connects the estates register to infection prevention and control (IPC), clinical operations, capital planning and board decisions. Assessment of AMR risk includes environmental reservoirs and transmission opportunities without transferring clinical accountability to estates.

New Hospital Programme planning should use this reasoning to test whether design, maintainability, commissioning and operational resources support the care model throughout the asset lifecycle.

THE METHOD

Assessment starts with a reported defect or credible concern, recording verification status, location, service function and affected patients.

It identifies the plausible failure pathway, technical requirement and consequences of continued use or withdrawal.

Evidence remains distinguishable: estate returns, engineering inspection, guidance, surveillance, investigations, research and professional judgement.

Interim controls need a competent owner, monitoring, review dates and escalation triggers, with residual risk and continued use decisions recorded by the authorised service lead.

Prioritisation considers clinical vulnerability, control failure, recurrence, resilience and evidence confidence alongside cost and condition. Uncertainty remains visible while investigation proceeds; risk ratings cannot replace reasoned challenge.

THE WORKED EXAMPLE

In an illustrative ward, water ingress damages finishes close to a treatment area.

Estates establishes the source, extent and affected services; IPC assesses damp materials, cleaning, storage and patient placement; repair plans address dust and disturbance where vulnerable patients remain nearby.

Clinical leaders consider service restriction or decant risks, including pressure on isolation capacity. Ventilation performance is checked when systems or intended room function are affected.

Temporary arrangements are recorded with decision authority and review dates. Closure separates repair completion, functional verification and authorised acceptance of the restored care environment; independent technical challenge is proportionate to risk.

Repainting alone cannot establish that the original failure has been resolved.

IMPLICATIONS AND LIMITATIONS

Boards should receive a concise account of material exposure, control confidence, interim arrangements and the decision required.

The method supports challenge over deferred expenditure and repeated extensions of temporary controls while retaining uncertainty about clinical causation. Infection prevention design guidance and applicable Health Technical Memoranda provide technical context; local assessment determines relevance.

The proposal requires testing for consistency, workload and investment usefulness. It cannot convert national backlog totals into attributable infections or an AMR burden. Evaluation should test reviewer agreement on control dependencies and whether decisions change when mitigation expiry and recurrence are visible, using a documented comparison method.

WASTEWATER EVALUATION

An Evidence-Chain Assurance Method for NHS PAM Domains and Built-Environment Infection Prevention Risk



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THE PROBLEM

Healthcare wastewater can contain microorganisms, resistance genes, pharmaceutical residues, detergents and suspended solids, with composition varying by source.

Recovery requires evidence for the specified destination, including exposure created by reuse.

The New Hospital Programme (NHP) linen and laundry work identifies approaches used in B Corp laundries and wider industrial research. B Corp certification concerns business impact and does not establish a treatment specification.

Operational Neuropathy arises when specifications or recovery percentages become assurance without verified water quality, failure response or safe residual handling.

Treatment performance, environmental discharge benefit and patient protection require different evidence and must remain distinguishable.

THE TECHNOLOGIES

Screening and microfibre filtration capture selected solids according to particle size and maintenance.

Equalisation moderates flow and loading. Biological reactors use microbial biomass to metabolise biodegradable organics; membrane bioreactors combine biology with membrane separation, while moving bed systems retain biomass on carriers.

Ultrafiltration performance depends on the membrane and its integrity. Reverse osmosis separates permeate from concentrated reject without destroying rejected substances.

Activated carbon adsorbs selected contaminants, requiring capacity monitoring and replacement before unacceptable breakthrough.

UV disinfection targets specified microorganisms; advanced oxidation targets selected chemicals. Both require validated operating conditions, with oxidation by-products assessed. Heat recovery requires safeguards against cross-contamination.

THE AIM

The proposed Healthcare Process Water Treatment Unit begins with feasibility assessment of segregated laundry/process effluents, with named inclusions and exclusions.

Discarded medicines, cytotoxic waste and radioactive streams remain outside the initial pilot under dedicated disposal arrangements.

Characterisation covers flow, suspended solids, organic loading, target residues and biological inhibitors. Water and contaminant balances precede technology selection. Potable and clinical supplies require verified separation and backflow protection.

HTM 04-01 informs Water Safety Group oversight; IPC, microbiology, pharmacy, engineering and environmental specialists agree destination-specific quality criteria.

Reuse assessment addresses aerosols, staff contact and effects on linen decontamination or subsequent recontamination.

THE VALIDATION PLAN

Acceptance criteria specify intended use, target organisms and chemicals, limits, sampling frequency and release evidence.

Culture and susceptibility testing assess viable resistant bacteria; DNA detection alone cannot establish viability or expressed resistance. Influent and effluent sampling accounts for residence time and representative loading, reporting recovery, detection limits, matrix effects and flow-adjusted loads.

Operating surrogates require correlation with validated performance. Distribution integrity and regrowth require ongoing verification. Commissioning challenges fouling, membrane integrity, overload, power loss, sensor failure, bypass and storage regrowth.

Hold or diversion limits, escalation and release authority are defined. Sludge, filter solids, spent media and concentrate require characterised disposal routes and a documented contaminant balance.

IMPLICATIONS AND LIMITATIONS

This is a feasibility proposal requiring controlled piloting, not an approved hospital reuse system. Downstream treatment does not remove existing near-patient drain reservoirs or replace source controls. HTM 04-01 confers no discharge permission.

Trade-effluent consent is required where a public sewer discharge qualifies; surface-water or groundwater discharge may require an environmental permit. Applicable permissions precede operation. NHP economic assumptions need operational testing; microbiological efficacy requires separate treatment validation.

Organism removal, gene reduction and pharmaceutical degradation are distinct endpoints. Any claim of reduced resistant-organism transmission or improved patient outcomes needs clinical evidence beyond treatment performance, including the intended exposure pathway.

ID14: Lifting the Curtain on Ensuite Shower Safety

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BEIPI BUILDING SAFER HOSPITALS

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With our grateful thanks to Liverpool University Hospital NHS Foundation Trust

Introduction

There is a national move towards 100% single-room occupancy in new hospitals, with associated ensuite facilities, including showers. Patient, relative and public engagement increasingly informs hospital design and architectural briefs. Such engagement reflects perceived benefits to patient dignity, wellbeing and quality of stay through access to ensuite showers.

Our poster examines the reality of patient showering across two hospitals, incorporating feedback from patients with lived experience following construction. We assessed the appropriateness of 100% single-room ensuite shower provision against five criteria:

1. **Patient voice**
2. **Actual shower utilisation data from a newly built hospital with 100% single-room ensuites**
3. **Patient safety, focused on infection risk**
4. **Capital investment and ongoing operational costs and resources**
5. **Sustainability**

1. The "Patient Voice"

The process of gathering and interpreting feedback from patients, relatives and the general public can have a significant impact on results (Table 1). When data is gathered directly from inpatients the desirability and actual usage for a shower is much lower (~ 17-20%) than perceived by patient representative groups (~ 100%).

Table 1: Impact of ascertaining patient preferences regarding ensuite showers

Patient Voice Group	Question Detail	Answer "Yes"	Reliability of Answer
Patient representative group outside of hospital	Would you like to have a shower in your ensuite?	100%	Low
Patient representative group outside of hospital	Would you like to have a shower in your ensuite? (With simultaneous explanation of the risks)	< 100%	Low
Hospital Inpatients*	Would you like to have an ensuite shower?	17%	High
Hospital Inpatients*	Use of remote monitors to measure actual shower usage events. No questions or interaction with patients or staff	20%**	High

* Each distinct in-patient group should be surveyed and monitored to capture differences in shower usage

**Detailed information within the study publication Whapham C, Nesbit G, Leadbetter P, Weinbren M. Continuous. Continuous remote sensor surveillance of hot and cold water usage within a new hospital building: relevance for design, patient safety and sustainability. J Hosp Infect. 2026 Aug; 174:246-253.

Case Study 1: University Hospital Limerick

At University Hospital Limerick, two 16-bed units were completed under a rapid build construction project with n=2 communal showers plus one ensuite shower in a side room. No CPE transmission has occurred in these units over the past 2 years, unlike all other wards where showers have been retained. A questionnaire was reviewed individually with 29 general medical patients (Table 2), comprising adult males and females. Of there n=23 had access to a communal shower, and n=6 had their own ensuite shower.

Table 2: Inpatient Questionnaire Feedback

Patient Statement Selection	Communal Shower Patient Group (n=23)	Ensuite Shower Patient Group (n=6)
Is it important to me to have my own shower in my room while I am in hospital	4 (17%	4 (67%)
I am satisfied to have access to a communal shower on the ward while I am in hospital	9 (39%)	2 (33%)
I prefer to shower when I go home	3 (13%)	
Due to my illness, I am having a wash at my sink or a bed bath	7 (30%)	

Among patients without ensuite showers, only 17% considered them desirable and important during hospitalisation. Most were satisfied with communal showers (39%) or did not shower (43%). One patient commented **"more beds are needed, not showers."** Conversely, 67% of patients with ensuite showers considered them important. However, the questionnaire did not establish any actual daily or regular shower use, nor did it explore awareness of infection risks associated with showers and drains.

2. Actual Patient Shower Use

In-patient showering events demonstrate some predictability, for example,

- patients with relatively short hospital stays (i.e. < 5 days; elective surgeries) are less likely to shower during admission
- patients with surgical wounds, catheters, long lines are advised not to shower until wounds have healed or skin access points removed.
- patients who are unwell, fatigued, immobile, unsteady, experiencing balance difficulties, or cognitive changes, are less likely to shower
- needed staff availability to assist less mobile patients to shower
- showering is a matter of personal choice; some patients decline to shower or do not shower in their home environment

Gathering actual shower usage data from in-patients is critical for decision making regarding new design and refurbishment projects. Such data is easily and unobtrusively accessible through use of remote sensor monitors.

Case Study 2: Liverpool Royal University Hospital

Continuous remote sensor monitoring in a newly built UK hospital with 100% single ensuite rooms recorded inpatient showering events (Whapham *et al.*, 2026). Two mirrored 28-bed wards, Gastroenterology and Care of the Elderly (28 ensuite showers in each), were monitored during September–October 2025 and January 2026, respectively. Table 3 illustrates low shower utilisation across both cohorts, despite differences in mobility and perceived ability to shower.

Staff feedback indicated that the larger communal shower rooms (2900 × 2600 mm; photograph below) were better adapted to assisted showering, whereas the smaller ensuites (2100 × 1900 mm) were less suited to the logistical and patient-centred requirements of assisted care.

Table 3: Shower Usage Frequency by Location September 2025 – January 2026

Shower Usage During n=25 Day Study Period	Gastroenterology	Care of the Elderly
No use over 25 days – No Use	2/28 (7%)	0/28 (0%)
< once daily use – Low Use	26/28 (93%)	27/28 (97%)
≥ once daily use – Daily Use	0/28 (0%)	1/28 (4%)
Days With/Without Shower Use		
Average Use per Shower per Day	0.3	0.8
Average Days Without Use per Shower	18/25	14/25

During the 25 day study periods on each of the 28 bed wards, only 376 shower usage events ≥ 2 minutes in duration were evidenced, representing < 20% potential daily inpatient usage.

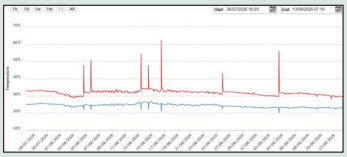
- Despite mobility and length-of-stay differences, inpatient shower usage events were similar, averaging six daily events per 28 bed ward.
- During the UK's record-hot summer of 2026, with multiple heatwaves, remote sensor data (selected traces) from a random sample of six Gastroenterology Ward showers were analysed to determine whether utilisation increased over a seven-week (26 July–13 September 2026) summer period (Table 4).

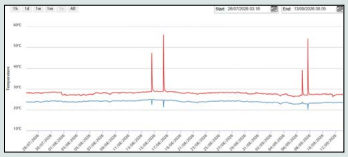
Across six randomly selected patient ensuite showers, 39 showering/usage events were recorded over 49 days, ranging from 1–12 events per room. Despite heatwave conditions, utilisation did not increase compared with the September–October 2025 baseline.

Maximum combined daily usage was three events, recorded on four days (27–28 July, 14 August and 7 September). No showering events were recorded on 23/49 days. Average number of usage events for the combined 6 showers was 0.8 per day. These findings suggest that one communal shower could adequately meet the needs of six Gastroenterology in-patients.

Table 4: Shower Usage Frequency in Gastroenterology During Summer 2026

Shower Usage During 7 Week (49 day) Period 26 July – 13 September	N=6 Ensuite Showers Gastroenterology
No use over 7 week period – No Use	0/6
< once daily use – Low Use	6/6 (100%)
Days With/Without Shower Use	
Average Use per Shower per Day	0.1
Average Days Without Use per Shower	43/49





3. Risk Recognition & Patient Safety

Patient safety is predominantly assessed from the risk of acquiring infection (Table 5), however, slips due to water dispersal from the shower and ease of patient/staff use must also be recognised within spatial designs.

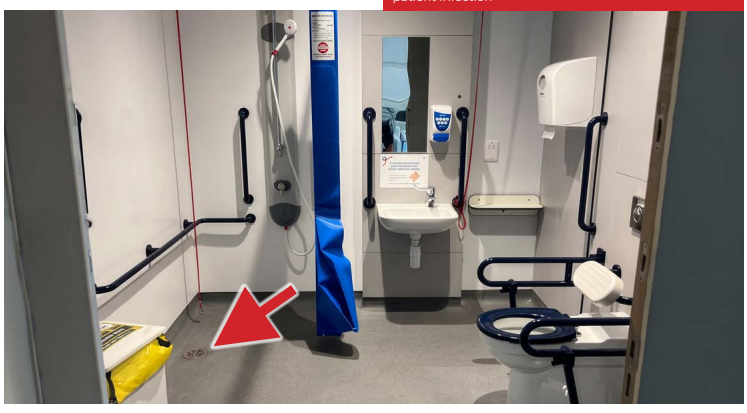
Table 5. Infective Risks from Showers

Source	Organisms	Mechanism
Water supply	Opportunistic-premise-plumbing pathogens (OPPPs) including Legionella spp, Pseudomonas aeruginosa, atypical mycobacteria	Lack of control of temperature, circulation, throughput and usage which predisposes to biofilm formation and microbial amplification
Drain	Wide range of wastewater organisms, including Multi-Drug Resistant Organisms (MDRO)	Patient contact with drain, water delivered from showerhead directly or indirectly hitting the drain, poor cleaning or maintenance practices spreading organisms on cloths and tools, air pressure transients in the wastewater system distributing contaminated aerosols from the ubend into the environment, slow drainage or blockage leading to contact with wastewater organisms
Showerhead (Flexible hose)	Wide range of organisms	Contamination from poor cleaning or maintenance practices, using showerhead close to wounds, allowing contact with skin, walls, floor or shower drain
Building Fabric	Moulds	Ingress of water due to leakages from pipes or failure of wet room sealing

Shower drains, often inaccessible within the building fabric, are recognised reservoirs of antimicrobial-resistant organisms, with dispersal difficult to control and interventions offering limited, short-lived effectiveness. Where showers are installed, risk assessment should prioritise locating drains well away from patient standing/seated positions and direct water flow. This has implications for room dimensions and spatial costs. Communal showers offer greater scope for larger, safer layouts, better accommodating patient-centred care and assisted showering.

The only known effective mitigation from the shower drain is either eliminate the shower, or position the drain well away from the patient and direct/indirect splashes. Where patient infections are traced to incorrect place of the shower drain placement it is near impossible to mitigate as these are built into the fabric of the building.

Typical shower drain placement which increases risk of patient infection



4. Resourcing & Costs

Regular manual flushing of approximately 600 underused showers is estimated to cost over £250,000 annually, including carbon, water, wastewater treatment, hot water energy and staffing (Whapham *et al.*, 2026). This excludes cleaning, maintenance, microbiological testing and remediation. Costs increase substantially when pathogens or inadequate thermal performance are identified. Such expenditure is unsustainable and flushing does not eliminate other risks associated with unused assets.

Table 6. Resourcing, Risks & Cost Burden from Overprovision of Shower

Impact	Consequenes
Larger water system required	Greater hydraulic balancing and temperature control challenges, increased biofilm surfaces and stagnation risk, higher installation costs and energy demand
Larger pipework installations	Cold-water heat gain from inadequate turnover, promoting biofilm formation and microbial growth Increased hot-water volumes for heating and circulation, raising energy costs and carbon emissions
Effective and compliant system to assure water turnover at predictable no/low use shower outlets	Manual flushing is unreliable without a dedicated, competent team, which incurs significant costs Intelligent auto-flush showers have higher installation costs but eliminate human-dependent failures. However, water dispersal must be controlled to avoid wetting occupants, adjacent assets, floors or patients and increasing slip risk. Screens and curtains introduce additional biofilm surfaces, increase cleaning demands, and rely on unreliable user intervention unless shower rooms are designed sufficiently large to accommodate splash

Table 7. Costing based on 2 different shower installation models

A: Hospital comprised of 20 wards of 30 beds; n=600 single patient room with ensuite shower. Number of ensuite showers = 600

B: Hospital comprised of 20 wards of 30 beds; n= 3 larger communal showers + n=2 isolation rooms with ensuite shower per ward. Number of communal showers = 60. Number of ensuite showers = 40.

Costing Parameter	Model A: 600 Ensuite Showers	Model B: 100 Showers (60 x Communal + 40 Ensuite)
Real Estate Space @ £2800 per m2 assuming 3 x 2.5 m allows for "safe" placement of the shower drain	£12,600,000	£2,604,000* Assuming communal showers will benefit from being larger (3.5 x 3 m) to assure assisted showering activity
Shower Installation (wet room construction)	£6,000,000	£1,000,000
Water Usage, including Flushing, assuming each ensuite shower is flushed for 5 minutes per day	10,950,000 litres per annum	2,920,000 litres per annum
Dedicated daily flushing team (internal resource), assuming 6 showers flushed per hour during a 7 hour working day	> 14 full time staff daily, £500,500 per annum	1 full time staff daily, £35,000 per annum
Water Wasted due to Flushing No/Low Use Shower Outlets (assuming 20% real shower use)	8,760,000 litres per annum, costing £40,000 per annum	584,000 litres per annum, costing £2,667 per annum
Energy Wasted due to (Hot Water) Flushing No/Low Use Shower Outlets	£61,320 per annum	£4,088 per annum
TMV Maintenance, Service, Failsafe Checks. Replacement of Cartridges (@ 15% failure rate per annum)	£28,800 per annum	£4,800 per annum
Quarterly Shower Hose & Head Replacement	£21,120 per annum	£3,520 per annum
Water Sampling & Testing (assuming 25% all shower outlets rotational tested quarterly based on risk assessment)	£60,000 per annum	£10,000 per annum
Daily Housekeeping Cleaning (@ 3 minutes per shower)	10,950 hours; 6 full time housekeeping staff, £204,000 per annum	£68,000 per annum
Basic Annual Costs (excluding investigation, remedial and verification costs)	**£915,740 per annum**	**£128,075 per annum**

Although these example costings and services (Table 7) may not apply universally, Capital Projects and Water & Wastewater Safety Groups must understand the full costs of their plumbing systems and assets. Such data are difficult to obtain. Substantial ongoing operational costs may overwhelm already overloaded NHS Estates and Housekeeping teams and budgets.

5. Sustainability

Water hygiene and patient safety must take precedence over sustainability goals. However, predictable low/no-use outlets, such as ensuite showers, generate unnecessary water and energy consumption and associated carbon burden, while residual patient safety risks remain. In addition, regular replacement of plastic component parts (shower hose and head, thermostatic mixing valves)are an environmental burden. Publications regarding routine drain disinfection, raise concerns regarding positive selection for waterborne pathogens; tolerance to biocide is common in biofilm dwellers and waterborne pathogens.

"Green" designs should use updated consumption calculations and evidenced usage to support smaller, less complex systems. Climate-driven water scarcity, including drought and flooding, must also inform healthcare planning. Risk-based design and lessons learned can reduce construction, commissioning and lifetime operational costs while prioritising patient safety and not introducing unintended consequences.

Recommendations

Risks from microorganisms in shower supply water can generally be mitigated through hose and showerhead replacement and point-of-use filtration. However, risks from poor user behaviours (contact contamination), splash and aerosolisation, particularly at the shower drain and wastewater interface, are considerably harder to control.

Our recommendations are:

Prioritising patient safety: Safety of future occupants must remain the primary consideration and focus in all new healthcare designs and refurbishment projects.

Adopting a risk-based approach: Design decisions must be informed by a robust, evidence-based assessment of risk rather than the blind following of unevidenced guidance.

Early integration of multidisciplinary competence: Failure to assemble the necessary expertise from project conception presents a significant and unacceptable risk. Safe healthcare environments cannot be achieved through the application of guidance alone. Architectural design teams must work alongside technical and clinical professionals within a multidisciplinary team to ensure that risks are appropriately recognised, correctly assessed and mitigated.

Effective "patient voice" integration: Patient experiences and perspectives are important, however, these must be interpreted, contextualised and balanced appropriately against clinical evidence. Failure to do so results in design decisions that inadvertently compromise patient safety.

Antimicrobial resistance and healthcare-associated risks: The growing challenge of antimicrobial resistance (AMR) is bringing increased attention to the association between routine healthcare activities and preventable patient morbidity and mortality. Activities, including showering and other forms of water exposure, must be critically evaluated in relation to patient infection risks. Patient ablution must be considered holistically. Without effective AMR preventative measures, the ability to deliver even basic healthcare procedures will be compromised.

Should the “Frimley Faucet” become a standard design principle for safer healthcare water and wastewater systems?

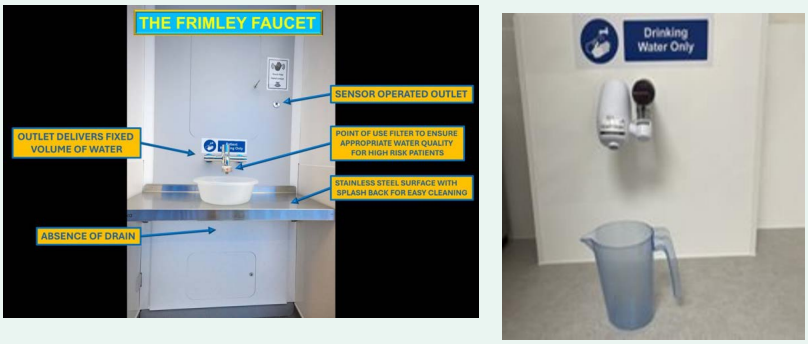
C Callow, C Nagy, V Gentry, T Broom, H Wilding, M Meda

Background

- Healthcare wastewater in sinks and drains can harbour antimicrobial-resistant (AMR) organisms, including difficult to treat, carbapenemase-producing *Enterobacterales* (CPE).
- Contact with drains and splash-back introduces mechanisms for transmission of such dangerous organisms to patients.
- Wexham Park Hospital introduced water and wastewater safe environments (WAVE) in 2023, retaining water for patient washing and drinking while redesigning infrastructure.

Design and implementation

- Drain-free, filter fitted outlets replaced basins, drains and pipework.
- Sensor / pressure operated taps (mixed hot and cold for wash and cold only for drinking), ensure risks against unintended overflow are minimised.
- IPC, estates, architects and clinical teams co-designed workflows, embedding training on maintenance and cleaning (non-touch filter outlet).



Frimley Faucet installations: Wash and Kitchen

Design findings

- Removed local drain contact during bowl and jug filling.
- Staff and patients generally preferred water to wipes for patient washing.
- “Do not touch” filter labels and staff training reduce contamination risk.
- Estates follow filter-change intervals.

Anticipated benefits

- Lower contamination risk
- Less basin maintenance
- Lower water and energy use
- Potential sustainability gains

Conclusion

An innovative design principle for patient-care water collection. Adoption requires IPC input, local risk assessment , training and responsibilities identified at outset. In our hospitals, these have proved to be safe, sustainable and saving resources. No unintended consequences have been identified to date.

Key message Drain-free patient-care water merits consideration in healthcare design, subject to local risk assessment and wider evaluation.

Reference: Callow C et al. The Frimley Faucet - an innovation in design of water-dispensing units in healthcare. Infect Prev Pract. 2026 Feb 16;8(2):100513. doi: 10.1016/j.infpip.2026.100513.

Public Services Delivery
Scotland

NHS SCOTLAND

Infection Prevention and Control in Healthcare Design: A Rapid Scoping Analysis to Inform Evidence-Based Guidance for Priority Clinical Areas

Catherine Ho, Gemma Waugh, Emma Hooker, Hayley Kane, Chris Paterson, Diane Stark

NIPCM

Antimicrobial Resistance & Healthcare Associated Infection (ARHAI) Scotland
An NHS Scotland Assure Service

Introduction

The healthcare-built environment can contribute to the transmission of infectious agents and healthcare-associated infections, particularly among clinically vulnerable patient groups. Intensive care units (ICU), neonatal units (NNU) and haematology-oncology-bone marrow transplant (H-O-BMT) units were identified as priority settings (Figure 1).

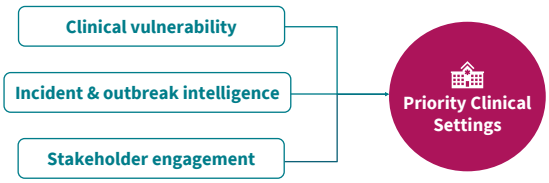


Figure 1 – Selection of NNU, ICU and H-O-BMT Settings

No dedicated infection prevention and control (IPC) guidance resource existed for the design of these specialist healthcare settings. Therefore, a gap analysis of extant guidance was undertaken to identify specific gaps to inform the development of setting-specific guidance.

Rapid Scoping Review of Guidance

Methods:

A rapid scoping review (ScR) was conducted using established frameworks, an internal protocol, and the PRISMA-ScR reporting checklist.[1]

MEDLINE and Embase (29 January 2024); Google Scholar and 26 organisational websites (30 January to 13 February 2024) were searched for guidance published or updated from 2000 onwards. A tailored search strategy combined keywords and subject headings related to infection prevention and control, healthcare design and IPC, with unit-specific terms for ICU, NNU and H-O-BMT settings.

- Pre-specified inclusion and exclusion criteria were applied.
- Screening, data extraction and deductive mapping (see Figure 2) were undertaken by single reviewers.
- Descriptive and bibliometric analyses were used to identify guidance coverage and gaps.
- Critical appraisal was not performed.

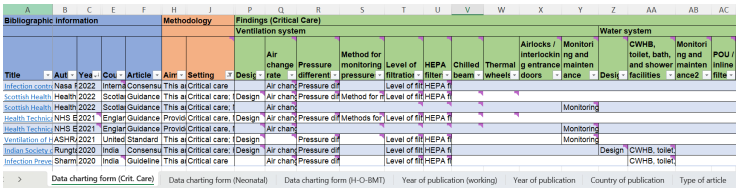


Figure 2 – Example Data Charting Spreadsheet

Key Findings:

Of 1,422 records identified through database and supplementary searching, **44 guidance documents met the inclusion criteria**. Most documents were applicable across **all three settings** (64%, n=28). The evidence was geographically concentrated, with **Scotland, the UK and the US** representing the largest contributors.

Guidance mostly addressed **general physical design features for ventilation and water systems** (33-44% of guidance across settings).

Frequency of reporting of **specific design features:**

Infrequently Reported	Frequently Reported
Thermal wheels	Air change rates
Chilled beams	Filtration systems/devices
Renal dialysis facilities (NNU, H-O-BMT)	Sanitation facilities
H-O-BMT commissioning	System maintenance

Overall, the ScR demonstrated that extant guidance did not comprehensively address the IPC design needs of the specialist healthcare settings.

The ScR identified important gaps within extant guidance. However, it did not assess the underlying evidence or its quality. Consequently, a systematic literature review (SLR) was commissioned to support guidance development and is currently underway (Figure 3), using National Infection Prevention and Control Manual (NIPCM) methodology.[2]

	Rapid Scoping Review	Systematic Literature Review
Database search	Limited	Multiple targeted
Evidence	Guidance	Primary Studies + Guidance
Critical appraisal	✗	✓
Evidence synthesis	✗	✓
Primary Output	Identify guidance gaps	Recommendations + Good Practice Points (Rs and GPPs)

Figure 3 – How the SLR Builds On the Rapid ScR

From Evidence to Scottish Guidance

Phase 1: SLR

Synthesised evidence base
Considered judgment (evidence quality)

CURRENT STAGE

- ☑ Questions and scope established (Figure 4)
- ☑ Search Strategy developed
- ☑ Multi-disciplinary Short Life Working Group (SLWG) convened
- ☑ Clinical site visit completed
- ☐ Database and supplementary search
- ☐ Screening, critical appraisal and data extraction
- ☐ Review write up

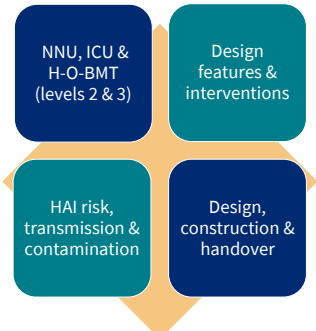


Figure 4 – SLR Scope

Phase 2: Evidence to decision

Development of Rs and GPPs
Considered judgment (benefits, harms, feasibility)
Expert SLWG review and consensus

Phase 3: Scottish NIPCM Guidance

Development of Scottish NIPCM content
Stakeholder consultation
Publication of guidance and resources

Conclusion

The ScR identified 44 guidance documents addressing healthcare design of NNU, ICU, and H-O-BMT settings; however, coverage was concentrated on general physical design features for ventilation and water systems, with several specialist design considerations and their associated IPC risks underrepresented. A systematic literature review is underway to critically appraise and synthesise primary evidence and guidance to inform Rs and GPPs for Scottish NIPCM guidance, supplemented by expert opinion where evidence is limited.

References

1. Tricco AC, Lillie E, Zarin W, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467-473. doi:10.7326/M18-0850
2. ARHAI Scotland. National Infection Prevention and Control Manual: Methodology. Version 6.0. 2026. Available from: https://www.nipcm.hps.scot.nhs.uk/media/2627/2026-06-22-nipcm-methodology-v60.pdf

Contact Information

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SLR Lead: gemma.waugh@nhs.scot

Scan for full NIPCM methodology

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NHS Frimley Health NHS Foundation Trust

Expanding on UK's first water and wastewater safe environment (WAVE) hospital's experience from adult Intensive Care to a Neonatal Unit

McKinney C*, Ambohang T, Porro F, Jaiswal S, Sivarama Krishnan S, Gentry V, Fortes-Aguila M, Broom T, Tinkler L, Meda M
Frimley Health NHS Foundation Trust

Background

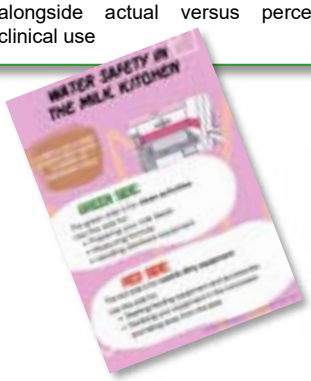
Water outlets within healthcare environments are recognised reservoirs for waterborne pathogens[1] that present a significant infection risk to vulnerable patient groups.
Frimley Health NHS Foundation Trust completed a project to design the UK's first Intensive Care water and wastewater-safe environment (WAVE) in April 2025.
The temporary relocation of a Level 2 Neonatal Unit (NNU), for reinforced autoclaved aerated concrete (RAAC) remediation work in October 2025, provided an opportunity to co-design a WAVE Neonatal Unit that supports safe clinical workflow and facilitates sustainable changes in staff practice.

3M-WAVE Approach

The approach to designing a WAVE in NNU had three main (3M) components:
1) Surveillance and setup
2) Preparation for redesign
3) Redesign and innovation

1) Surveillance and setup

- **Surveillance** and evaluation (pre- and post-intervention metrics): Healthcare-associated infections, staff skin health, clinical practice observational audit
- **Establishment of a multidisciplinary team** (MDT)
- **Project planning and business case** (Figure 1)
- **Education and training**: Stakeholder engagement; Focus groups and presentations; Leaflets and posters created for (and by) staff and families
- **Risk Assessment:** Workflow mapping; Hierarchical Task Analysis; Assessment of each water outlet considering engineering factors alongside actual versus perceived clinical use



2) Preparation for redesign

- Risk-assessed removal of 11 conventional hand wash basins (HWB) from high-risk locations
- Installation of a single scrub trough in a safe corridor location for use as the centralised hand wash station
- Two-metre exclusion zone where HWB remain
- Hand sanitiser as the primary approach for hand hygiene
- 'Sink etiquette' education: Wash-Dry-Sanitise

Figure 1: Plan for redesign of NNU



3) Redesign and innovation

- 'Frimley Faucet' (patient bathing, and for incubator decontamination) and custom-made trough sinks with offset drains (Figure 2)
- Redesign of clinical areas including dirty utility,' spaces (dirty-to-clean segregation) (Figure 3)
- Involving staff and parents in product evaluation and adaptation
- Hands-free solutions (e.g. foot- operated doors, offset-drain showers)
- Environmental cues, equipment placement and organisation

Figure 2: 'Frimley Faucet' for baby bathing water; demarcated cot spaces; centralised hand wash trough in Unit corridor



Evaluation & Learning

- Staff valued ability to lead on an innovative project
- Early engagement of clinical teams and parents promoted MDT working
- Human factors analysis demonstrated HWB removal affected more than hand hygiene - revealing hidden dependencies such as incubator decontamination, bottle preparation, and infant bathing
- Workflow redesign, clean/dirty demarcation, product adaptation, staff education, simulation, and parent-facing resources were concluded to be critical for implementation alongside infrastructure change

Figure 3: 'Clean' and 'dirty' demarcation in the Decontamination Room (A) and Milk Kitchen (B)

A



A



B



Conclusion

Creating a WAWE NNU is a complex sociotechnical intervention, not simply an estates project. Human factors methods enabled safer environmental design by revealing contamination risks embedded in routine work systems. This collaborative approach offers a practical framework for embedding infection prevention principles into healthcare building design and reducing risks in this high-risk clinical area.

Reference
1. Meda M *et al* 2024 Polymicrobial outbreak of carbapenemase-producing Enterobacterales managed using universal admission and discharge screening and water-safe built environment *Journal of Hospital Infection* 156: 1-12

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NHS
Sheffield Children's
NHS Foundation Trust

Building bridges: Improving liaison between IPCT and Estates

Chris Lynch, Emma Boldock, Gayti Morris, Sarah Thompson, Andrew Brown, Jamie Douglas, James Lines, Lauren Gallagher, Natalie Greaves, Veronica Parker, Jennifer Cherrington

Background

Infection prevention and control (IPC) within the built environment is critical to patient safety. While national guidance such as Health Building Note (HBN) 00-09 exists, implementing these standards requires collaboration between the IPC Team (IPCT) and the Estates department. Here we outline the development of an initiative to improve liaison across both capital projects and routine maintenance.

Project

The initiative addressed two aspects of Estates management:

- **New builds and refurbishments** - Embedding IPC principles and national guidance compliance directly into the initial design phase and establishing building safety protocols.
- **Maintenance operations** - Utilising scheduled summer bed closures to carry out essential works.

This was formalised with a co-produced Standard Operating Procedure (SOP) including an integrated patient risk group/construction risk matrix, pre and post works checklists and structured communication.



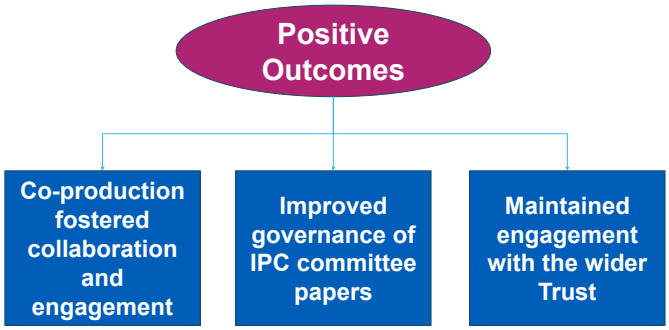
Successes

- Marked improvement in collaboration and ownership from Estates teams and clinical ward managers
- Capital project teams now systematically and proactively contact the IPCT for advice
- Elevated profile for IPC across the estate infrastructure



Challenges

- Balancing operational and project management priorities with IPC requirements
- Engagement with other stakeholders such as domestic services
- Implementation of water safety principles such as flushing during construction



Conclusion

Co-production of an SOP between IPCT and Estates created a robust framework for building and maintaining safer clinical environments. Structured governance ensures that the healthcare infrastructure prioritises patient safety at every stage.

Public Services Delivery Scotland

NHS SCOTLAND

Animate to Educate: How using animation can inform Infection Prevention and Control (IPC) risks in healthcare construction

Aim

- Improve knowledge of healthcare domestic water and above ground drainage systems
- Recognise the IPC risks associated with a healthcare water and drainage system
- Understand the health impact of the design risks on patients, visitors, staff and the wider community
- Recognise how and why these IPC risks commence during the design phase.

Infection

ion, prevention and control (IPC) risks associated with a healthcare water and drainage system during construction, maintenance, and retrofit activities – as well as improve understanding about why these risks emerge and how they can develop if not properly managed.

Method

A collaborative working group was established to develop educational content and learning needs for all staff involved with healthcare construction projects. We used human factors theory utilised on previous projects to promote learning and sustained change. The working group consisted of infection preventionists, educationalists, architectural and engineering colleagues.

The proposed output was an animation promoting best practice for the design, construction, commissioning and handover of healthcare domestic water and above ground drainage systems. Draft storyboards and learning outcomes were developed, then revised ensuring messaging, aims, learning outcomes and human factors were embedded.

The final story boards were shared with digital development teams for final product production. Regular meetings were held with developers to ensure the key aims and objectives were captured.

Results

The development of a suite of five water animations for use by clinical and project teams to inform staff and operatives of the IPC risks associated with heath care construction projects were delivered and are available online at:

https://learn.nes.nhs.scot/70353/infectiion-prevention-and-control-ipc-zone/healthcare-built-environment-hbe/water-safety

How do I find out more?

Please scan the QR code:

Introducing water & IPC risks



Design



Construction



Commissioning



Handover



From First Fill to Handover: Monochloramine Dosing as a Strategy to Prevent Waterborne Pathogen Related Delays in New-Build Hospital Water Systems

Hari Singh, Business Development Manager, Goodwater Ltd

h.singh@goodwater.co.uk

01 The vulnerable window

Between first fill and handover, new pipework can sit stagnant or barely used for months. Low flow and new surfaces favour rapid biofilm formation and growth of *Legionella*, *Mycobacterium,* and other waterborne pathogens. Failures in microbiology sampling of the water system, enacts cycles of remedial disinfection and resampling that can quickly delay project programs.

WHEN IT GOES WRONG

Worthing Integrated Care Centre: *Legionella* found before opening; budget up from £41m to £48.9m.

Royal Papworth Hospital: a coroner called for urgent review of guidance on commissioning hospital water systems. 3 deaths related to Mycobacterium found in water.

02 Aim and approach

Aim:
to show how monochloramine (MCA) dosing, applied from the first fill, keeps new-build hospital water systems compliant through construction, commissioning and handover.

Approach:
case-based review of SANIKILL deployments in new and recommissioned healthcare buildings in Italy and the UK. Outcomes reviewed: TVC, *Legionella*, *Pseudomonas* and coliform results, time to compliance, and effect on the handover programme.

03 Why monochloramine

SANIKILL generates monochloramine in-situ by combining chlorine and ammonia precursors in controlled proportions, dosing directly into the cold and/or hot water systems.

- **Stable residual** that reaches the extremities of the system and provides longer residual treatment.
- **Deep penetration of biofilm**, rather than only treating upper layers
- **Lower reactivity** with organic matter than free chlorine
- **Effective at low, continuous dose,** compatible with drinking water
- **Mild oxidising potential,** with low corrosion impact and enhanced material compatibility

04 Implementation: protecting the system from first fill to handover

STAGE 1
First fill
Fill with MCA-dosed water, never untreated. Typical residual around 3 mg/L.

STAGE 2
Construction
Continuous low-level dosing holds a residual in stagnant, low-flow and unused branches.

STAGE 3
Commissioning
Residual and microbiology sampled to the agreed regime and reviewed by the Water Safety Group.

STAGE 4
Handover
A compliant, documented baseline is handed to the Trust without remedial delay.

STAGE 5
Occupation
Dosing can continue as secondary disinfection under the Water Safety Plan.

Where contamination is already established: a short shock at around 10 mg/L followed by 2–3 mg/L maintenance (Bergamo), or continuous dosing below 3 mg/L with no shock at all (Cortina).

05 Case studies: water quality outcomes

BERGAMO, ITALY · 2012
Papa Giovanni XXIII Hospital, 1,000 beds
<24 h
to clear all monitored points

Contaminated before handover across 10 hot water loops, up to ~10,000 CFU/L. Ten SANIKILL units dosed a shock of ~10 mg/L for 24 h, then 2–3 mg/L. Running continuously since, with under 1% positive samples over 13+ years.

PADUA, ITALY · 2025
New Paediatric Pavilion, 200 beds
0
positive results, first fill to opening

Dosed at ~3 mg/L from the very first fill of both cold and hot networks, preventing contamination caused by stagnation. TVC, *Legionella*, *Pseudomonas*, *E. coli* and coliforms stayed negative throughout commissioning.

CORTINA D'AMPEZZO, ITALY · 2026
Olympic Hospital, Milano Cortina 2026
48 h
to clear every point, days before the Games

A former sanatorium, closed since 2019 and recommissioned at short notice, tested up to ~10,000 CFU/L. Two units dosed continuously below 3 mg/L with no shock. Weekly sampling stayed negative.

UNITED KINGDOM · ANONYMISED
New Acute Hospital Development
On time
handover on the contractual date

High TVC results blocked sign-off after other disinfection approaches had failed. A SANIKILL unit was used to disinfect and fill the system, bringing TVC within compliant limits.

Sanikill has also been applied during pre-commissioning at the new pavilion of the European Institute of Oncology (IEO), Milan.

06 MCA against conventional approaches

Criterion	Free chlorine	Thermal and flush	Silver stabilised H_2O_2	MCA
Residual duration	Short, decays fast	None, one-off event	Moderate, days to weeks	**Long, stable**
Biofilm penetration	Limited	Surface only	Moderate	**Strong**
Low-flow and dead-legs	Poor	Poor	Moderate	**Strong**
Pipework impact	Higher corrosion	Thermal stress	Low	**Low**
Fit with phased handover	Hard to sustain	Disruptive, repeat visits	Common, needs repeat dosing	**Continuous, compatible**

Summary of typical performance in healthcare distribution systems; actual outcomes depend on system design, water chemistry and dosing control.

07 Relevance to UK new builds

In Scotland, the Commissioning Key Stage Assurance Review (KSAR) now audits first fill. Project teams must evidence:

- a disinfection method agreed in advance (SHTM 04-01 Part A)
- protection of the system until occupation
- a defined plan if commissioning results fail

> **We do not fill water systems with untreated water. This is our minimum standard, regardless of the specification.**
>
> National Commissioning Lead, Crown House Technologies (20+ UK hospitals delivered)

Conclusions

1. The weeks between first fill and handover decide whether a new water system opens clean. Protect them from day one.
2. SANIKILL dosed from first fill kept a new 200-bed building free of positive results from fill to opening.
3. Where contamination was already established, SANIKILL restored compliance within 24 to 48 hours in large, complex systems.
4. Agreeing the disinfection strategy in the commissioning brief aligns infection prevention with the construction programme.

References: 1. NHS Scotland Assure, Key Stage Assurance Review Workbook: Commissioning, V1.0 (2022). 2. Adur & Worthing Councils (Feb 2026); BBC News. 3. Coroner's Prevention of Future Deaths report, Royal Papworth Hospital (2024). 4. Case data supplied by Sanipur (Bergamo, Padua, Cortina). **Limitations:** observational case series from operational deployments, not controlled studies.

goodwater

Sanipur
INNOVATING WATER HYGIENE

Making Older NHS Estates Safer Through the Implementation of Water and Wastewater Safe Environment (WAVE) Principles in Existing Older People's Wards

C Nagy, V Gentry, C Callow, C Mejia, K Van Den Abbeele, M Meda

Frimley Health NHS Foundation Trust

Background

Hospitalised older adults are particularly vulnerable to healthcare-associated infections due to frailty, comorbidities, recurrent hospitalisation, cognitive impairment, and high care dependency.

Healthcare water and wastewater systems are increasingly recognised as potential sources and transmission pathways for susceptible and antimicrobial-resistant pathogens.

Aim

To implement Water and Wastewater Safe Environment (WAVE) principles within older people's wards and evaluate whether environmental redesign can improve infection prevention while maintaining person-centred care.

Our approach

Drawing on lessons from the UK's first fully redesigned water-free adult intensive care unit, a comprehensive WAVE strategy was introduced across two older people's wards.

The intervention combined:

-board-to-ward engagement,

-behaviour change approaches,

-hierarchical task analysis of ward activities,

-patient involvement,

-enhanced surveillance of Gram-negative bacterial colonisation and infection, including *Clostridioides difficile* infection (CDI).

What we did: The three WAVE components

Component 1
Surveillance and setup

Evaluation (pre- and post-intervention metrics)
Establishment of a multidisciplinary team (MDT)
Project planning and business case
Education and training
Risk-based assessment (every water/wastewater route)

Build the evidence, people and plans for safe care

Component 2
Preparation for design

Rationalisation of non-essential plumbed water/wastewater services (sink rationalisation)
Two-metre exclusion zone where sinks remain
Introduction of wipes for equipment and skin decontamination
Alcohol or non-alcohol hand rub as the primary approach for hand hygiene
Sink etiquette education (wash-dry-sanitise)

Remove avoidable risk and prepare the environment

Component 3
Redesign and innovation

Redesign of clinical areas including dirty utility spaces (dirty-to-clean zoning)
Hands free solutions (e.g. foot operated doors, off set showers)
Environmental cues, equipment placement and workspace organisation
Innovation such as the "Frimley Faucet" and custom-made through sinks with offset drains.

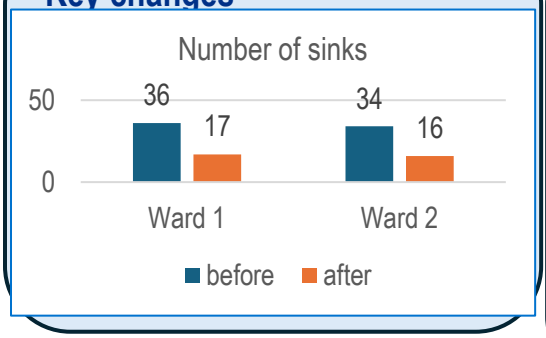
Create a safer, sustainable environment

Redesign dirty utility rooms



Defined dirty-to-clean workflows within the existing estate

Key changes



Sink etiquette



Findings



Conclusion

WAVE principles can be successfully applied within existing wards in ageing NHS estates without major structural redevelopment. Sink rationalisation, behavioural design and workflow redesign created safer care environments while maintain essential patient care activities and reducing water-related infection risks.

Key messages

Older people wards can be made safer through practical WAVE implementation.

Sink rationalisation and workflow redesign reduce infection risks.

A safer water and wastewater environment can be achieved without major redevelopment, while maintaining person-centred care

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Susanne Surman-Lee [3]
Catherine Whapham [4]
George McCracken [5]
Michael Weinbren [6]

Defining "Safe" Hospitals: Proposing the Foundations for Healthcare Buildings of the Future

[1]Environmental Research Laboratory – University College London Hospitals NHS Foundation Trust, London.
[2]Frimley Health NHS Foundation Trust, Surrey UK. [3]Leegionella Ltd UK. [4]Independent Water Hygiene Consultancy Ringwood, [6]University Hospitals Coventry & Warwickshire NHS Trust, Coventry UK; Built Environment Infection Prevention Initiative (BEIPI)

Paper No. 23

Building Safer Hospitals Conference 2026

Presenter* **Contact Information:** Environmental Research Laboratory, University College Hospital, EGA wing, 235 Euston Road, London, NW1 2BU, UK. E-mail: shanom.ali@nhs.net
Keywords: patient safety; hospital buildings, water and wastewater, new hospital programme

What is a Safe Hospital ?

No International consensus on what constitutes/defines a "safe hospital" Benchmarks and criteria to assess safety of healthcare buildings from microbial and chemical hazards, physical harm (falls/scald-risk), accessibility, are needed to assure "safe" environments. These can be achieved through competent and effective governance, collaboration and feedback at all RIBA stages to reach optimal design and construction.

Good hospital design and management allows for effective infection control

Healthcare buildings are expected to provide a "safe" environment to patients, visitors, contractors and staff.

Hospitals are complex ecosystems of clinical specialties and patient risk-groups which the built-environment must accommodate.

Foundations for "safe" healthcare buildings

A framework that underpins new/refurbished buildings must feature:
Risk recognition and assessment, hierarchical-task analysis, education, training & development, competence-assurance, designation of responsibility/accountability, commissioning, routine/risk-based environmental surveillance testing, handover and post-occupancy review and maintenance.

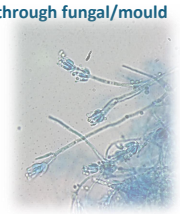
Hidden risks of hospital water systems: Opportunistic premise plumbing pathogens (OPPPs) and wastewater pathogens

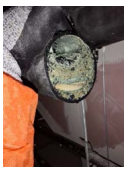
The primary goal for designing healthcare spaces should be ensuring they are safe for the intended occupants

Despite efforts, healthcare-associated infections continue to occur in new hospital builds caused by a diversity of opportunistic plumbing-pathogens including *Legionella spp. P. aeruginosa, Non tuberculous Mycobacterium spp. (NTM),* Enterobacterales*, Amoebae, Fungi*

Leaks, water damage, climate change, and ageing infrastructure further compromise indoor air quality through fungal/mould contamination.

Aspergillus niger
Aspergillus spp.
Cladosporium spp.
Mucor spp.
Penicillium spp.





Drains systems are connected networks that are prone to blockage and are reservoirs for pathogenic microorganisms; here, AMR and associated genes may develop and spread . Image: Harper Water

Outlet drains and the wastewater interface are reservoirs for spread of Carbapenemase-Producing-Enterobacteriaceae (CPEs) and other antimicrobial-resistant organisms



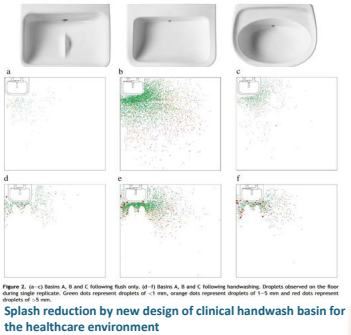
Enhanced surveillance of water and wastewater

Research has demonstrated the greatest indicator of contamination risk on a ward for *Pseudomonas aeruginosa* is through monitoring the drain flora.

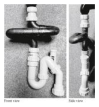
Surveillance of drains and wastewater may improve infection control of other pathogens, e.g. CPEs.



Research, Innovation, validation and optimisation of healthcare sanitary products is essential



Splash reduction by new design of clinical handwash basin for the healthcare environment
https://www.journalofhospitalinfection.com/article/S0195-6701(19)30275-0/abstract



Novel drain design
Image: Journal of Hospital Infection https://www.journalofhospitalinfection.com/article/S0195-6701(24)00362-1/abstract

Design of "safe" healthcare spaces should always focus around the patient

"It may seem a strange principle to enunciate as the very first requirement in a Hospital that it should do the sick no harm"
Florence Nightingale, 1863

The advent of Hospital 2.0

The UK entered a new phase of healthcare buildings with the advent of the New Hospital Programme. However, the necessary framework to appropriately design and implement healthcare environments that are fit for the future is incomplete.

Building safer hospitals requires an understanding of why there have been new build failures and delays and a root cause analysis into infrastructure problems in the existing NHS estate. This includes water and wastewater risk.

Papworth Hospital: Contaminated water led to women's deaths - inquest
BBC News, November 2022

Hospital water supply faces bacteria risk - coroner
BBC News, November 2022

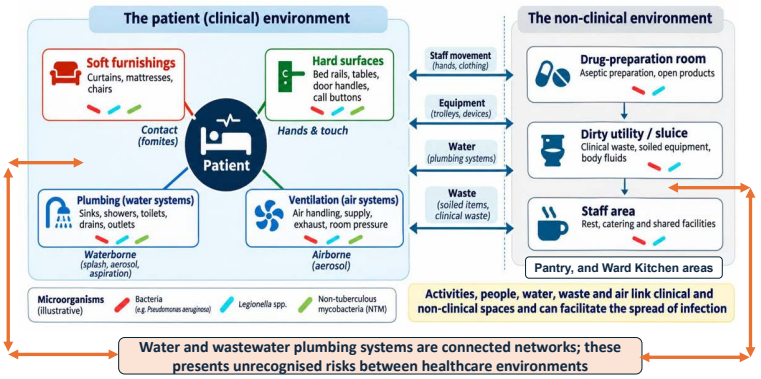
Troubled Aberdeen hospital project faces further delays
BBC News, 2026

Hospital concerns ignored for 15 years, scientist tells inquiry
BBC News, 2026

Royal Liverpool delayed to 2022 and will cost £300m more to finish
Building, December 2019

The Scottish inquiry of the Queen Elizabeth University Hospital (UK) highlighted current planning, construction and commissioning of modern hospitals are not fit-for-purpose, prompting urgent intervention for hospitals of the future.

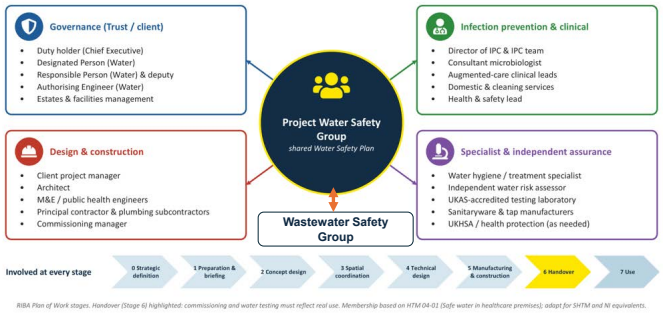
Recognising the activities in a healthcare space is important in understanding infection risk and transmission pathways



Developing "safe" healthcare spaces

should be a collaborative effort with good governance, competent Project Water (and wastewater) Safety Groups developing project-specific water safety plans ! We should not be working in isolation

A competent project Water Safety Group: everyone at the table, from RIBA Stage 0



RIBA Plan of Work stages. Handover (Stage 6) highlighted: commissioning and water testing must reflect real use. Membership based on HTM 04-01 (Safe water in healthcare premises); adapt for SHTM and NI equivalents.

Education is Essential

Education and knowledge should be shared and accessible
e.g. NHS Estates Technical Bulletin (NETB) No.2024/3

Access to educational courses:
"Water and wastewater safety in healthcare"
https://www.his.org.uk/training-events/water-safety-in-healthcare/

Post-occupancy review: feedback should inform improvement

Membership with initiatives
Built Environment Infection Prevention Initiative (UK and EU)

Acknowledgments. The perspectives and viewpoints in this paper are those of the authors and are not the views of their corresponding Trusts, Companies or Initiatives displayed

Environmental Research Laboratory
NHS University College London Hospitals NHS Foundation Trust
Leegionella Ltd
NHS Frimley Health NHS Foundation Trust
NHS University Hospitals Coventry and Warwickshire NHS Trust
BEIPI BUILDING SAFER HOSPITALS

Designing for Safety: Translating the NIPCM Chapter 4.1 (Water) into Practice through Governance, Risk Assessment and Organisational Assurance

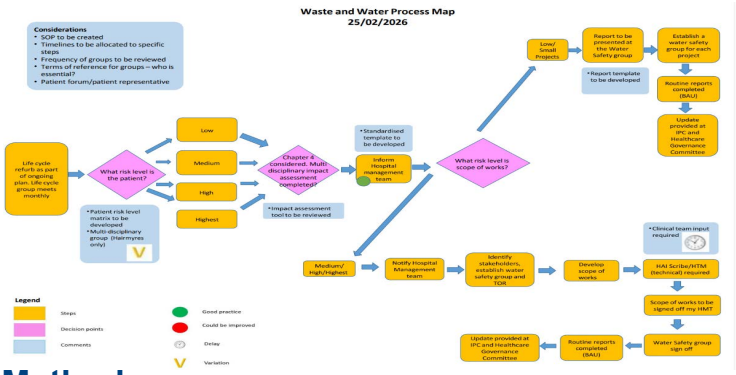
From Compliance to Confidence: Creating Safer Healthcare Water Systems

Christina Coulombe, Director of Infection Prevention and Control; MaryAnne Kane, General Manager Property and Support Services Division , NHS Lanarkshire, Water and Waste Water Working Group, NHS Lanarkshire

Aim

The healthcare built environment is a critical determinant of occupant safety, influencing the risk of healthcare-associated infection (HCAI). Chapter 4.1 (Water) of the NHS Scotland National Infection Prevention and Control Manual (NIPCM) provides evidence-based requirements to minimise risks associated with water systems and waterborne pathogens within healthcare environments. Implementation presents particular challenges when considering the lifecycle management, relocation or removal of clinical wash hand basins (CWHBs), where competing risks associated with water safety, clinical workflow and hand hygiene infrastructure must be carefully balanced. This project describes how a large NHS Board translated national guidance into local practice through a governance-led approach that supports consistent, risk-based decision-making and provides organisational assurance and oversight.

Workshops Work: Utilising a Quality Improvement Methodology to process map decision pathways



Methods

A number of workshops were delivered with key members of the Water and Waste Water Working Group facilitated by Quality Improvement colleagues to map out project decisions. A multidisciplinary governance framework was also developed to support implementation of NIPCM Chapter 4.1 across capital developments, refurbishment programmes and lifecycle replacement projects involving water systems and CWHBs. Infection Prevention and Control, Estates and Facilities, clinical services and project teams collaborated to develop standardised risk assessment and impact assessment tools which were embedded within organisational governance processes. Staff, patient and visitor surveys were developed and undertaken to better understand operational impact.

The framework supported systematic assessment of proposed basin removals, relocations and infrastructure changes, considering patient safety, clinical activity, waterborne pathogen risks, accessibility, hand hygiene compliance and operational & technical impact. Governance arrangements will ensure decisions are subject to multidisciplinary scrutiny, documented risk assessment and formal approval processes, aligned with the principles of locally approved, risk-based decision-making outlined within the NIPCM.



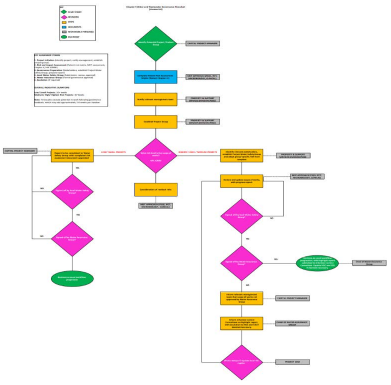
References

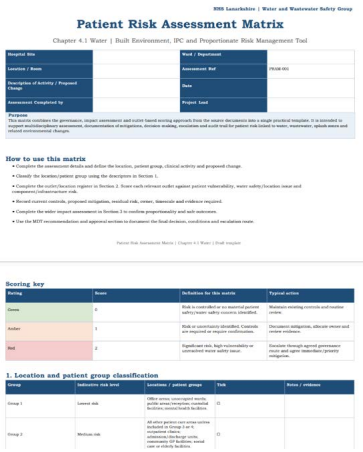
- National Infection Prevention and Control Manual: Home
- NHS Lanarkshire Water and Waste Water Short Life Working Group

Outcomes/results

Implementation of this approach improved consistency, transparency and assurance across a number of healthcare built environment projects. Standardised assessment processes enabled a structured evaluation of CWHB requirements, supporting proportionate and evidence-based decision-making while reducing variation in practice.

Key lessons learned demonstrated the importance of early IPC engagement during project design, clear governance pathways, multidisciplinary collaboration and a strong focus on a holistic approach to water safety. The framework strengthened organisational assurance by ensuring risks associated with water systems and CWHB removal were formally identified, mitigated and escalated where required. It also supported informed decision-making that balanced water safety risks with the need to maintain effective hand hygiene infrastructure and clinical & technical functionality.





Conclusions

Embedding NIPCM Chapter 4.1 (Water) through governance, risk assessment and organisational assurance provides a practical and scalable model for managing risks associated with healthcare water systems and infrastructure change. Lessons learned from CWHB lifecycle management and removal programmes demonstrate the value of moving beyond compliance-based implementation towards proactive, evidence-informed decision-making.

The experience demonstrates that effective water safety is achieved not simply through compliance with standards, but through governance structures that enable organisations to make justifiable, risk-informed decisions.

Key learning points

Governance-led implementation of NIPCM Chapter 4.1 enables safer healthcare water systems and defensible infrastructure decisions. A multidisciplinary framework translated national guidance into consistent local practice.

- Standardised risk assessments evaluated CWHB removals and relocations against patient safety, waterborne pathogens, accessibility, hand hygiene, clinical activity and operational impact for staff, patients & visitors.
- Early infection prevention and control involvement, documented scrutiny and formal approvals improved organisational assurance while balancing water safety with clinical functionality.

Next steps

- Implement → Close Gaps → Manage Risk → Embed into Business as Usual

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Increasing Research Activity in NHS Lanarkshire
Increase funding to increase support
Increase support to increase activity
Increase activity to increase funding

ID25: Improved Healthcare Dirty Utility Design

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Background

Standardised dirty utility room designs are widely implemented in healthcare despite limited evidence that layouts and asset provision meet clinical needs or address patient safety risks. Key deficiencies include:

- Lack of purposeful design, where the area is an afterthought, shaped by residual ward space
- Deficient Hierarchical Task Analysis (HTA), facilitating inappropriate layouts and assets
- Conflicting decontamination, waste disposal, clean storage, and hand hygiene workflows within restricted space
- Suboptimal user behaviours
- Hazards presented by sinks, basins, slop hoppers, macerators, and drainage configurations

Conventional designs (photographs 1–3) lack effective dirty-to-clean segregation and increase cross-contamination risks. Storing single-use pulp items or decontaminated equipment (e.g., commodes) within two metres of water outlets exposes patient-contact materials to splash and wastewater aerosols containing opportunistic pathogens, including Clostridioides difficile endospores and carbapenemase-producing Enterobacterales (CPE).

Hierarchical Task Analysis (HTA) determines that poorly designed Dirty Utility layouts compel clinical and housekeeping staff to adopt high-risk workarounds:

- Misuse: Filling patient washbowls or housekeeping buckets from dirty utility sinks; draining or storing items in or above sinks and hoppers.
- Temporary Storage: Placing fouled bedpans on worktops, sink rims, or equipment surfaces.
- Splash and Aerosol Exposure: Storing cleaned commodes near water outlets, risking cross-contamination from splashes and wastewater aerosols.
- Bulk Fluid Disposal: Emptying high-volume effluent (e.g., dialysis bags) without mechanical support, increasing splash and spillage risks.

Recognising the predictable risks of conventional Dirty Utility Design, daily asset use in Outpatient Department Dirty Utility rooms at a newly designed hospital was monitored across two separate time periods.

1



2



3



Photographs 1, 2 and 3, courtesy of Harper Water Management Group

Methods

Continuous remote sensor monitoring (Omnia Klenz Ltd) quantified asset utilisation in standard-design Dirty Utility rooms across eight outpatient departments at a UK hospital commissioned in 2022. Monitoring was conducted in March 2025 (Whapham *et al.*, 2026) and September 2026, recording use of wash-hand basins, sinks, sluice hoppers, and macerators.

Results

Standard Design Dirty Utility Rooms within Eight Outpatient Departments: Sink, Slop Hopper & Macerator Usage Events (March 2025)

Water Usage Frequency over 25 Day Study Period	Sink Usage Events	Slop Hoper Usage Events	Macerator Usage Events
No use during study period	0/10 (0%)	4/5 (80%)	0/4 (0%)
< once daily (low use)	8/10 (80%)	1/5 (20%)	2/4 (50%)
Once daily to < 3 times daily use (minimal use)	2/10 (20%)	0/5 (0%)	1/ 4 (25%)
≥ 3 times daily use (well used)	0/10 (0%)	0/5 (0%)	1/4 (25%)

Only 1/19 (5%) Dirty Utility assets were considered to be well used during the March 2025 data collection (Whapham *et al.*, 2026).

Monitoring data was continuously collected from five outpatient departments from this original study and the reported usage data evidenced during September 2026 are as follows:

Standard Design Dirty Utility Rooms within Five Outpatient Departments: Wash Hand Basin, Sink, Slop Hopper & Macerator Usage Events (September 2026)

Water Usage Frequency over 30 Day Study Period	Wash Hand Basin Events	Sink Usage Events	Slop Hoper Usage Events	Macerator Usage Events
No use during study period	0/5 (0%)	0/10 (0%)	0/5 (0%)	0/4 (0%)
< once daily (low use)	2/5 (40%)	10/10 (100%)	2/5 (40%)	2/4 (50%)
Once daily to < 3 times daily use (minimal use)	2/5 (40%)	0/10 (0%)	3/5 (60%)	1/ 4 (25%)
≥ 3 times daily use (well used)	1/5 (20%)	0/10 (0%)	0/5 (0%)	1/4 (25%)

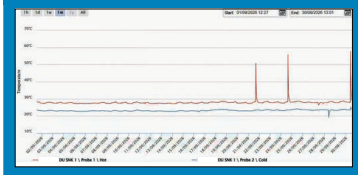
Only 2/24 (8%) Dirty Utility assets were considered to be well used during the September 2026 data collection.

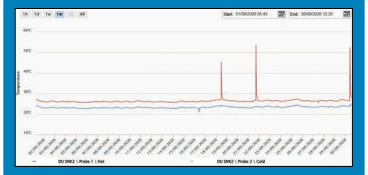
Utilisation was consistently low across assets monitored–within the initial study period in March 2025 and later study period in September 2026 – confirming chronic underuse. If macerators were utilised for all slop hopper and macerator events, the total number of usage events would improve – however there may not be any requirement for such fluid waste disposal in some clinical areas. Design must be tailored to match user needs.

Dirty Utility assets monitored are shown in Photograph 4 with example water asset usage traces below.

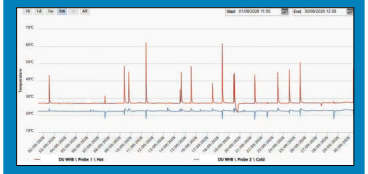
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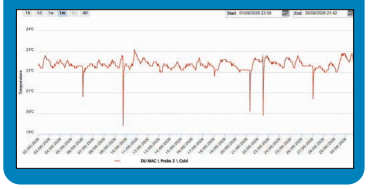












Photograph Courtesy of Royal Liverpool University Hospital

Discussion

These findings demonstrate plumbing asset overprovision, causing prolonged stagnation in hot- and cold-water systems, extensive periods of water temperatures sitting at room temperature, stagnation in drainage pipework, and trap water. Although compliant with Health Building Note guidance, the standard Dirty Utility configuration—two decontamination sinks, sluice hopper, macerator, and clinical handwash basin—does not reflect operational needs and introduces avoidable water quality and patient safety risks.

Evidence-based design, rather than adherence to outdated or inappropriate guidance, can reduce stagnation, improve sustainability, mitigate infection transmission, lower capital and operational costs.

Design teams should prioritise a "safe space" tailored to clinical workflows and where equipment provision supports waste product management, clinical and housekeeping practices. For example, a macerator and clinical wash-hand basin may suffice. In Photograph 5, the "Dirty" entrance provides direct access to the macerator, while the clinical wash-hand basin is positioned near the "Clean" exit. Although not universally applicable, this layout demonstrates detailed Hierarchical Task Analysis (HTA) and competent water and wastewater risk assessment and mitigation, aligned with guidance NETB 2024/3.

5



Photograph courtesy of Harper Water Management Group

Hospital Dirty Utility 15-Point Design Plan

To protect patients from waterborne pathogens, Dirty Utility design must consider and align:

1. Individualised layouts informed by Hierarchical Task Analysis (HTA) and competent risk assessment.
2. Hands-free access options - door and equipment controls - to minimise contact transmission.
3. Removal of sinks and slop hoppers in favour of lower-risk macerators and washer-disinfectors. Equipment cleaning may use sporicidal wipes, not sinks.
4. Optimal room dimensions, layout, equipment and workflow must support effective infection control and good user behaviours.
5. Clearly delineated dirty-to-clean workflow areas, using colour-coded surfaces and physical barriers.
6. Appropriate waste disposal equipment and set-down areas for contaminated items within dirty zones.
7. Drainage design with adequate space for swept bends, backflow protection, accessible rodding points outside patient-care and clean areas, and no shared drainage branches upstream of the main sewage stack.
8. Designated space for cleaning wheelchairs, commodes, and drip stands; sporicidal wipes offer an evidence based cleaning method.
9. Protected, covered storage for decontaminated equipment and, where risk-assessed, pulp items.
10. Clinical wash-hand basins positioned at exit door or dirty-to-clean transition point in one-way workflows.
11. Minimise transport distances for contaminated fluids and wash water by optimal room location. Ward-based sluice bays with macerators and clinical wash-hand basins may reduce inappropriate disposal and provide resilience during equipment failure. Shared facilities may reduce stagnation and costs where appropriate.
12. Avoid locating Dirty Utility rooms at the end of water pipeworks where usage is predictably low. Alternatives such as Staff WC or automatic dump-valves may maintain water turnover without compromising patient safety.
13. Train clinical, housekeeping, estates, and infection prevention and control (IPC) teams in risk recognition and mitigation relevant to the Dirty Utility.
14. Provide adequately resourced maintenance agreements with defined downtime and clear contingency arrangements for waste disposal during equipment failure.
15. Include Dirty Utility facilities in Legionella and Pseudomonas risk assessments.

Supporting References

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Hospital sewer systems: a longitudinal wastewater analysis

From passive drainage infrastructure to an integral component of infection prevention

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Introduction

Hospital sewer systems can harbour antimicrobial resistance genes and opportunistic pathogens, with implications for patient safety and environmental dissemination. This highlights the need to include wastewater infrastructure in infection prevention strategies.

Methodology

1. Detection: Longitudinal wastewater sampling and digital PCR targeting ESBL en carbapenemase genes



2. Persistence & 3. Patient acquisition: NGS-based comparison of isolates from routine environmental cultures and patient samples

1. Detection

What flows through?



Multiple ESBL and carbapenemase genes detected

Repeated over time

Resistance genes throughout the hospital sewer network

2. Persistence

One clone in shower drains, seven years apart





Same *Enterobacter spp.* clone in shower drains, seven years apart

Consistent with long-term persistence in drain biofilms

Closely related isolates also detected in patients

3. Patient acquisition





Sink positive before patient acquisition

Highly related sink and patient isolates

Sink strongly implicated as the source

DESIGN AND MANAGE WASTEWATER SYSTEMS FOR INFECTION PREVENTION

- Remove unnecessary sinks and other water points
- Design to prevent exposure
- Use water points safely
- Manage connected drainage networks
- Verify sustained risk reduction
- Consider wastewater treatment before discharge to the public sewer

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