Improving catheter care to prevent infections

A behavioural intervention in three NHS hospital trusts

Health Innovation Network South London
The Health Foundation
REVEALING REALITY

EXECUTIVE SUMMARY

Simple, low-cost behavioural interventions improved urinary catheter checking behaviours and promoted earlier removal in sites where there was established practice of prolonged catheterisation

The intervention

A behaviour change intervention designed to increase clinically appropriate urinary catheter checks and reduce catheter dwell times[1] was developed and rolled out in six wards specialising in geriatric medicine at three NHS trusts in 2024.

The intervention was low-cost, £176 per ward, consisting of stickers, posters and magnets, and a short staff briefing[2]. The materials were co-designed with NHS staff to evoke feelings of disgust, make information about duration of catheterisation more available, and cut through to change practice in busy and noisy NHS environments.

A range of strategies were implemented to promote continued engagement with the project: telephone and email reminders about the audit, regular calls with trusts offering support to address any emerging challenges and site visits to relaunch the intervention with posters, chocolates, and branded mugs.

A daily catheter audit was carried out across each ward, monitoring catheter removals and dwell time, and, during the intervention, the presence of the intervention stickers.

[1] Dwell time refers to the total duration of catheterisation

[2] Note that in the pilot there was an auditing process for evaluation purposes, which may have had some positive impacts on intervention outcomes, but is not included in this cost. The upfront design of the intervention materials is also not included in this cost.

The intervention significantly reduced average catheter dwell time at two of the three hospitals

The impact

Statistical process control (SPC) charts showed that the intervention significantly reduced average catheter dwell time (duration of catheterisation) at two of the three hospitals: Lewisham and Greenwich and King's College Hospital Trusts.

At King's College Hospital NHS Trust, the average dwell time decreased from 13.3 days to 7.4 days, and at Lewisham and Greenwich NHS Trust, it decreased from 13.4 days to 10.2 days. At these two trusts there was also a higher proportion of early removal of catheters - those removed in under 48 hours - after the intervention had been implemented.

The third trust, The Royal Wolverhampton NHS Trust, showed no significant reduction following the intervention implementation; instead, the average dwell time increased from 6.5 days to 7.5 days, however this was not statistically significant.

The pre intervention dwell times were higher at the two trusts where the intervention was effective, 13.4 and 13.3 days respectively, compared to the Royal Wolverhampton Hospital Trust whose pre intervention average dwell time was 6.5 days. Therefore, catheter checking and removal behaviours were already comparatively optimised at The Royal Wolverhampton Hospital Trust.

Baseline dwell time data:

- The Royal Wolverhampton Hospital Trust **156 hours (6.5 days)**
- Lewisham and Greenwich Hospital Trust **320.8 hours (13.4 days)**
- King's College Hospital Trust **320.3 hours (13.3 days)**

The Royal Wolverhampton Hospital Trust's existing, relatively optimised catheter management practices may have created a 'ceiling effect,' where further substantial improvements were more challenging to achieve through the intervention.

Staff reported that the 'best before' stickers made it easier to check how long a catheter had been in for

Staff at all three sites reported that it made it easier for them to check how long catheters had been in for, and that stickers prompted conversations about removing catheters. **'Catheter ninja' magnets prompted conversations between staff** about catheter removals in wards where staff used whiteboards.

Given the relationship between duration of urinary catheterisation and catheter associated urinary tract infection (CAUTI), it is likely that this project had a **positive impact on patient outcomes,** though this was not something that was measured.

The intervention was cost-saving at two of the three trusts

Cost-comparison analysis indicates that this intervention, in the first and subsequent years, is **cost-saving at King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust**, and it is cost-incurring at The Royal Wolverhampton NHS Trust.

This project demonstrates that low-cost, easy to administer interventions have the potential to shape NHS staff behaviour

Conclusions

It shows how simple behaviour change concepts such as reducing cognitive load, evoking emotional responses, and adopting a tone and style designed to stand out from routine NHS messaging, can be effectively used in a healthcare setting.

It is unclear whether the intervention's observed impact would have occurred without the effort to ensure continual engagement with the pilot. The pilot also did not determine the extent to which the daily checks for the presence of stickers on catheters influenced staff's behaviour.

We recommend implementing this intervention in wards that exhibit suboptimal catheter management practices, in order to improve patient outcomes and save money.

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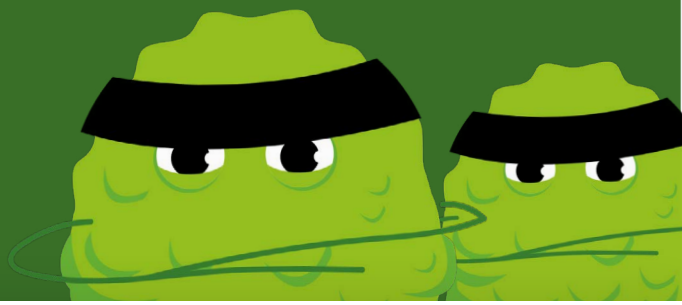

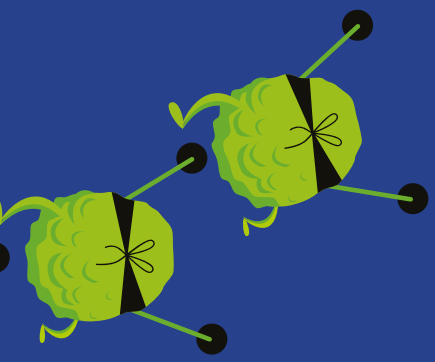

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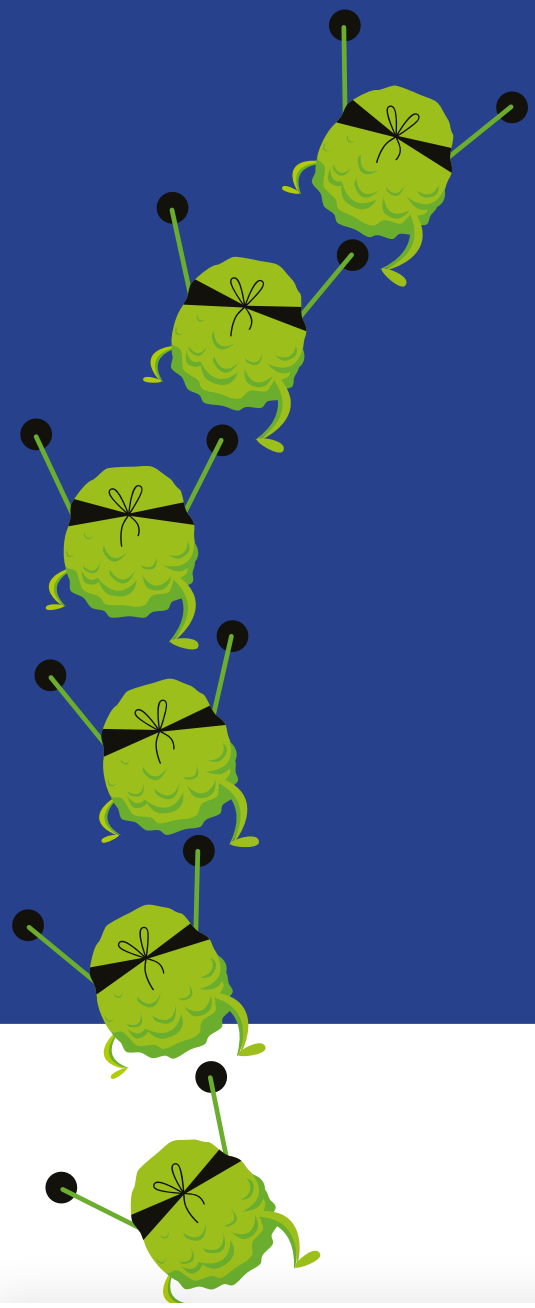
Catheter-associated urinary tract infections (CAUTIs) represent a significant yet preventable source of harm in healthcare settings. The project, funded by the Health Foundation's Behavioural Insights Research Programme, was to develop and evaluate behavioural interventions aimed at reducing CAUTI rates.



Introduction

The problem of catheter associated urinary tract infections (CAUTIs)

Catheter-associated urinary tract infections (CAUTIs) represent a serious healthcare challenge, with potentially severe consequences for the patient, including death. These infections, largely preventable through proper catheter management, are a common cause of hospital-acquired bacteraemia (blood stream infections) and contribute to the estimated £1 billion annual cost of healthcare-associated infections to the NHS.

For some patients, urinary catheterisation is required as a long-term intervention, but more commonly in hospital acute care, urinary catheterisation is used to support monitoring of urine output during the initial phase of serious illness. This should usually only be short term. However, more prolonged catheterisation increases the risk of CAUTIs starting from approximately 48h, with risk incrementally increasing with increased duration. In addition, there are other adverse effects of urinary catheterisation including delayed mobilisation, which is particularly important for patients living with frailty, as it may increase hospital-acquired deconditioning and discomfort.

Many of the problems with catheter care are well known, and research by Revealing Reality for the Phase 1: "Explore" part of this project reiterated the absence of effective systems for tracking catheters and a wide range of communication barriers which prevented timely removal:

- Unclear accountability structures, creating an environment where inaction becomes the default and responsibility is easily displaced
- Limited visibility of catheter tracking data, with critical information about duration of use often difficult to access (e.g. insertion date)
- Knowledge gaps among healthcare staff, resulting in low confidence and insufficient awareness of catheter-related risks

Working alongside healthcare professionals, the team developed a bundle of interventions targeting three critical areas: improving awareness of CAUTI-related harm, enhancing communication and documentation processes, and strengthening staff empowerment and responsibility for catheter care.

Phase 1 of the project was the *Explore phase* in which the issues with catheter care and ways in which it could be improved was understood through observation at healthcare sites and interviews with practitioners.

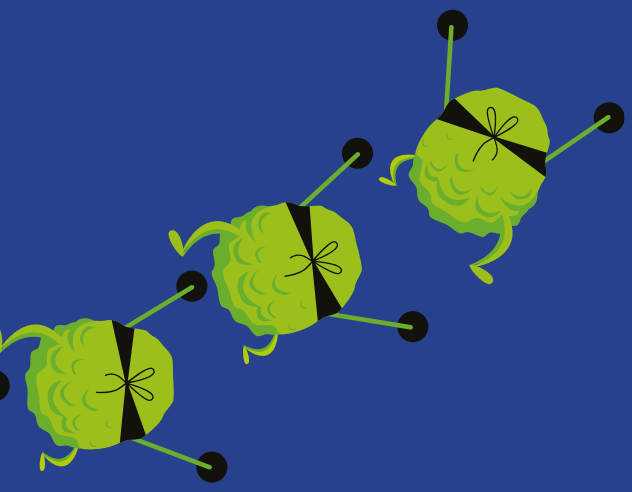
https://healthinnovationnetwork.com/resources/behavioural-insights-research-project-innovating-in-catheter-practice-in-the-hospital-and-community/

Phase 2 of the project was the *Design phase* in which an intervention comprising a number of components was co-designed with healthcare professionals.
More information about this phase can be found in Appendix 2 of this report.

Phase 3 was the *Test phase* in which the co-designed intervention was implemented on wards in three hospitals and the impact this had on activities associated with catheter care was monitored.

This report covers the results from this phase of the work.

The key question for the Test phase was whether these behavioural change interventions improved catheter checking behaviours and therefore infection prevention.



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What were we trying to find out?

The Explore phase found that there was absence of an effective system for tracking catheters and a wide range of communication barriers, therefore the primary goal of the intervention was to **increase the frequency and consistency of catheter checks** (i.e. checking whether there is a need for ongoing catheterisation) **within in-patient medical ward environments.**

By improving these monitoring practices, the intervention sought to achieve three interconnected outcomes: minimise unnecessary catheter dwell time, reduce the incidence of catheter-related infections, and enhance the overall patient experience.

Further potential consequences of the intervention were agreed with the trusts, project sponsors and advisors. These included:

- Increase catheter checking
- Increase awareness of catheter presence
- Increase sense of responsibility
- Increase data availability around catheters
- Increase conversation about catheter presence
- Increase status of catheters in the ward

The reduction of CAUTIs was a key aim of the intervention. Identification of CAUTI requires a combination of both patient clinical assessment (e.g. the presence of flank pain, haematuria, delirium or fever) and lab testing of a urine sample to confirm the presence of significant bacteria in the urine. These assessments were not done routinely or consistently at the test sites. This meant that measuring the impact of the intervention directly against CAUTI rates was not possible. However, risk of CAUTI is correlated with the duration of catheterisation when > 48h. As a result, this project used outcome measures which indirectly link to CAUTI risk, such as checking or awareness, as well as directly measuring the dwell time of catheters.

A Theory of Change was developed based on the findings from the Explore phase.

Theory of change

Catheter Care: No Catheter, no infection

OUTCOMES/ MEASURABLE EFFECT

Short term

Status raising
- Staff understand the risks of using a catheter
- Catheters considered to be important within the team

Conversation
- Staff feel permission and have the confidence to question the need of every catheter on the ward
- Encourage questioning of catheter presence

Data availability
- Data relating to catheters is easier to find
- Improved documentation around catheters
- Clearer if a delay in catheter removal has happened
- Data more accurate
- Reduced time finding catheter information
- Increased confidence in checking catheter documentation

Medium term

Awareness of catheter presence
- Improved awareness of catheter presence on the ward

Increased awareness of catheter-based infections
- Awareness that catheters left in unnecessarily increases risk of infection

Increased sense of responsibility
- Increased sense of personal responsibility for preventing infection through checking catheters

Perception of catheters as temporary Improved documentation around catheters
- Awareness of time sensitivity of non-permanent catheters

Catheter checking behaviour
- Increase catheter checks
- More regular checking of catheters

Reduction of catheter days
- Reduce average number of days patient has catheter in per ward

OUTCOME

Long term

Reduction of rates of CAUTI's

PROJECT GOAL

Increased frequency of catheter checks to improve patient experience and reduce catheter related infections

ASSUMPTIONS

- Staffing levels stay stable during the trial period
- Wards are stocked with a sufficient supply of intervention materials and catheters throughout the period
- Level of demand from patients and patient case mix remains stable during the trial period
- No other unexpected external events that could disrupt the project
- There are no other major interventions taking place at the same time. If any, they align rather than conflict with this one

The intervention was designed to be both practical and impactful within busy healthcare environments.

What were the components of the intervention?

From the outset key criteria for the intervention included:

- Low cost
- Easily integrated into a diverse range of clinical settings, without disrupting established workflows
- No change to any clinical decision-making processes or responsibilities
- Time-efficient

Additionally, through co-design with staff from the NHS trusts, it was agreed that the intervention should:

- Evoke emotional response of disgust, not fear
- Stand out in crowded hospital environments by taking a different style and tone to 'classic' NHS-looking interventions
- Be immediately understandable and easy to use
- Prompt conversations about catheters as part of normal patient care

The intervention was co-designed with hospital Trusts. More information about this process can be found in Appendix 2.

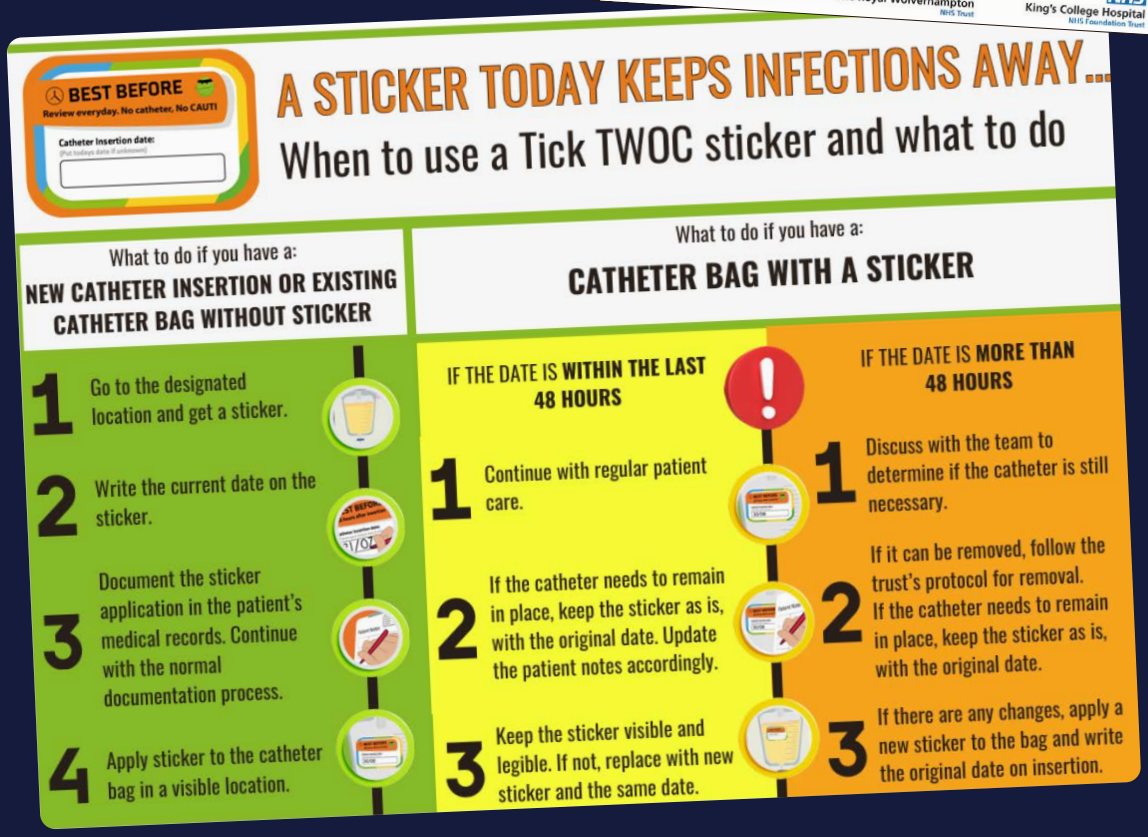
Sticker

- The sticker features a single data point - the insertion date - keeping it simple to complete and read and ensuring focus on this critical piece of information
- Using the phrase “best before” deliberately evokes familiar feelings associated with expired food products, creating a subtle sense of urgency without being overtly clinical
- The stickers were designed to be colourful and taking a different style and tone from those found elsewhere in the ward environment
- Instruction was included for cases where the insertion date is unknown, addressing a common challenge with patients arriving through emergency or community pathways
- The design creates gentle pressure to consider catheter removal while respecting that timing remains a clinical decision - avoiding prescriptive rules or specific timelines
- Language was refined through staff collaboration to ensure clarity and practicality in real healthcare settings
- Staff preferred rolls of stickers to be printed as these were less easily lost or misplaced than flat sheets of stickers
- Stickers were placed directly in the middle of the catheter bag to be as visible as possible

Posters

The intervention included two complementary posters:

- An awareness poster highlighting the role of catheters in healthcare-associated infections, featuring the date sticker as a key tool for prevention
- A practical guidance poster demonstrating how to use the sticker across different scenarios, displayed near sticker storage areas to support staff at the point of use
- TWOC is the abbreviation for 'trial without catheter' the procedure to trial the removal of a urinary catheter. The term 'Tick TWOC' builds on this and reinforces the gentle pressure to remove the catheter sooner rather than later
- The phrase 'No catheter, no infection' was developed building on similar phases such as 'No catheter, no CAUTI' which had been previously used in some healthcare settings

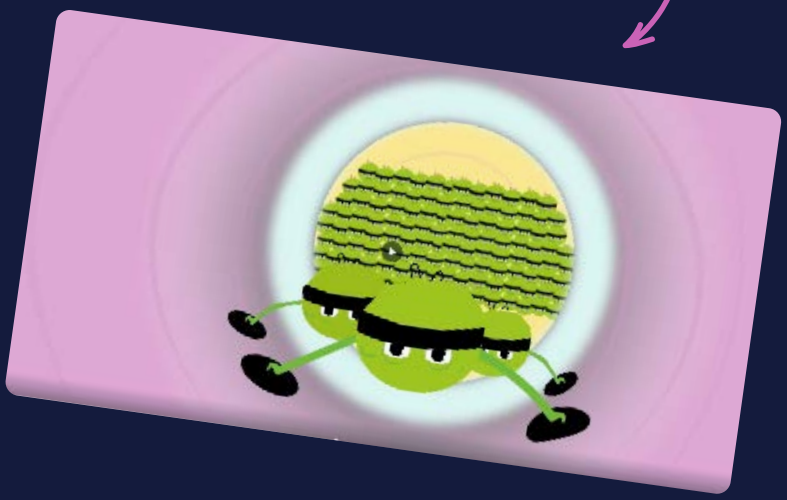


Magnets

Catheter-identification magnets were developed at staff request to highlight catheterised patients on whiteboard displays, which contain information about each patient on the ward, and are used to keep track of the care provided to patients and steer decision making. Magnets were designed to stand out from existing whiteboard magnets, prompting discussion of catheter care during daily team reviews. While effective in wards with physical whiteboards, this tool was implemented selectively, as some units had transitioned to digital patient tracking systems.

Animation

A brief animation was created to support the ward-level implementation of the intervention. This visual tool was integrated into the launch process and shown to ward staff when they were briefed about the intervention. It was also intended to be used as a reminder during the intervention period – although it was rarely used for this purpose. It was initially shared via email to the ward matrons and at one trust it was shared as a message in the staff WhatsApp chat. However, there wasn't a prompt to look at it again.



Behavioural science principles underpinning the intervention

The design of the interventions draws on a range of behavioural science theories to improve their impact:

- **Reducing cognitive load:** *The total amount of mental effort being used in working memory – things that require more cognitive load take longer to process.* The intervention's simple designs, particularly the focus on a single data field of the sticker, were developed to reduce cognitive load. Reducing available information to one key data field, reduces mental effort and is designed to increase standout, making compliance more likely
- **Choice architecture and salience:** *Designing choices to highlight desired options and influence decisions.* Care was taken to ensure that the different elements of the intervention were strategically placed at key decision points (large, colourful sticker on catheter bags, posters near supplies, magnets on ward whiteboards) to make desired behaviours easier and more intuitive. Distinctive visual designs and colours help cut through the visual stimuli of clinical environments, leveraging the von Restorff effect to capture attention. *The von Restorff effect, also known as the isolation effect, predicts that when multiple similar stimuli are presented, the one that differs from the rest is more likely to be remembered*
- **Social proof and normalisation:** *The tendency to follow others' actions.* The system encourages catheter discussions during routine care, making catheter monitoring a visible, normal part of ward culture
- **Affect heuristic:** *Making quick decisions based on emotions.* Using "best before" language taps into intuitive feelings about expiration and contamination, while avoiding fear-based messaging that can lead to defensive responses

Where did we test the intervention?

The three NHS Hospital trusts that took part in this intervention were Lewisham and Greenwich NHS Trust, The Royal Wolverhampton NHS Trust, and King's College Hospital NHS Trust.

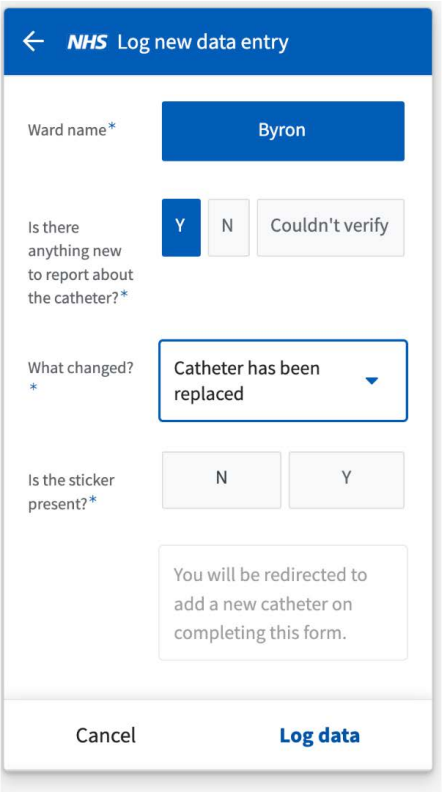
Trusts volunteered to take part in the project. Trusts were invited to participate in the pilot by the Health Innovation Network (the HIN), having attended a catheter improvement event organised by the HIN.

Inclusion criteria were that they had to provide a local district general hospital service and had wards that specialise in geriatric medicine.

Trusts were paid £17,000 for participating in the intervention. This was to cover the costs of a member of staff to carry out daily audits of the catheters and facilitate other evaluation activities, such as ward visits.

Factors that influenced the decision to test the intervention in geriatric wards:

- The project focused on the acute (urgent and emergency) care pathway not elective care. A typical pathway is that patients are admitted via the emergency department into a short stay ward such as a medical admission ward where patients are initially treated. Whilst catheterisation can be performed in many settings, for emergency admissions it most commonly takes place upon initial presentation either in the emergency department or admission ward so that the time of catheter insertion needs to be handed over to the next (geriatric medicine) ward. Some patients, mostly those living with severe frailty who need more prolonged treatment, are then transferred for ongoing treatment to wards specialising in geriatric medicine.
- Wards specialising in geriatric medicine were chosen because catheterisation rates are high, the need for early removal is high because of the adverse consequences of CAUTI, and vulnerable patients, particularly those patients with underlying dementia or experiencing delirium, may not demand catheter removal. These patients tend to have longer lengths of stay so that removal of a urinary catheter to support patient discharge may be delayed. These wards offer a degree of case-mix standardisation between test-sites and serve older adults living with frailty, who are particularly vulnerable to complications of catheter-associated urinary tract infections.



Screenshot of the bespoke catheter logging app

How did we carry out testing?

Sustainable improvements in healthcare require both measurable outputs and an understanding of how changes work in real clinical settings.

Data collection included:

- **Daily audit of catheters.** Daily checks of catheters to log any catheters that were removed and their dwell time
- **Ward visits** pre, during and post intervention to observe changes to the ward and the use of intervention materials, and collect survey and interview data pre and post intervention
- **Staff survey** pre and post intervention exploring outcomes such as staff awareness of catheters, availability of data, and perceptions of responsibility for catheter care
- **Short interviews** with staff during ward visits pre and post intervention

Daily audit of catheters

A bespoke catheter logging app was created to enable staff from the Infection Prevention and Control Team from each trust to carry out daily audits of catheters.

At each site, a small team of auditors (2-4 members of staff) had access to the catheter logging app. This app allowed staff to record catheters, noting when they had arrived in the ward and when they had last been checked by the auditing team.

Staff carried out the catheter audit once a day, Monday to Friday, visiting both wards.

The app prompted staff to report whether the catheter was a short- or long-term, and if there was anything new to report about the catheter (e.g., patient transfer, catheter removal).

Initially, this data was intended to distinguish between the long- (where the clinical decision is that the catheter should remain in place) and short-term catheters (where the catheter was introduced to support acute care management and it should be removed when the patient is stable). As the intervention was primarily designed to influence short-term catheter removal behaviours, this would have enabled analysis of the intervention's impact on short-term catheters only.

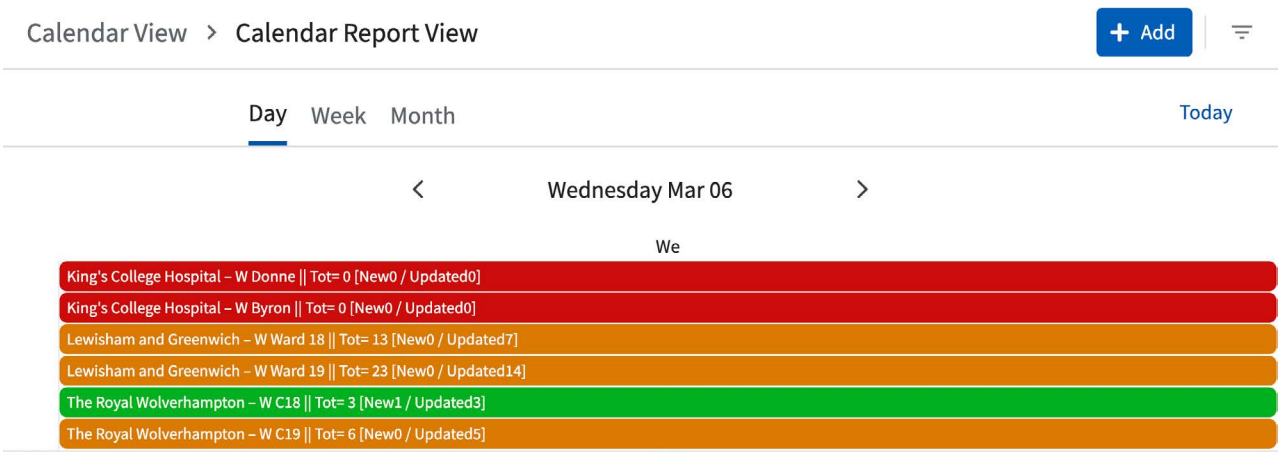


Figure 1- Each ward was assigned a daily RAG rating for the number of checks they had completed each day (Red – no new checks completed, Orange – less checks made than number of catheters recorded as present in the ward, Green – number of checks made equals the number of catheters at the ward)

However, the reliability of this data was low, with an unexpectedly high proportion of long-term catheters reported (35% at King's College NHS Hospital Trust, 36% at Lewisham and Greenwich Hospital NHS Trust, and 94% at the Royal Wolverhampton NHS Hospital Trust). Additionally, there was little difference in the dwell times between the two categories. As it was not possible to accurately distinguish between the two groups, all catheters have been included in the analysis, regardless of whether self-reported to be long or short term.

During the intervention stage of the pilot, staff were also asked to record whether or not stickers were present for each individual catheter.

At two of the sites, staff had downloaded the app onto their work mobile phones where they were able to sign into their trust specific account to carry out the audit. At Wolverhampton, staff were given a tablet with the app pre-installed.

Prior to the pilot, a 10-minute training call was conducted with staff to brief them on how to use the app and offered tech support throughout the intervention. The project team also monitored the number of daily checks reported and if there had been a noticeable period of missing data entry (e.g. more than 2 days) this would be followed up with staff via phone calls and emails.

Impact of daily auditing

The daily auditing of catheters and physical checks on sticker use may act as an intervention in itself, raising awareness and influencing staff behaviour relating to catheter removals, due to feeling monitored. As a result, it's challenging to separate the impact of auditing from the overall intervention. Future rollouts of the intervention should explore whether outcomes are achieved in the absence of the daily auditing.

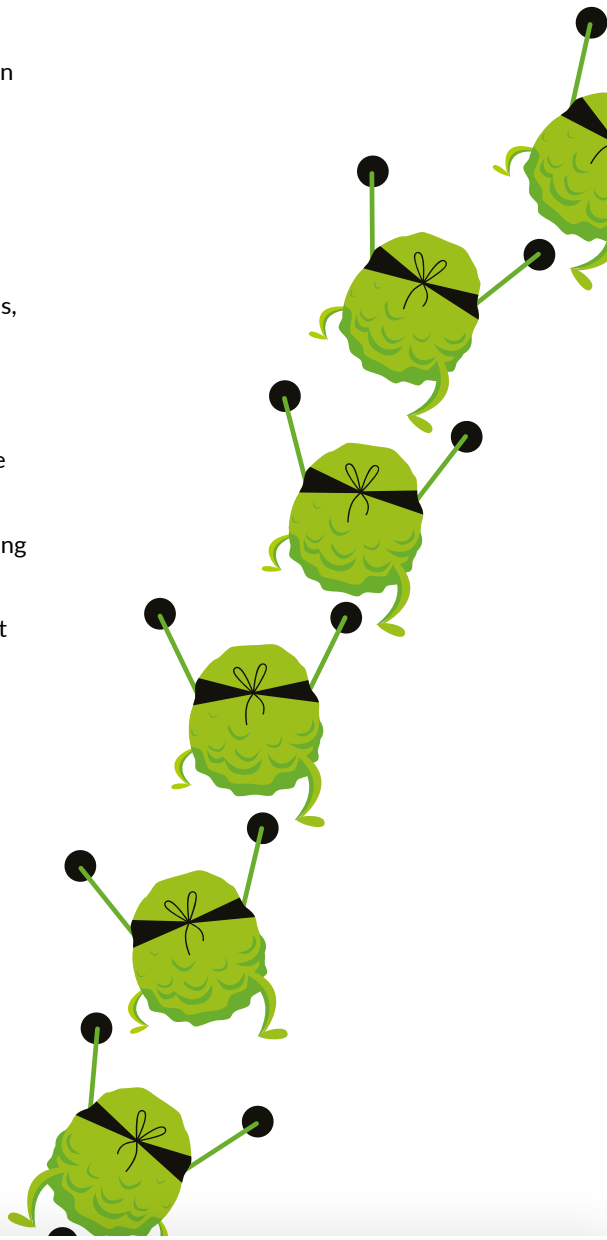
Statistical Process Control (SPC) was used to analyse catheter dwell time data

Statistical Process Control (SPC) is a method of statistical analysis used to measure variations in a data point over time. SPC is used to identity meaningful trends, patterns, and statistically significant shifts in datasets.

Unlike traditional statistical methods, SPC charts are able to identify trends in smaller datasets while accounting for natural or expected variation. SPC analysis provides a structured approach to determining whether observed patterns or changes in data are statistically significant or a result of random variation.

This method ensures a more reliable evaluation than comparing averages pre and during the intervention, as it provides insights into process stability and change over time.

A trend may be identified where there are 7 consecutive points in either a pattern that could be; a downward trend, and upward trend, or string of data points that are all above, or all below the mean. A trend would indicate that there has been a change in process resulting in a change in outcome.[3]



[3] https://www.lpft.nhs.uk/about-us/how-we-are-performing/guide-using-spc-charts-and-icons-and-reading-demand-charts>

Ward visits during the pilot

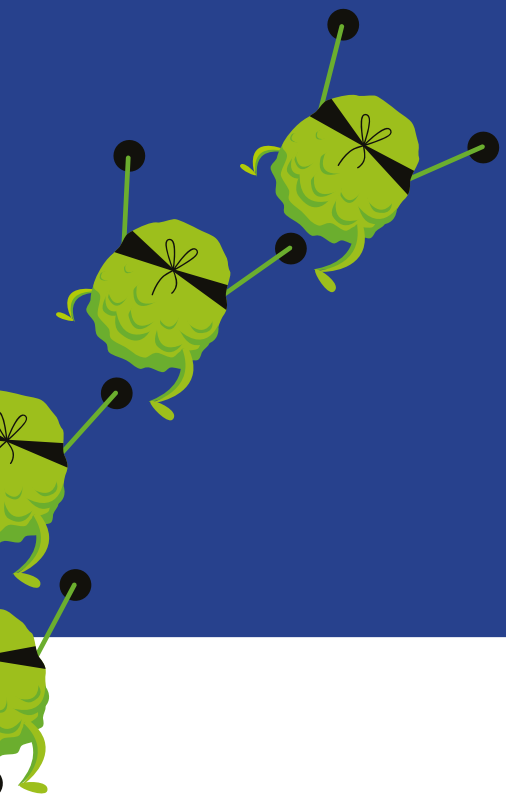
During the pilot, four separate rounds of visits to the wards were made:

Visits	Description
1st ward visit February / March 2024 *Baselining stage*	• Staff completed short pre-intervention interviews and surveys during this visit
2nd ward visit July/August 2024 *Start of intervention*	• Wards were provided with intervention materials (stickers, posters, magnets) • A 10-minute briefing was conducted with staff on the background to the pilot and how they would use the materials
3rd ward visit November 2024 *During intervention*	• Two of the three trusts were revisited during the final two months of the intervention to resupply wards with materials, including a newly designed magnet and mugs • Chocolates and sweet treats were also given out as a token of appreciation for staff • Due to operational pressures, and ongoing infection control measures due to a Norovirus outbreak, the team was unable to visit New Cross Hospital in person • Instead, a "goodie bag" with materials and chocolates was sent
4th ward visit January 2025 *Post intervention*	• All three trusts were visited for a final time to gather staff feedback on the pilot and to assess its potential impact • The project team spent up to two days at each of the participating wards, and short interviews and surveys were conducted with staff

Staff survey

A staff survey was conducted both before and after the intervention to assess its impact. The survey aimed to measure goals aligned with the Theory of Change, including staff awareness of catheters on their ward, their sense of responsibility around catheter removal, the availability of catheter-related data, and the frequency of conversations and discussions around catheter removal. The post-intervention survey included a section at the end with reflections asking specifically about the intervention.

All ward staff involved in catheter care – doctors, nurses and healthcare assistants – were asked to respond to the survey.



The survey was created online, and a link was shared directly with each trust. In total, we received the following number of responses:[4]

Trust	Pre intervention	During intervention
King's College Hospital NHS Trust	17	23
Lewisham and Greenwich NHS Trust	29	24
The Royal Wolverhampton NHS Trust	19	20

Despite efforts to encourage participation, fewer than 30 staff members responded to the post-intervention survey within each of the three trusts. Additionally, the responses were not comparable to the pre-intervention survey sample, as the staff roles and lengths of time working on the wards differed between the two surveys. Due to the small sample size and these differences, it is not possible to draw any clear conclusion from the responses to these surveys.

Data tables for the survey responses are included in Appendix 1, which show no consistent trends emerged across the questions. Some questions showed improvements in the Theory of Change outcomes, while others showed no change or a decline.

Short interviews with staff

Short interviews were conducted with ward staff pre and post intervention. During these interviews, staff were asked about their experiences of providing catheter care and, in the post intervention interviews, their views on the intervention.

The interviews ranged from 5-minute interviews with healthcare assistants, wards nurses and doctors, to longer 25-30-minute conversations with members of the Infection Control and Prevention teams about their role within the pilot.

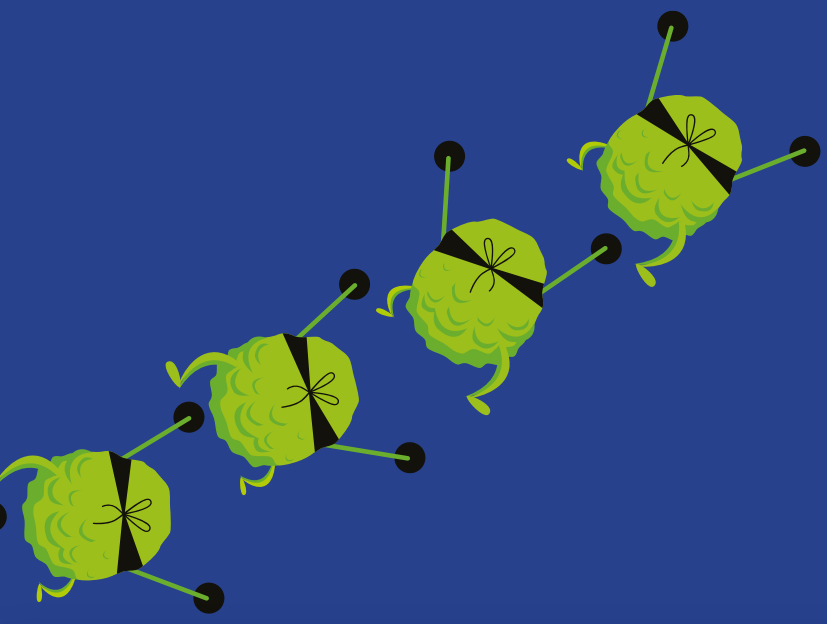
Limitations of the project

This pilot lacks a control group. Originally, this project included a control group (a non-intervention ward) within each trust for comparison with an intervention ward. Due to extensive COVID-19 related delays, the project timeline was significantly compressed. This resulted in insufficient time to collect sufficient catheterisation data across both intervention and control wards. Specifically, we were unable to meet the statistical power calculations required for a valid comparison between the two wards, forcing the elimination of the control group.

The pre-intervention data was collected during the spring and summer of 2024, while the intervention itself ran from summer through winter of the same year. Winter pressures typically cause increased demand for admission of frail patients which will translate into increased pressure on ward staff. This means that seasonal factors (like increased patient volume during flu season or variations in staffing or demand on staff) could have influenced the results – likely reducing the effectiveness of the intervention during winter. Because the pre-intervention and intervention periods occurred during different seasons, it is not possible to rule out the impact of these seasonal variations.

Further reflections on the challenges and learnings in relation to implementing and evaluating the intervention in busy hospital environments can be found in **the Process Learnings section.**

[4] Total number of responses is based on the total number of staff that completed the entire survey, and that have been working on the ward for 1 month or more.

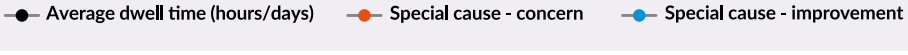


The intervention significantly reduced average catheter dwell time (duration of catheterisation) at two of the three hospitals

Statistical process control (SPC) charts showed that the intervention significantly reduced average catheter dwell time (duration of catheterisation) at two of the three hospitals, the two hospitals that had the highest pre intervention dwell times.

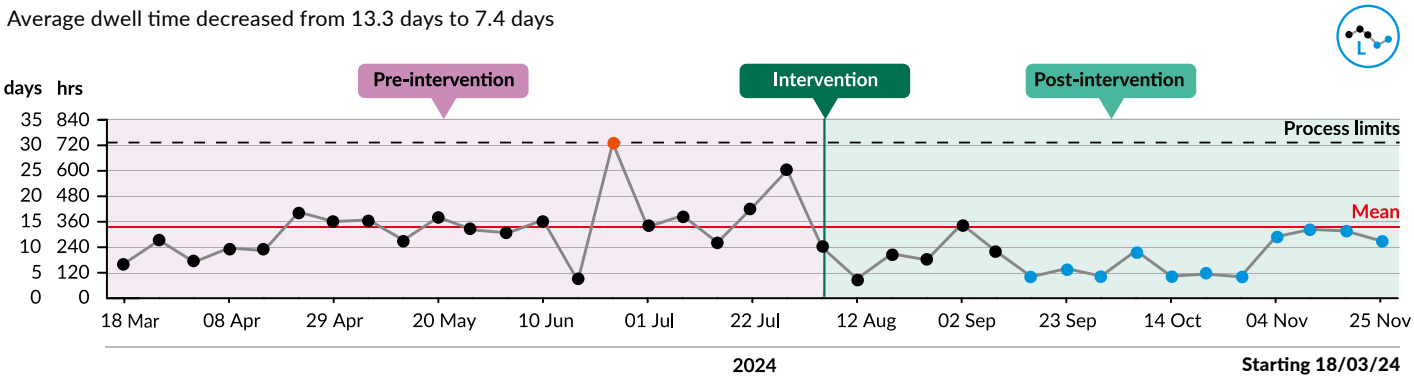
At King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust, there was a higher rate of early catheter removals:

- **King's College Hospital NHS Trust** During the intervention, 37% of catheters were removed in <4 days compared to only 22% pre intervention
- **Lewisham and Greenwich NHS Trust,** 31% of catheters were removed in <4 days intervention compared to only 15% pre intervention



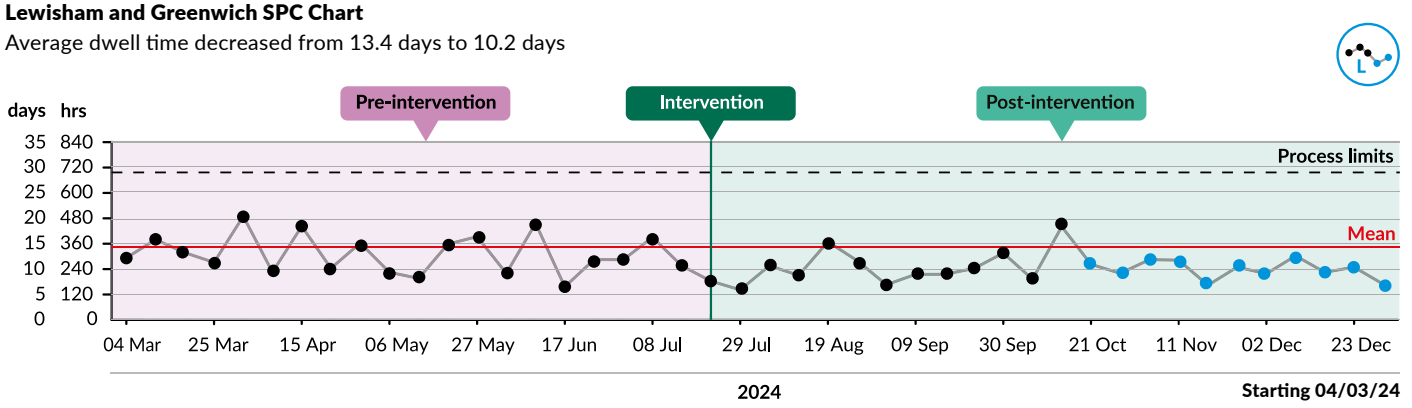
King's College SPC Chart

Average dwell time decreased from 13.3 days to 7.4 days



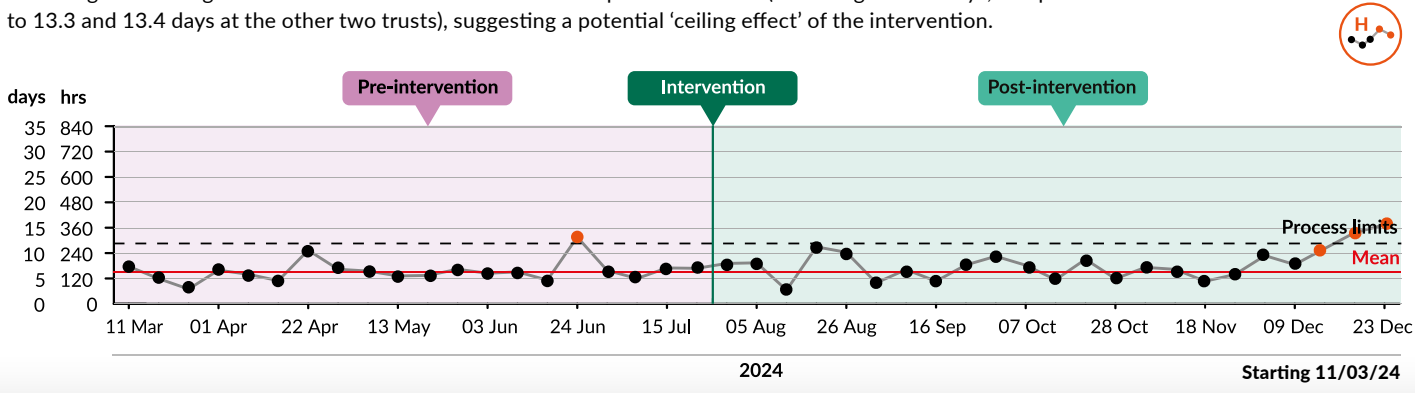
Lewisham and Greenwich SPC Chart

Average dwell time decreased from 13.4 days to 10.2 days



Royal Wolverhampton SPC Chart

No changes of average dwell time. Lower catheter dwell times pre intervention (an average of 6.5 days, compared to 13.3 and 13.4 days at the other two trusts), suggesting a potential 'ceiling effect' of the intervention.



How to interpret

Special cause indicators

In the SPC charts included in this report, each dot represents the average catheter dwell time for a specific trust during a single week.

Blue points indicate a special cause improvement, which may indicate a statistically significant change in catheter dwell time that is unlikely to be due to random variation. A special cause improvement in this case occurs when more than seven consecutive points fall below the mean

Orange points indicate a special cause concern, signalling an unusual increase that may require further investigation

SPC chart icons

In the top right corner of each SPC chart, an icon is displayed to provide a quick visual summary of the underlying pattern:

Normal variation - (common cause) fluctuations in data points that sit between the upper and lower control limits that do not reach the criteria for a Trend

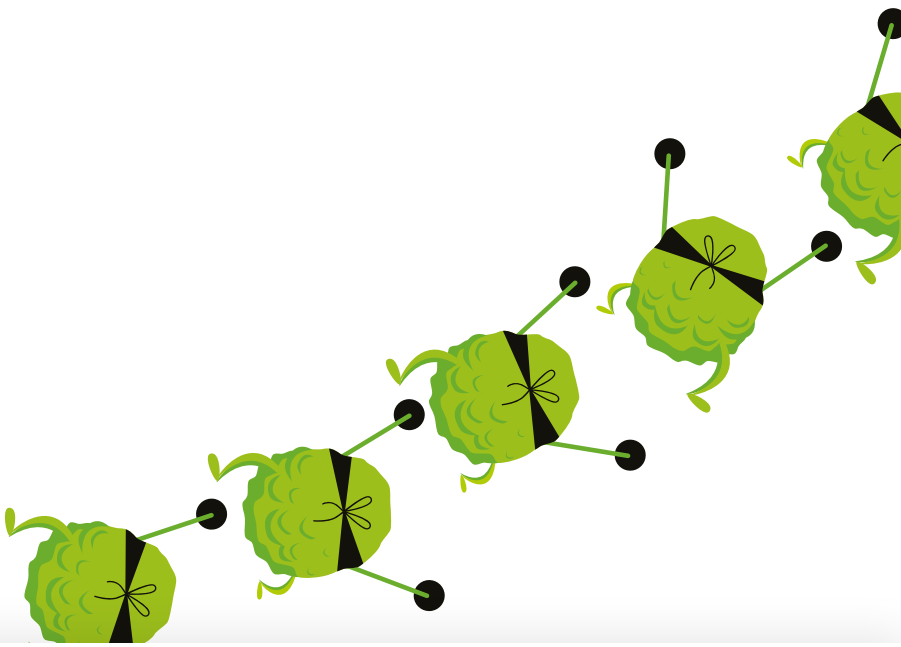
A downward trend (7 points below the mean) showing cause for improvement

An upward trend (7 points above the mean) showing cause for concern

For further information on SPC in healthcare improvement, refer to the following NHS resources:

The NHS guide to creating and interpreting run and control charts.

The NHS guide to using SPC charts and icons, and reading demand charts.



Staff across the three sites reported that the 'best before' stickers made it easy to check how long a catheter had been in for and prompted conversations about removing catheters

"Checking the date with the stickers are quite helpful. Before we would just check what the bag looks like, looking for discolouration for example, but now we look at the date so the stickers are very helpful. Sometimes you can check on the system but sometimes I don't even have the time to. Like today, I don't think I'll have the time to pick up a computer."

Healthcare Assistant at King's College Hospital

"I think it's good to know when it was inserted, how long they are keeping it in for. It makes us think about how long they need the catheter for. It helps us to prevent infections"

Nurse at Queen Elizabeth Hospital

Trust	Staff indicating stickers were 'very useful' *	Staff indicating, they wanted the stickers to continue *	Sticker compliance rate (The proportion of checks where a sticker was reported as present during the intervention for the three trusts was as follows)[5]
King's College Hospital NHS Trust	**75%** (15/20)	**95%** (19/20)	**81%**
Lewisham and Greenwich NHS Trust	**78%** (18/23)	**100%** (23/23)	**96%**
The Royal Wolverhampton NHS Trust	**55%** (11/20)	**80%** (16/20)	**78%**

Sticker compliance rates ranged from 78-96%

[5] This calculation excludes the last catheter check, where this data isn't logged (e.g., patient discharge, death, ward transfer, or catheter removal).

* Please note, that questions marked with an asterisk were only asked to staff that were aware of the 'best before' stickers.

IMPACT OF THE INTERVENTION

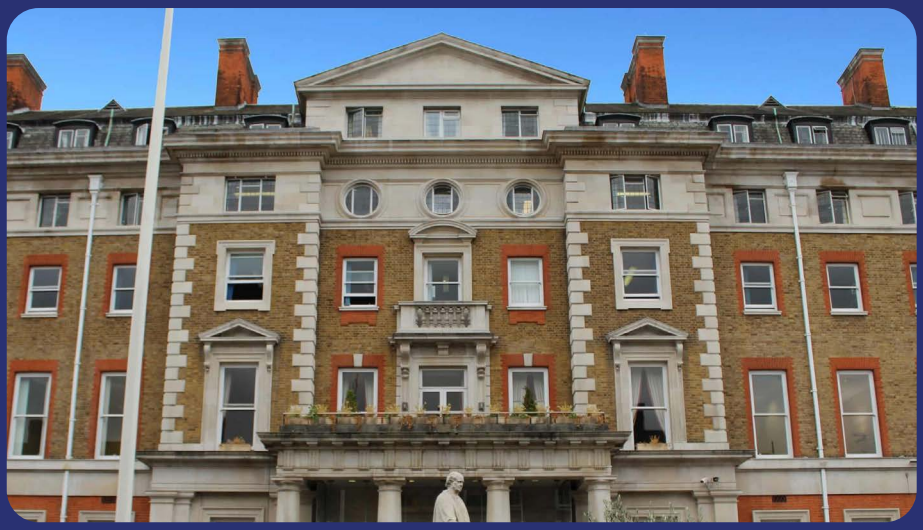
King's College Hospital Trust

King's College Hospital is a teaching hospital and major trauma centre at Denmark Hill in Camberwell in the London Borough of Lambeth.

Two wards specialising in geriatric medicine in the Hospital took part in this intervention, each ward had 25-30 beds.

Baseline period: 18th March to 4th August 2024 (19 weeks)

Intervention period: 5th August to the 25th November 2024 (16 weeks)



Throughout this period, dwell time data was collected on 227 catheters. This equates to 227 catheters over 37 weeks, averaging approximately 6.1 catheters per week across both wards, which was lower than the two other trusts, both of which had an average of over 10 catheters per week.

During analysis, 32 (14%) of catheters were excluded due to patient death or ward transfer. As a result, the final dataset included 195 catheters: 103 from the baseline phase and 92 from the intervention phase.

During the intervention, staff placed stickers on catheter bags and had access to informational posters for guidance on catheter care.

Catheter dwell times decreased following the intervention

Outcome: Dwell time

Pre intervention

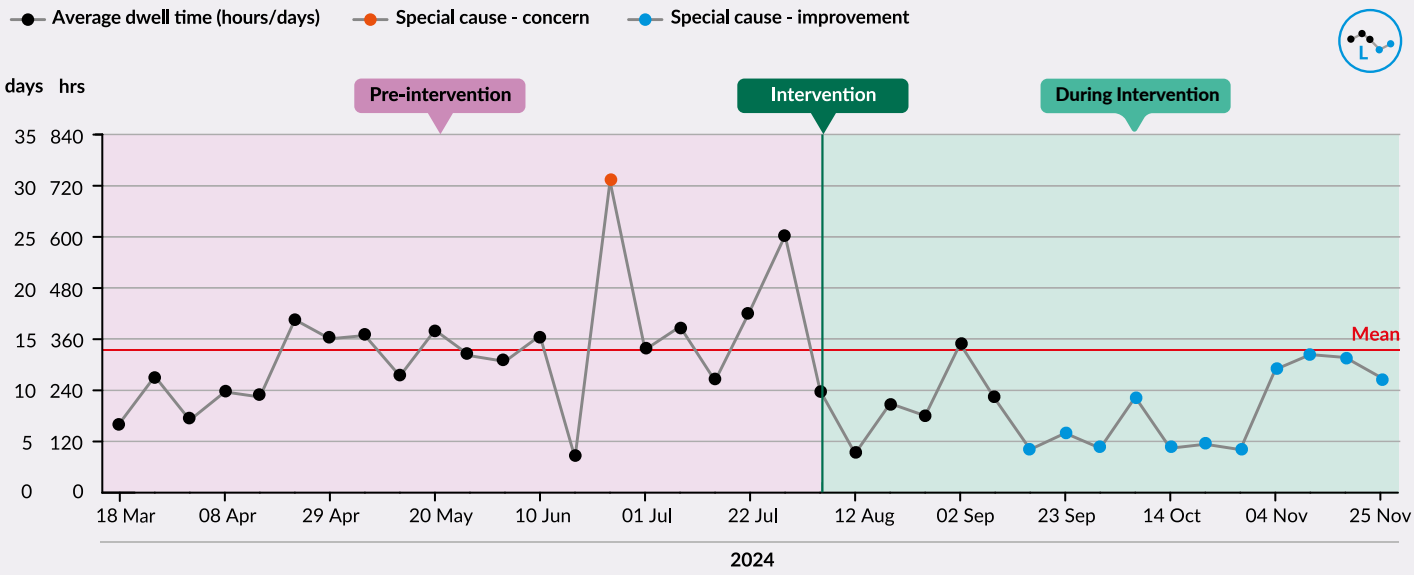
Overall, the average catheter dwell[6] time in the 20 weeks prior to the intervention was **320.3 hours (13.3 days) during** the intervention period,

During intervention

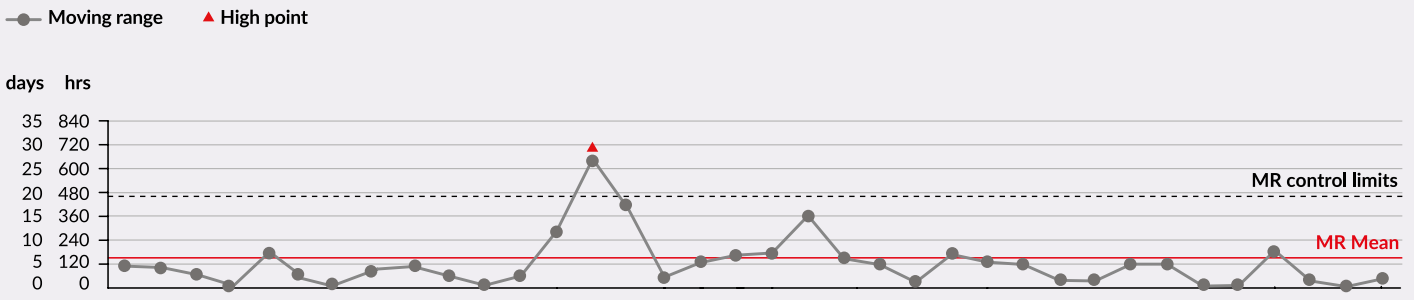
which decreased to **176.8 hours (7.4 days)** during the intervention period. This difference was statistically significant.

The average dwell times of catheters removed each week[7] have been plotted on the SPC chart below. A special cause variation is observed during the intervention period, as indicated by multiple blue points, which suggests a statistically significant change in pattern of catheter dwell time.

King's College SPC Chart - starting 18/03/24



King's College SPC Chart - Moving range, starting 18/03/24



[6] The average catheter dwell time was calculated by summing the total dwell time (in hours) of all catheters across the period and dividing this by the total number of catheters. This average represents the overall catheter dwell time and is not calculated on a weekly basis, unlike the SPC charts, which use weekly data.

Pre-intervention

Before the intervention started, there were no special cause improvements (blue points), indicating that changes in dwell time during this period were within expected levels of variation.

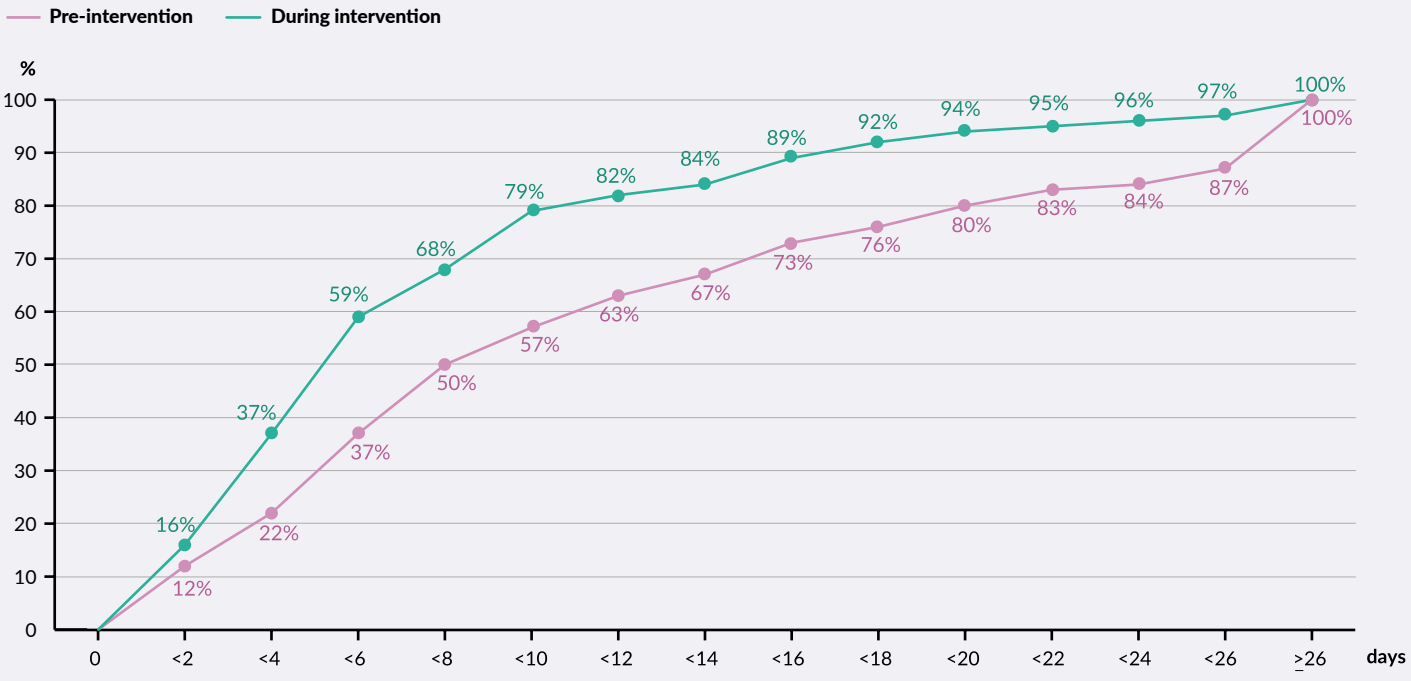
During the intervention

Following the implementation of the intervention, roughly four weeks after the intervention, a downward shift in dwell times is observed. Multiple blue points appear from early September to the end of the intervention, indicating a statistically significant shift in dwell time. These 12 blue points appear consecutively below the mean, suggesting that the reduction is sustained rather than random. Whilst there is still some variation in the data, no further orange points appear, suggesting no concerning increases in dwell time post the implementation of the intervention.

This pattern suggests that the intervention had a meaningful impact, with a delayed but sustained improvement in catheter dwell time.

There was a shift towards earlier catheter removal following the intervention

Cumulative frequency chart of the dwell time of catheter removals pre-intervention and during the intervention.



The chart demonstrates that catheter removal times were faster during the intervention, as indicated by the leftward shift of the cumulative frequency curve, showing a greater proportion of catheters removed within shorter timeframes.

During the intervention, 37% of catheters were removed in less than four days, compared to 22% of catheters removed in less than four days pre-intervention. This suggests a shift towards earlier removal following the intervention.

[7] The average catheter dwell time of catheters removed during each week was calculated by summing the dwell time of all catheters removed that week and dividing by the total number of catheters removed.

Staff reported that stickers made it easier to work out how long a catheter had been in for

Staff at King's College Hospital, including Healthcare Assistants, Nurses, and Doctors, found that stickers made it easier to track how long a catheter had been in for, compared to checking this information digitally.

"[The stickers] are helpful because most of the time when I'm checking when this patient was catheterised I normally just search on Epic [IT system], but now I can just look on the patient's bag"

Doctor at King's College Hospital

"I think it [the sticker] is the best way. There are so many posters on the wall – I don't know what most of them say – but actually the practical intervention of having it on the catheter [bag] itself even if you haven't read the information about it - that is the best way. Because on our ward rounds every day, we will check all the catheters and look at the bag so it's really useful"

Doctor at King's College Hospital

"Checking the date with the stickers are quite helpful. Before we would just check what the bag looks like, looking for discolouration for example, but now we look at the date so the stickers are very helpful. Sometimes you can check on the system but sometimes I don't even have the time to. Like today, I don't think I'll have the time to pick up a computer."

Healthcare Assistant at King's College Hospital

Some staff said that alongside verbal cues, such as going through catheterised patients at handover, the stickers served as a regular reminder to consider when a catheter had been inserted and if it needed removing.

"We do have a handover but you know sometimes when we are busy you might easily forget this kind of thing [when catheters have been inserted]. So, whenever we approach the patient, it can be a better reminder for us as well"

Healthcare Assistant at King's College Hospital

However, there were some reports of confusion about how to use the stickers, with reports of confusion about what to write on stickers when the catheter bag was changed. When asked in the survey what could improve the interview, two people thought that greater clarity was needed on what to write on the stickers when there was a bag change.

"I want them [stickers] to stay. I like it but … sometimes they [the ward staff] still make a mistake that they put the date of insertion as the date of the bag change, but the majority know what to do now."

Ward Sister at King's College Hospital

"[To improve the intervention] let staff be aware that the best before date is when the catheter was inserted not when the bag is changed"

[Open survey response] Nurse at King's College Hospital

"[For the] catheter sticker, most people don't know the correct date to put. For instance, most of us don't know if we need to put the date we are putting the sticker on, the date the catheter was inserted or the date the catheter will need change or removed? … Clear information on what and when to write on the sticker is needed."

[Open survey response] Healthcare Assistant at King's College Hospital

Staff at King's College Hospital had digital boards rather than whiteboards and so they did not use the magnets. One doctor reported that while they did have some digital alternatives to magnets, this was not widely done.

"We do have a way of doing that for catheters and dementia on the system… on Epic, there are some ways of doing it on the system, but it is so hard to get anything embedded onto the system… It's mainly done on verbal basis"

Doctor at King's College Hospital

Overall, staff reported stickers were useful and wanted to keep using them

In the staff survey, 75% (15/20) reported the stickers as being 'very useful' and 95% (19/20) reported wanting to continue using the stickers after the intervention ends.

IMPACT OF THE INTERVENTION

Lewisham and Greenwich Hospital Trust

Queen Elizabeth Hospital is a general hospital in Woolwich in the Royal Borough of Greenwich.

Two wards specialising in geriatric medicine in the Hospital took part in this intervention, each ward had 25-30 beds.

Baseline period: 4th March to 21st July 2024 (20 weeks)

Intervention period: 22nd July to 31st December 2024 (23 weeks)

Throughout this period, dwell time data was collected on 547 catheters. This equates to 547 catheters over 44 weeks, averaging approximately 12.4 catheters per week across both wards.

During analysis, 84 (15%) of catheters were excluded due to patient death or ward transfer. As a result, the final dataset included 463 catheters: 180 from the baseline phase and 283 from the intervention phase.

During the intervention, staff placed stickers on catheter bags, used magnets to track catheterised patients on their whiteboards and had access to informational posters for guidance on catheter care.

Catheter dwell times decreased following the intervention

Outcome: Dwell time

Pre intervention

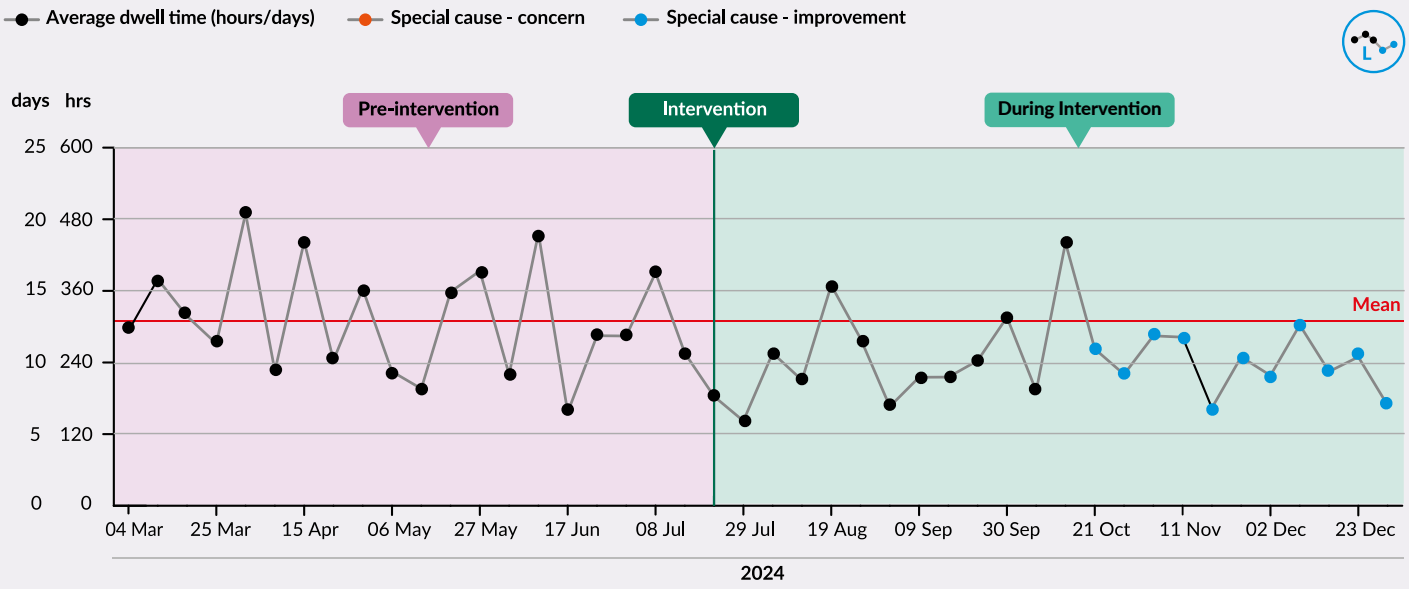
Overall, the average catheter dwell time in the 20 weeks prior to the intervention was **320.8 hours (13.4 days),**

During intervention

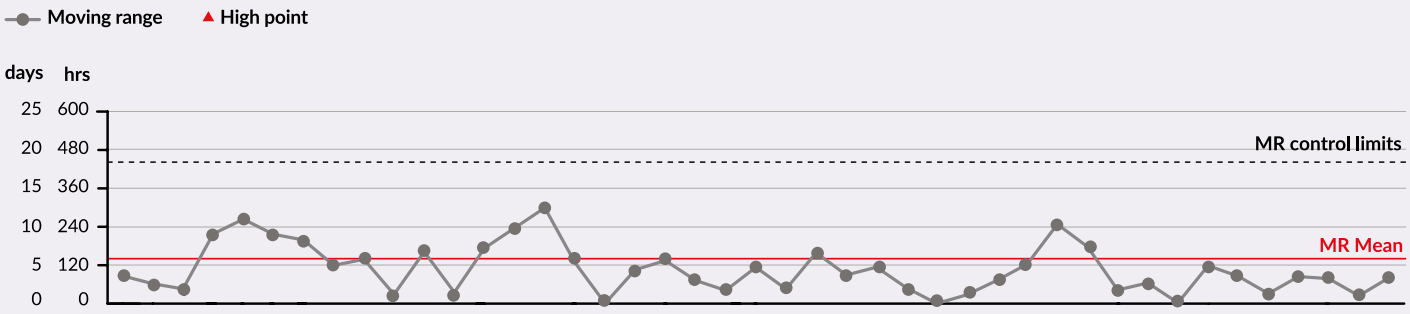
while the average dwell time decreased to **244.3 hours (10.2 days)** during the intervention period. This difference was statistically significant.

The average dwell times of catheters removed each week have been plotted on the SPC chart below. A special cause variation is observed almost halfway through the intervention period, as indicated by multiple blue points, which suggests a statistically significant shift in catheter dwell time.

Lewisham and Greenwich SPC Chart - starting 04/03/24



Lewisham and Greenwich SPC Chart - Moving range, starting 04/03/24



Pre-intervention

Before the intervention started, there were no special cause improvements (blue points), indicating that changes in dwell time during this period were within expected levels of variation. The average catheter dwell time appeared relatively unstable, fluctuating around the mean.

During the intervention

Following the implementation of the intervention, a higher proportion of the data points during the intervention were below the mean. From November onwards, there are 11 consecutive blue dots underneath the control line, indicating a special cause of improvement, and a statistically significant shift in the trend of average dwell time.

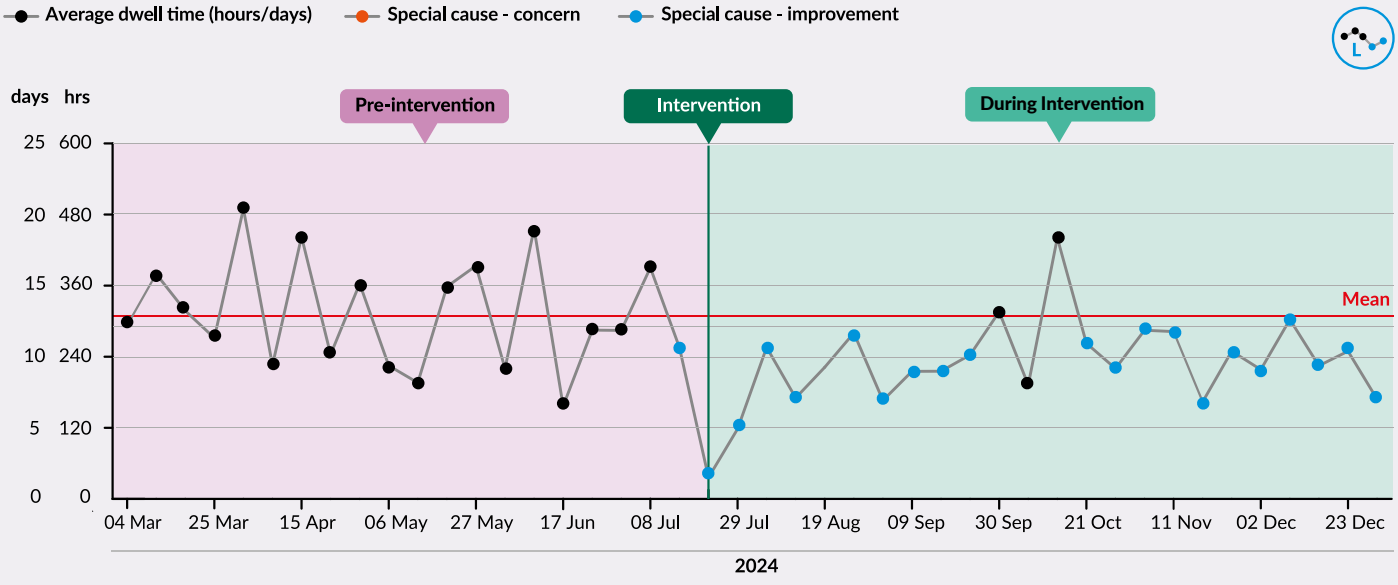
During the intervention, the variability of the average dwell time appeared more controlled, with fewer extreme fluctuations compared to the baseline period. This suggests sustained, yet delayed, improvement following the introduction of the intervention.

Catheters with overlapping dwell time

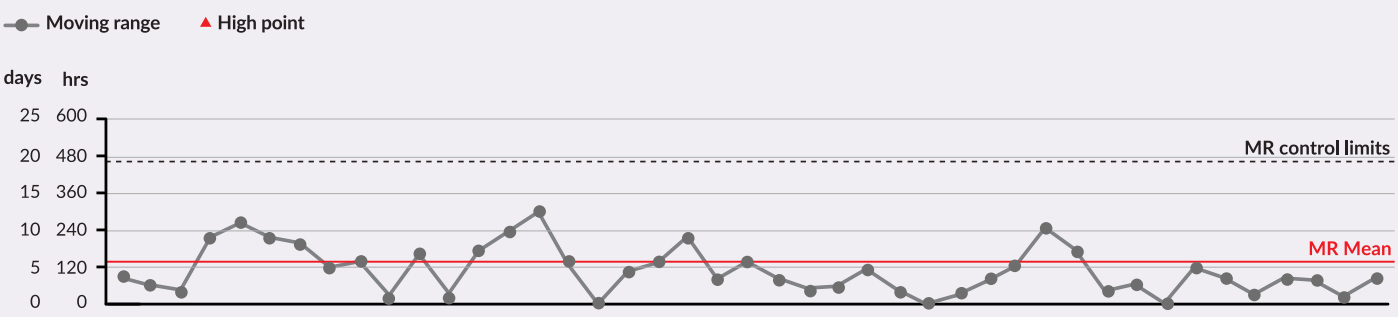
In the initial analysis, a high number of catheters had overlapping dwell times, i.e., catheters that were inserted before the intervention started but removed during the intervention period.

These overlapping cases potentially skew the results, as their dwell times would still be influenced by the pre-intervention processes rather than the changes introduced by the intervention (given that weekly dwell times are based on the average dwell time of catheters removed that week). In Lewisham and Greenwich Hospital Trust, there were 29 instances of catheters with overlap, compared to only 5 in the King's College Hospital Trust data.

Lewisham and Greenwich SPC Chart - Moving range, starting 04/03/24



Lewisham and Greenwich SPC Chart - Moving range, starting 04/03/24



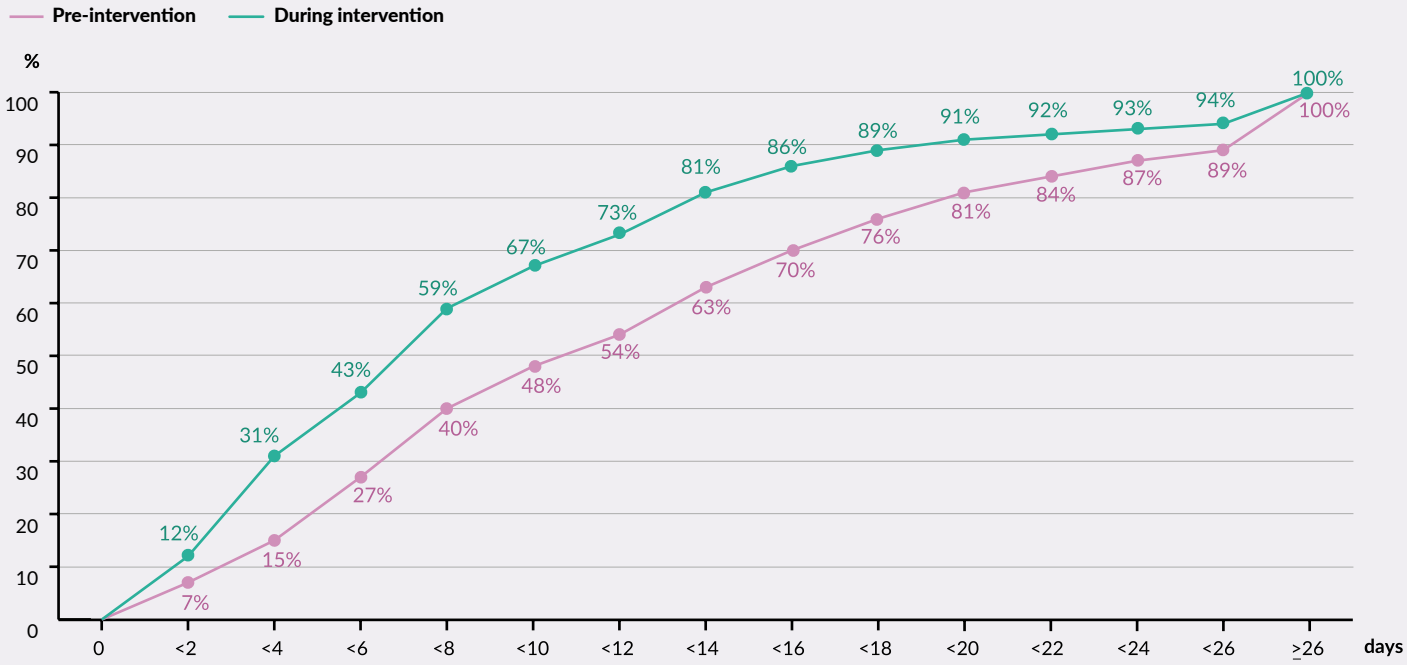
To investigate this further, all overlapping catheters were removed from the analysis, ensuring that only catheters inserted after the intervention began were included. This resulted in the SPC chart below:

After removing overlapping cases, the decline following the intervention is more immediate and pronounced. The initial drop is likely due to catheters removed in the first week of the intervention (week of the 22/07) which had only been inserted that week and therefore had a short dwell time.

However, the special cause variation starts earlier, indicating that the intervention appears to have had a larger impact on new catheters inserted following the intervention, rather than ongoing ones inserted prior to the intervention.

There was a shift towards earlier catheter removal following the intervention

Cumulative frequency chart showing catheter dwell times pre and during intervention.



The chart demonstrates that catheter removal times were faster during the intervention, as indicated by the leftward shift of the cumulative frequency curve, showing a greater proportion of catheters removed within shorter timeframes.

During the intervention, 31% of catheters were removed in less than four days, compared to 15% of catheters removed in less than four days pre intervention. This suggests a shift towards earlier removal following the intervention.

Staff reported that stickers made it easier to work out how long a catheter had been in for

Staff at the Queen Elizabeth Hospital, including Healthcare Assistants, Nurses, and Doctors, found stickers made it easier to track catheter duration, rather than checking digitally. Some said it prompted discussions about whether the catheter needed replacing or removing.

"I think the stickers are quite visual. Otherwise, you have to sift through the documents and notes to work out when the catheter was changed and if you are thinking about sources of infection that's a big one. So it is really useful."

Doctor at Queen Elizabeth Hospital

"Before we would have to look on the system and sometimes it's not there, sometimes we would not know if it's long term or not, and we would have to start again and see when the patient was admitted but now it's a bit easier for us to understand... After two days we will ask a doctor whether we should keep the catheter or remove it."

Nurse at Queen Elizabeth Hospital

Some suggested that the stickers could help them to prevent catheter related infections.

"I think it's good to know when it was inserted, how long they are keeping it in for. It makes us think about how long they need the catheter for. It helps us to prevent infections"

Nurse at Queen Elizabeth Hospital

"And because there's no quick way of checking [on the online system], you will literally just have to check through all of the notes. So, it [the stickers] saves us a lot of time and it is a good way of getting infections down"

Doctor at Queen Elizabeth Hospital

However, not all staff said that they used the stickers, and did not feel that it was their responsibility to check if the catheter needed removing or replacing.

"As a HCA, I personally just empty it. If the bag is looking discoloured, I will change the whole bag, But that's as far as we go as HCAs. Nurses will have to change the entire thing [catheter]. I will speak to the nurses if I think if it is leaking or if there is a problem with the catheter itself. To be honest, I never think about the date – I've never really noticed an out-of-date catheter, I never really study it"

Healthcare Assistant at Queen Elizabeth Hospital

Some staff also raised challenges with staff members changing catheter bags and then the stickers also being thrown away and not replaced, or replaced with the new date that the bag was changed and not the date the catheter was inserted.

"A lot of the HCAs are really good at it, some of the nurses not so much.... For example, if we have to do a bag change, the sticker comes off, that goes on to the new bag or a replacement with that date on it. However, sometimes they take it off and it goes into the bin."

Healthcare assistant at Queen Elizabeth Hospital

Overall, staff reported stickers were useful and wanted to keep using them

In the staff survey, 78% (18/23) reported the stickers as being 'very useful' and 100% (23/23) reported wanting to continue using the stickers after the intervention ends.

One staff member reflected on the design of the stickers, which drew their attention to information about catheters.

"Of course [they should continue using the stickers], not being funny but there a lot of people who will just go 'yep' here's a catheter and walk away. If you actually see the material and have a look, and it draws your attention because it has lovely bright colours, it gets people thinking.. [We should] definitely keep using them, they are brilliantly helpful"

Healthcare Assistant at Queen Elizabeth Hospital

Some staff also reported that magnets reminded them which patients had catheters and prompted discussion

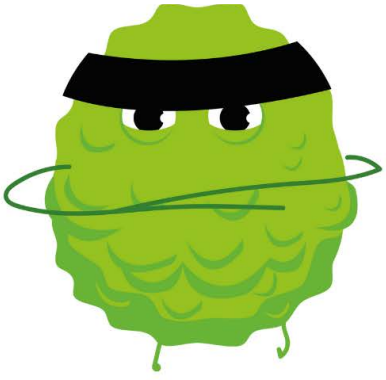
Staff reported that the intervention magnets were used at Queen Elizabeth Hospital on whiteboards to remind staff which patients had catheters or not. Some reported that this acted as a prompt when doing board rounds to discuss what the plan was with doctors.

"On the ward, we have magnets for the patients with catheters and when are doing the board rounds we ask the doctors what will be the plan. Are we TWOCing the patient? Or is this a long term catheter?"

Nurse at Queen Elizabeth Hospital

"Sometimes they put in [information about patients' catheters] on our handover but if it's a new patient you have to check... You can check on the iCare, and on the board, and on the stickers."

Nurse at Queen Elizabeth Hospital



*Ensure you are using the **'Best Before'** stickers*

*Ensure you are using the **'Best Before'** stickers*

IMPACT OF THE INTERVENTION

The Royal Wolverhampton Hospital Trust

New Cross Hospital is a teaching hospital in the Heath Town district of Wolverhampton.

Two wards specialising in geriatric medicine in the Hospital took part in this intervention, each ward had 25-30 beds.

Baseline period: 11th March to 28th July 2024 (20 weeks)

Intervention period: 29th July to 30th December 2024 (22 weeks)

Throughout this period, dwell time data was collected on 432 catheters. This equates to 432 catheters over 43 weeks, averaging approximately 10 catheters per week across both wards.

The pre-intervention dwell times at the Royal Wolverhampton Hospital Trust were lower than both Lewisham and Greenwich and King's College Hospital Trusts 6.5 days, compared to 13.4 and 13.3 days respectively. Therefore, catheter checking and removal behaviours were already comparatively optimised at The Royal Wolverhampton Hospital Trust.

During analysis, 103 (24%) of catheters were excluded due to patient death or ward transfer, a rate that was higher than King's College Trust and Lewisham and Greenwich Trust. Among these exclusions, ward transfers were the primary reason in The Royal Wolverhampton Hospital Trust (58%), compared to 13% in King's College Trust and 27% in Lewisham and Greenwich Trust, indicating a higher level of patient movement between wards in The Royal Wolverhampton Hospital Trust. As a result, the final dataset included 329 catheters: 147 from the baseline phase and 182 from the intervention phase.

During the intervention, staff placed stickers on catheter bags, used magnets to track catheterised patients on their whiteboards and had access to informational posters for guidance on catheter care.

Catheter dwell times increased following the intervention

Outcome: Dwell time

Pre intervention

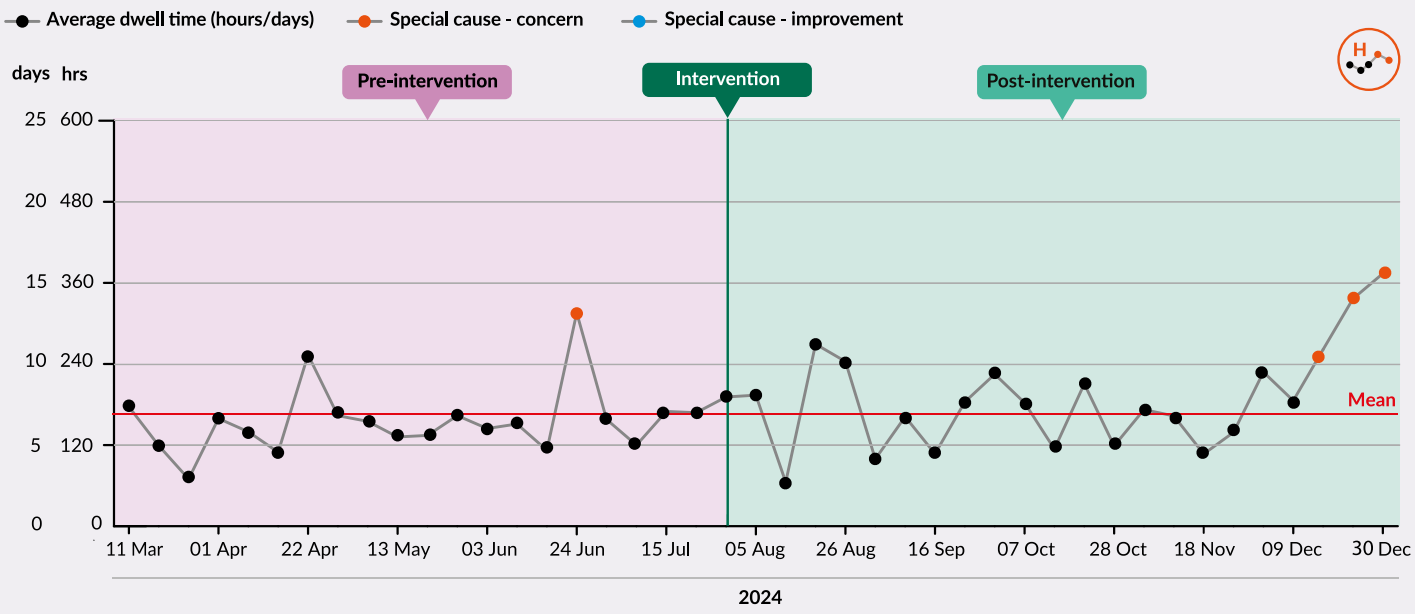
Overall, the average catheter dwell time in the 20 weeks prior to the intervention was **156 hours (6.5 days),**

During intervention

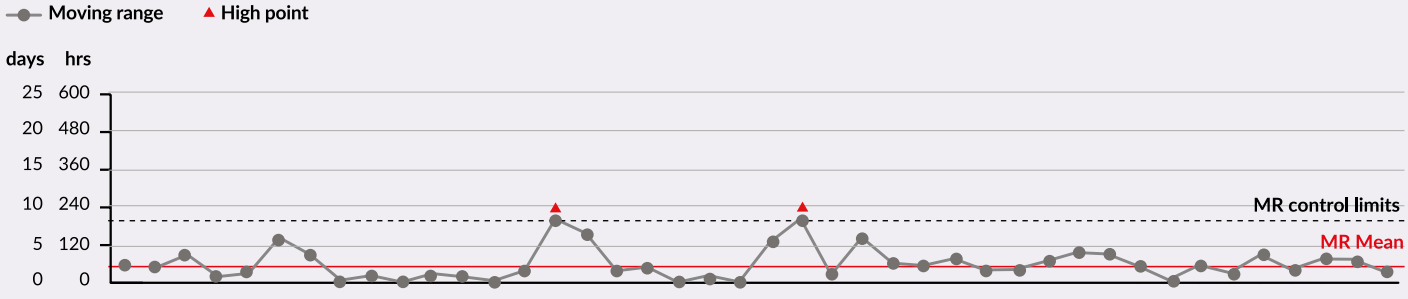
while the average dwell time increased to **180.2 hours (7.5 days)** during the intervention period. This difference was not statistically significant.

The average dwell times of catheters removed have been plotted on the SPC chart below. A special cause concern is observed both in the baseline period, as well as towards the end of the intervention period. Whilst there is some variability throughout the dataset, average dwell times seem to follow a negative trend from November 2024 onward.

Royal Wolverhampton SPC Chart - starting 11/03/24



Royal Wolverhampton SPC Chart - Moving range, starting 11/03/24



Pre-intervention

Before the intervention started, the average dwell time remained close to the mean, with no strong upward or downward trend. There is a single spike in dwell time in late June, but which was not part of a sustained trend, suggesting a temporary disruption rather than a sustained trend. Overall, the average dwell time appears stable but unchanging.

During the intervention

Following the implementation of the intervention, the Royal Wolverhampton NHS Trust did not show any positive change from the intervention during this period. The immediate intervention period (August-October 2024) remained stable, with no major improvements or declines. However, from early November 2024, dwell times began increasing steadily, leading to multiple special cause concern points (orange points).

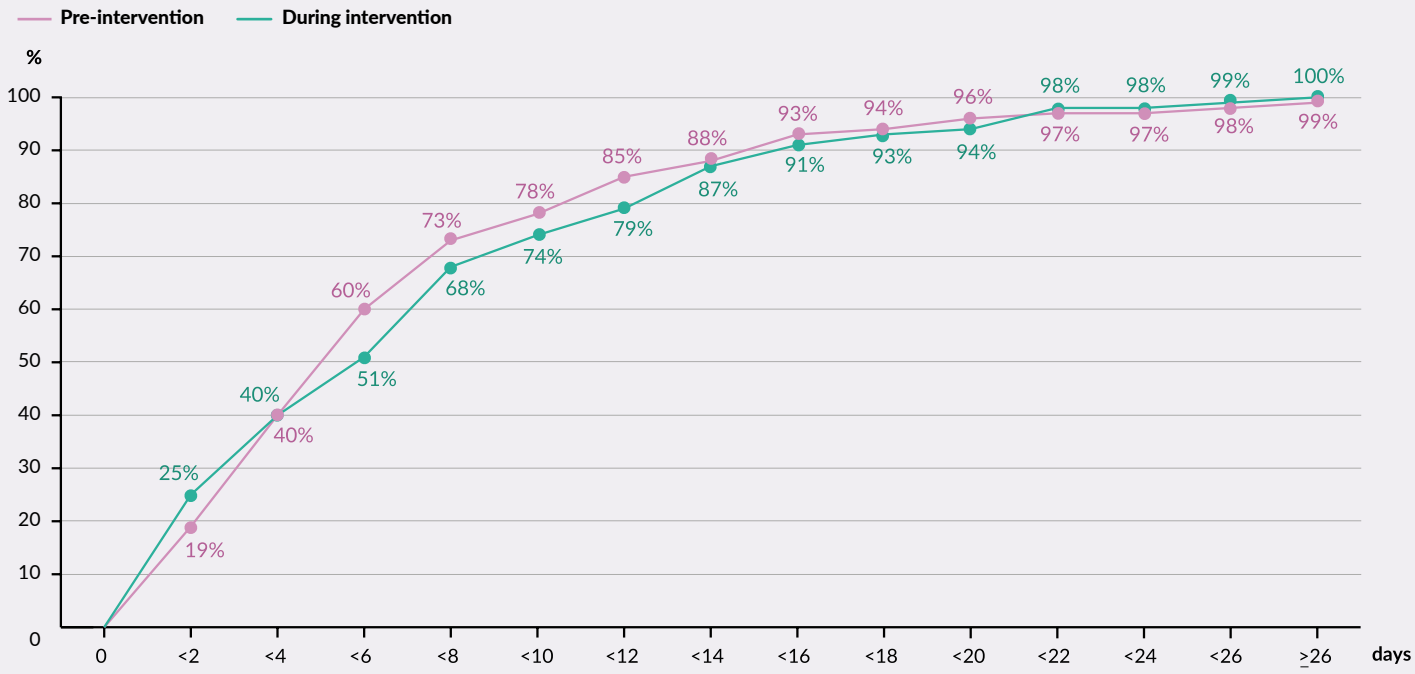
This sustained negative trend suggests a significant shift and may indicate concerns about potential issues with the intervention's implementation, the influence of external factors, or other underlying causes.

Alternatively, given that the Royal Wolverhampton NHS Trust initially had lower average dwell times compared to other trusts, it is possible that the possibility for further reduction was limited.

The Royal Wolverhampton NHS Trust had 13 cases of overlapping catheters. To investigate the impact of these catheters, these cases were removed from the analysis, however, unlike Lewisham and Greenwich NHS Hospital Trust, no differences were observed in the pattern of the data following the removal of the catheters with overlapping dwell time dates.

The intervention did not appear to impact how early catheters were removed

Cumulative frequency chart showing catheter dwell times pre and during intervention



The chart demonstrates that catheter removal times followed a similar pattern pre- and during intervention. There was no impact on early removal with 40% of catheters removed in less than four days both during and prior to the intervention period.

Staff reported that the stickers made it easier for them to check whether a catheter needed removing

Staff reported that the stickers made it easier for them to find out when a catheter had been inserted and saved them time having to check a digital system.

"I think it's [the stickers] are good because at least you can tell straight away when it needs removing, or when it was last put in... It means you can remove it more regularly, in time, because the information is there straight away. In the past, you've got to go online to see when it was last put in... It's more difficult [to find that information online] especially when you are busy. So, if you have that information regularly available it's easier"

Nurse at New Cross Hospital

"We wouldn't have known before [about the insertion date], just when the bag has been changed... On the books we can check that info [about insertion dates] but as HCAs we don't really use those books. They [the stickers] are a good idea, they make sure the information is to hand without having to find books"

Healthcare Assistant at New Cross Hospital

"[The stickers are] useful otherwise you just don't know how long a catheter has been in. Then you'll have to go trekking through the notes... It makes it easier for the documentation because you know you are looking for this specific sticker.... It's easier, more convenient."

Doctor at New Cross Hospital

Some staff said that the stickers made it easier for them to handover patients and share responsibility across multiple team members, helping to reduce the likelihood of catheter related infections.

"We do use them [the stickers] and they are very helpful. Even if you don't know anything about the catheter, it [the sticker] means you know when the catheter was inserted, when it needs to be changed... It's useful [the sticker] because it's not only one person who is looking after a patient, it's different people, at different times, so when you come, even if you are not there when it [the catheter] is being put in you have an idea of when it was put in and what you need to do."

Nurse at New Cross Hospital

"We have to be responsible - we are accountable and have to monitor everyone who has a catheter... The stickers serves as a reminder. It also helps to prevent patients getting infections – it's a fact, if they don't need it why does it need to stay?"

Nurse at New Cross Hospital

Staff felt that the stickers would be more useful if they could be put on the tube

Some staff reported that the stickers could end up being removed and not replaced when catheter bags were changed, which made it difficult to track when the catheter had been inserted. Some suggested a sticker that went on the tubing would be more helpful.

"If it's a small sticker, that can go on the tubing rather than the bag, then that might be more helpful because once they take off the bag, it's gone [the sticker]"

Nurse at New Cross Hospital

"Once we've planned to change the bag, the sticker goes with the bag. And if you're not the only who changed the bag, they might just change it... If there was something that just went by the tube itself and then something on the bag, for when you need to change the bag. Once it is on the bag and they change the bag, it's going to come off and I don't think anyone replaces it"

Healthcare Assistant at New Cross Hospital

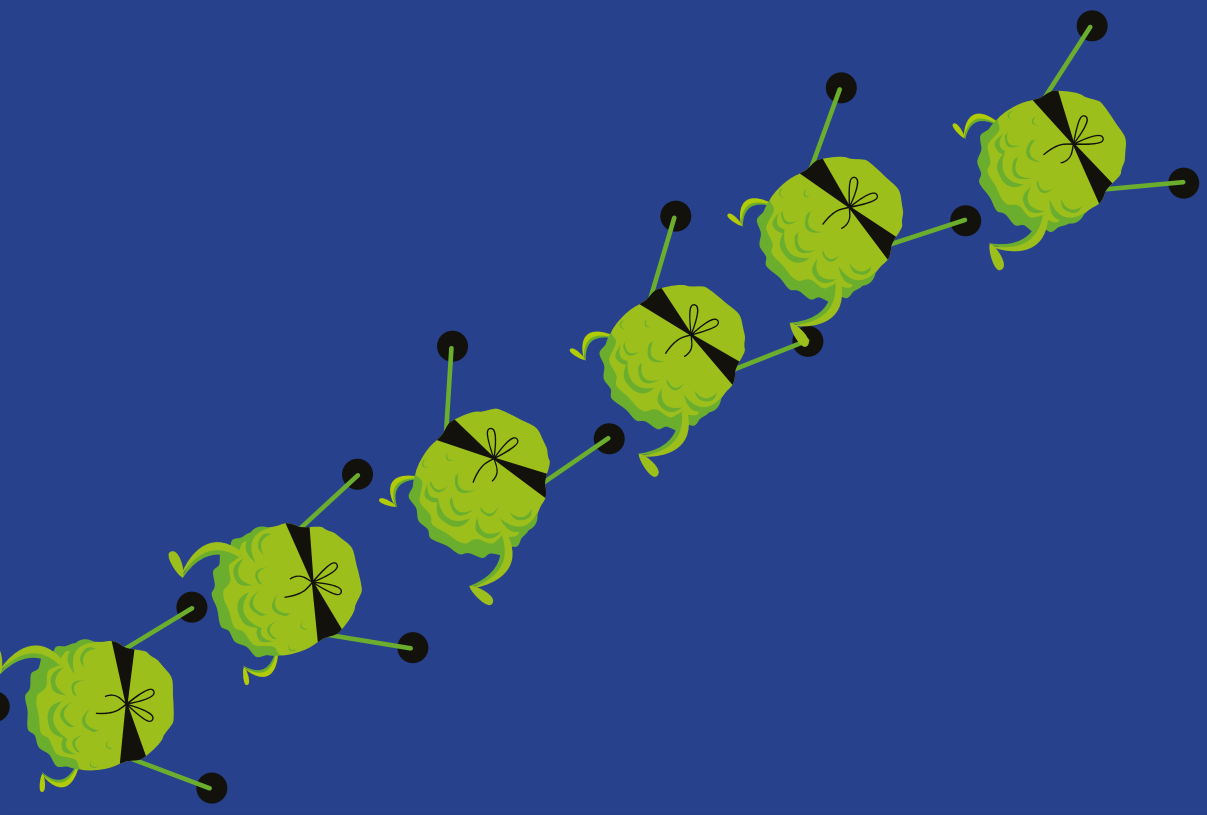
One staff member commented in the survey that the stickers fell off easily and could be 'more sticky'.

Some staff said they did not feel that the magnets had an impact on their individual level of catheter awareness

"I know which of my beds have a catheter but I'm not sure about the others... I haven't got time, the Sisters [nurses] do the board, I just look after my patients."

Healthcare Assistant at New Cross Hospital

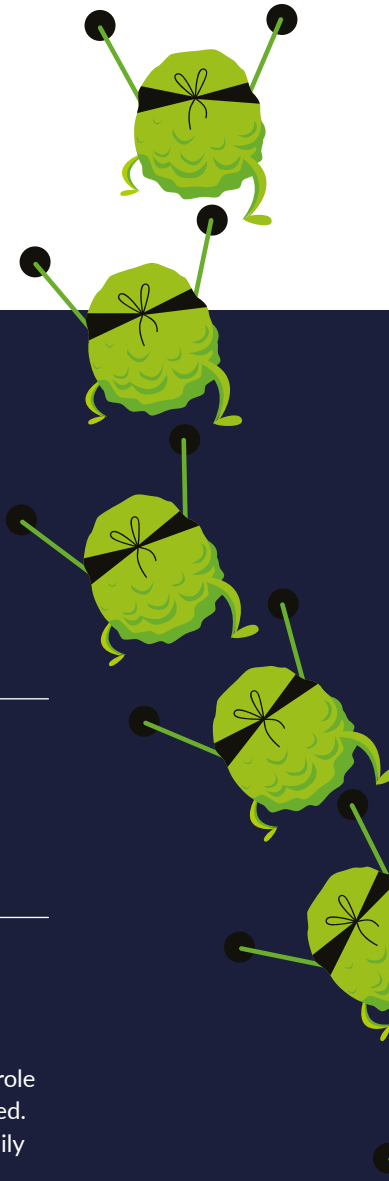
In the staff survey, 55% (11/20) reported the stickers as being 'very useful', and 80% (16/20) reported wanting to continue using the stickers after the intervention ends.



A cost-comparison analysis was conducted by a health economist at the Health Innovation Network. This compared the intervention's impact on healthcare resources against standard care.

This analysis indicated that, in the first and subsequent years, the intervention is **cost-saving at King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust**, and it is cost-incurring at The Royal Wolverhampton NHS Trust.

For more details of this analysis and the full report, please see **Appendix 3.**



Method

It used data on catheter dwell times, the cost of the intervention, and the costs of treating CAUTIs.

Analysis was run for each trust, exploring the costs associated with rolling out the intervention in two wards within each trust.

Two calculations were made for each Trust:

The total impact of the intervention on healthcare resource using the costs for Year 1 / during the pilot	• intervention materials for two wards and time for a formal staff briefing • intervention design costs • costs of daily catheter auditing which was conducted as part of the evaluation
The total impact of the intervention on healthcare resource using for subsequent years or future rollouts of the intervention	• intervention materials for two wards and time for a formal staff briefing • a small amount of time (5 minutes a day) for a staff member to ensure adherence to the intervention. This is based on the minimum time assumed needed for a staff member to do this role and ensure that the intervention is being correctly implemented. Note this is significantly less time than was required for the daily catheter audit.

Findings

The results presented in Tables 3-5 summarise the incremental changes in key outcomes and associated total resource use resulting from implementing the intervention.

A minus sign before a value in the incremental difference column indicates improvements or cost savings due to the intervention; conversely, a positive value in that column indicates outcomes deteriorated with implementing the intervention or that additional costs were incurred.

Table 3 King's College Hospital NHS Trust-Key outcomes and healthcare resource use results for Catheter Care

Outcomes	Standard of care[8]	Intervention	Incremental difference
Average dwell days/week	13.087	8.279	-4.810
Number of CAUTIs averted/annualised	–	12.502	-12.502
NHS resource impact/annualised	–	-£41,672	-£41,672
Total Costs of first year of intervention	–	£8,012	£8,012
Total Costs of subsequent years of intervention	–	£1,655	£1,655
Total Resource Impact (first year)	–	£33,660	-£33,660
Total Resource Impact (subsequent years)	–	£40,017	-£40,017

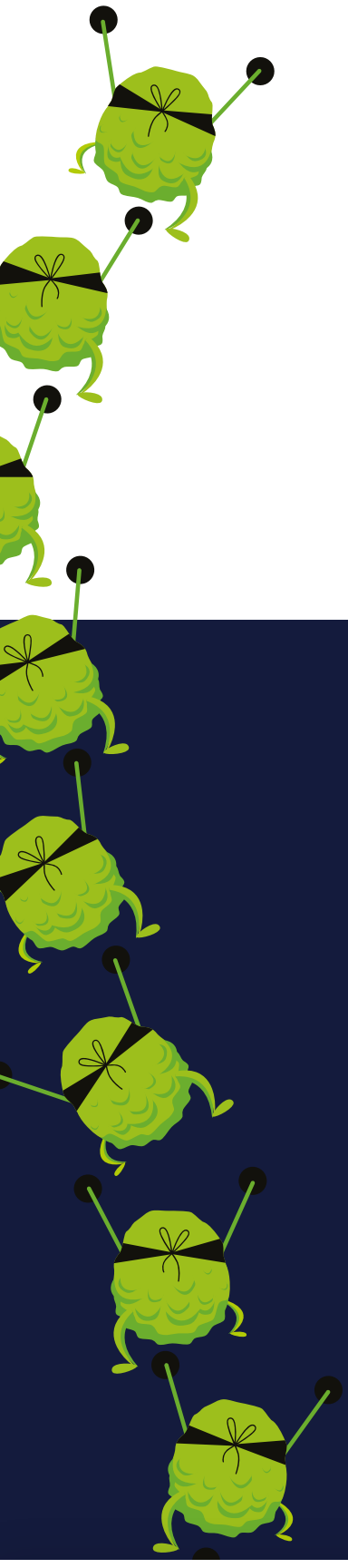
Table 4 Lewisham and Greenwich NHS Trust-Key outcomes and healthcare resource use results for Catheter Care

Outcomes	Standard of care[8]	Intervention	Incremental difference
Average dwell days/week	13.017	10.233	-2.780
Number of CAUTIs averted/annualised	–	7.237	-7.237
NHS resource impact/annualised	–	-£24,122	-£24,122
Total Costs of first year of intervention	–	£8,012	£8,012
Total Costs of subsequent years of intervention	–	£1,655	£1,655
Total Resource Impact (first year)	–	£16,110	-£16,110
Total Resource Impact (subsequent years)	–	£22,467	-£22,467

Table 5 The Royal Wolverhampton NHS Trust-Key outcomes and healthcare resource use results for Catheter Care

Outcomes	Standard of care[8]	Intervention	Incremental difference
Average dwell days/week	6.492	7.004	0.513
Number of CAUTIs averted/annualised	–	1.330	1.330
NHS resource impact/annualised	–	£4,422	£4,422
Total Costs of first year of intervention	–	£4,422	£8,012
Total Costs of subsequent years of intervention	–	£1,655	£1,655
Total Resource Impact (first year)	–	-£12,454	£12,454
Total Resource Impact (subsequent years)	–	-£12,454	£6,097

[8] Standard of care refers to the accepted and recommended practices for treating a particular physical or mental health condition, set nationally by the National Institute of Clinical Excellence (NICE) and is used as a benchmark for comparing the benefits and costs of new treatment options



The analyses indicate that implementation of this intervention results in 12.5 and 7.2 CAUTI averted annually at King's College Hospital NHS Trust (KCH) and Lewisham and Greenwich NHS Trust (L&G), respectively. Accounting for the related costs, the intervention is cost-saving at both trusts in the first year with overall savings of £33,660 at KCH and £16,110 at L&G. These savings are more pronounced in subsequent years due to lower set-up costs.

For the Royal Wolverhampton Trust, analysis shows that the intervention is cost-incurring at £12,454 in the first year- this is due to the catheter dwell hours being higher following the intervention [as discussed elsewhere in this report], resulting in an additional 1.33 incidence of CAUTI annually. The intervention remains cost-incurring in subsequent years.

Accounting for uncertainty in parameters, sensitivity analysis results indicate that the intervention remains cost saving at King's College Hospital NHS Trust in the first year, range of (-£54,496; -£12,824) and cost saving in subsequent roll-out years (-£60,853; -£19,181).

Similarly, sensitivity analysis results for Lewisham and Greenwich NHS Trust indicate that the intervention is cost-saving in the first year, range (-28,171; -£4,049) and cost-saving in subsequent years of roll-out (-£34,528; -£10,406).

At the Royal Wolverhampton Trust, the intervention remains cost-incurring in the first year with budget impact in the range of (£10,233; £14,675) and cost incurring in subsequent years of roll-out with a budget impact of (£3,876; £8,318). For the service to be cost-neutral or cost-saving, catheter dwell hours would need to decrease by 7.9% or more on average. service to be cost-neutral or cost-saving, catheter dwell hours would need to decrease by 7.9% or more on average.

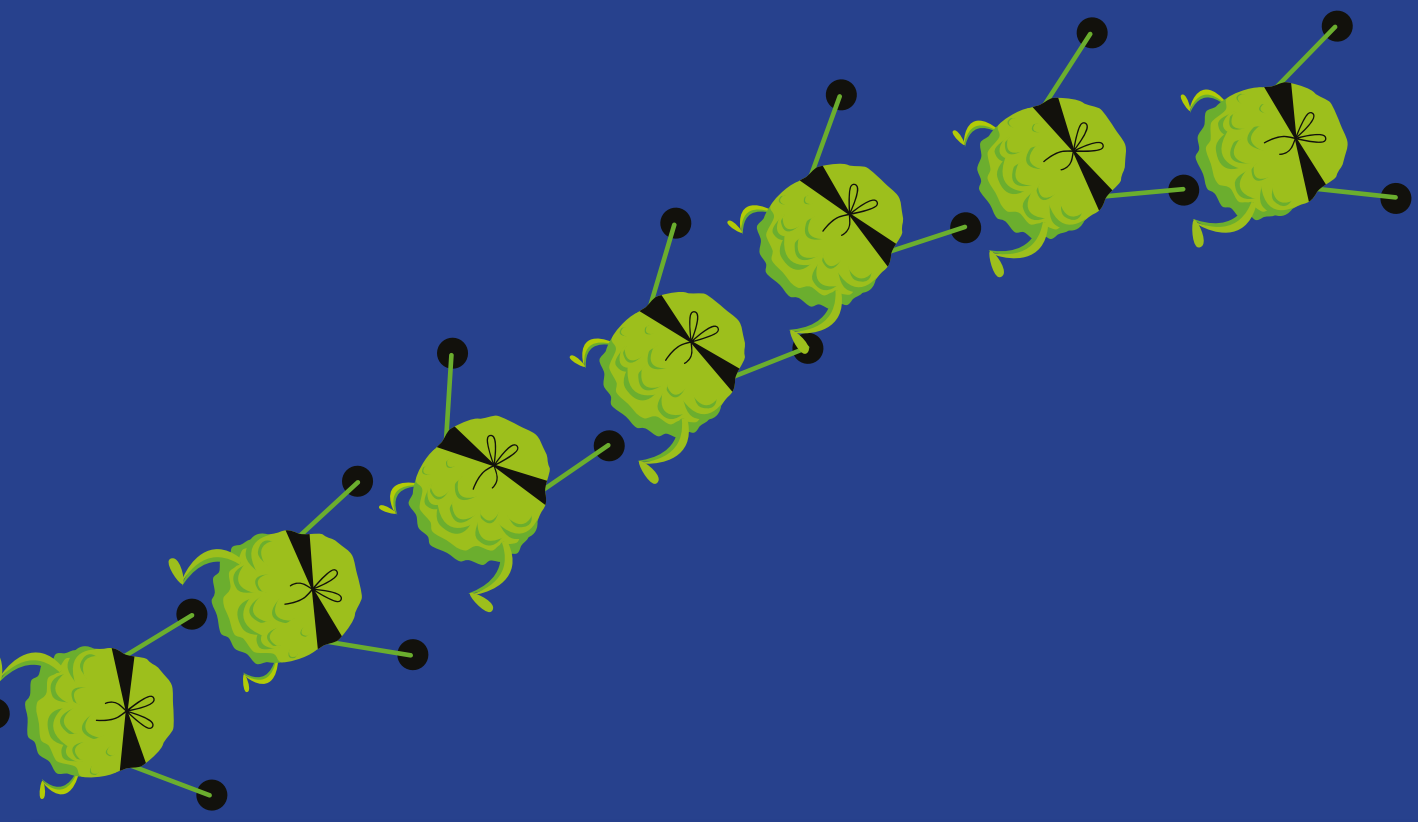
Interpretation and recommendations

The analysis indicated that this intervention, in the first and subsequent years, is cost-saving at King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust, and it is cost-incurring at the Royal Wolverhampton Trust.

These results are based on the data provided and existing published evidence available to conduct health economic analysis.

The analysis only considers incremental costs and resource use from the NHS perspective. Business case analysis would need to consider other factors when deciding whether this intervention should be continued or rolled out more widely. For example, with robust data, an analysis could consider which factors contributed to the divergence of results for South London versus Wolverhampton, and implications for the adoption nationwide.

We recommend caution in interpretation of the results based solely on the data from a pilot study. Further assessment of additional metrics, such as actual (rather than estimated) numbers of CAUTIs, data on staff capacity, bed days, ward occupancy rates and length of stay would improve robustness of the analysis and provide a more comprehensive picture.



The complex, fast-paced hospital environment can make it difficult to implement new interventions.

Throughout the evaluation of this intervention, there were challenges and learnings in relation to rolling out the intervention and evaluating it.

Consistently collecting dwell time data

A designated catheter auditor was meant to do daily checks on catheters, however this was often challenging to enforce. The project team regularly prompted auditors and monitored whether they were doing checks.

Auditors across the three trusts completed between 74% and 94% of the required daily checks throughout the baseline and intervention period according to our monitoring data (Monday-Friday).

Trust	Baseline	During intervention	Average across intervention	Total number of checks (based on the number of catheters)
King's College Hospital NHS Trust	86%	74%	81%	1,478
Lewisham and Greenwich NHS Trust	94%	93%	94%	4,016
The Royal Wolverhampton NHS Trust	90%	87%	88%	2,581

Therefore, some checks were not completed as planned, which impacts the quality of the catheter dwell time data, as a catheter may have been removed but would not be logged as removed and given a final dwell time until a check was completed.

To mitigate against this, some catheters were removed during data cleaning, based on the frequency of checks they had received.

Lewisham and Greenwich Hospital Trust consistently demonstrated higher compliance auditing rates than the other trusts, maintaining an average of around 94% during both baseline and intervention periods. Follow-up site visits and staff interviews did not reveal a clear explanation as to why this was case. However, potential contributing factors could include greater staff familiarity and engagement with quality improvement initiatives, fewer instances of simultaneous staff absences, and fewer competing priorities for the auditing team members.

Sticker compliance throughout the intervention

The proportion of checks where a sticker was reported as present during the intervention for the three trusts was as follows[8]:

King's College Hospital Trust	**81%**
Lewisham and Greenwich Hospital Trust	**96%**
The Royal Wolverhampton Hospital Trust	**78%**

Again, follow-up site visits and staff interviews did not offer a clear explanation for these differences, but higher rates of sticker compliance may have been driven by: a stronger culture of accountability, more active involvement of senior staff and staff familiarity with similar quality improvement interventions.

Average length of stay

The high rate of patient deaths and transfers at the Royal Wolverhampton Hospital NHS Trust may skew its average length of stay. This could be due to a different patient case-mix, perhaps with wards at this trust acting more like admissions units. While the overall length of stay for older people across the three hospitals is similar, the greater number of community hospital beds in the wards at the Royal Wolverhampton Hospital Trust, where patients are transferred, may be a contributing factor.

Survey and interview response rates

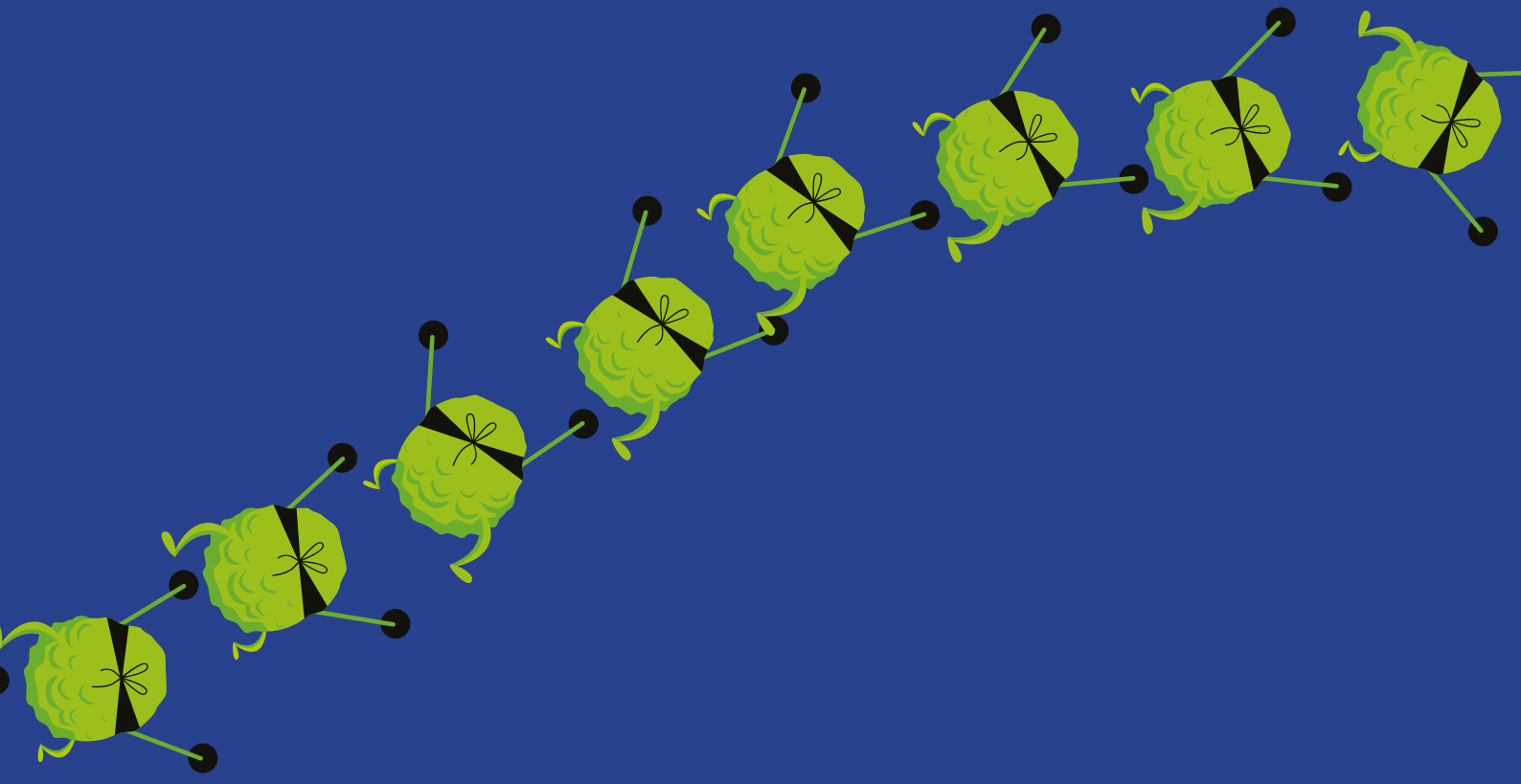
Getting staff within wards to complete the survey and take part in interviews was a challenge with time-poor staff members. The project team carried out site visits to each ward to encourage uptake and worked with senior hospital staff members to encourage responses. However, final response rates for the pre- and post-intervention surveys remain low, which has impeded the ability to make comparisons pre- and post-intervention.

The sample of staff completing surveys pre- and post-intervention also appeared to have some differences. For example, some staff in the post-intervention were new to the ward, and the makeup of staff in different roles was often different in the pre and post survey samples, further limiting the ability to compare survey data pre- and post-intervention.

In an effort to increase response rates, the project team visited each ward to distribute small QR code posters, making them easily accessible to ward staff. As an added incentive and to thank staff for their time, a chocolate bar was attached to each poster.

The impact of the catheter audit on intervention outcomes

The daily auditing of catheters and physical checks on sticker use may have acted as an intervention in itself, raising awareness and influencing staff behaviour due to feeling monitored. As a result, it's challenging to separate the impact of auditing from the overall intervention.



Health Innovation Network South London
The Health Foundation
REVEALING REALITY

Catheter dwell times improved following the intervention at two of the three trusts

King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust showed significant improvements following implementation, with marked reductions in catheter dwell times from their baseline measurements. These improvements were achieved despite the intervention period overlapping with winter pressures, which may have increased staff workload. These trusts had started with relatively higher baseline dwell times, providing greater opportunity for improvement.

The third trust, The Royal Wolverhampton NHS Trust, which began with comparatively lower baseline catheter dwell times, showed minimal change after implementation. This suggests their existing catheter management practices were already relatively optimised, creating a ceiling effect where further substantial improvements were more challenging to achieve.

Baseline dwell time data:

- The Royal Wolverhampton Hospital Trust **156 hours (6.5 days)**
- Lewisham and Greenwich Hospital Trust **320.8 hours (13.4 days)**
- King's College Hospital Trust **320.3 hours (13.3 days)**

The intervention led to an increase in early catheter removals in two of the three trusts

At King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust, the proportion of catheters removed in <4 days (i.e. soon after 48 hours) increased following the intervention. In this work it was not possible to separate long- and short-term catheters accurately, which meant it was not possible to examine the impact of the intervention on short-term catheters alone. Given the intervention was designed to target catheter removal behaviours for short-term catheters, it is possible the intervention would have shown a greater impact if long-term catheters were removed from the data.

However, overall, catheter dwell times remained relatively high

Despite reduction in catheter dwell times during the intervention, the overall average remained relatively high across all three hospitals. This suggests that one of the intervention's messages—prompting consideration of catheter removal after 48 hours—was not consistently translated into practice, and new benchmarks for considering removal were not established.

Future iterations of the intervention could focus more on promoting shorter dwell times and resetting benchmarks for considering removal. Reliable differentiation between long- and short-term catheters in future studies would also enable exclusion of long-term catheters, yielding more granular data about reduction in dwell times.

Staff felt that the 'best before' stickers made it easier to check how long a catheter had been in for

Interviews with staff at all three hospital trusts reported that the stickers had made it easier and quicker to work out how long a catheter had been in for. Some staff members suggested this had helped them to reduce catheter-related infections in the ward.

However, staff at Lewisham and Greenwich and the Royal Wolverhampton hospital trusts reported that there was some confusion with stickers being placed on catheter bags, as when the bag was removed, the sticker was often thrown away. A few suggested stickers on the catheter tube would be more helpful.

Most staff at all three trusts reported wanting to continue using the stickers after the intervention ended: 95% (19/20) at King's College Hospital Trust, 100% (23/23) at Lewisham and Greenwich Hospital Trust, and 80% (16/20) at the Royal Wolverhampton Hospital Trust.

The 'catheter ninja' magnets prompted conversations between staff about catheter removals in wards where staff used whiteboards

At Lewisham and Greenwich Hospital Trust staff were positive about the use of catheter magnets to put next to patient names on their whiteboard that had catheters. They felt that this was useful for their board rounds to remind staff which patients had catheters and discuss whether they should be removed. However, magnets were not used at King's College Hospital, where staff relied on digital boards. Future work should explore how this concept could be moved to digital whiteboards.

Improvements in catheter dwell time may have been due to a few 'champions' rather than widespread staff behaviour change

It's unclear whether the success of the intervention in reducing catheter dwell times at two of the three trusts was due to widespread staff behaviour change or because a few staff members took on the role of 'championing' best practice. The small staff survey sample sizes make it difficult to compare pre- and post-intervention results, but the mixed findings suggest the intervention may have been more effective for some staff than others.

It is not clear whether the daily auditing of the catheters had an impact on overall outcomes

The daily auditing of catheters and physical checks on sticker use may have acted as an intervention in itself, raising awareness and influencing staff behaviour due to feeling monitored. As a result, it's challenging to separate the impact of auditing from the overall intervention. Future roll outs of the intervention should explore whether outcomes are achieved in the absence of the daily auditing.

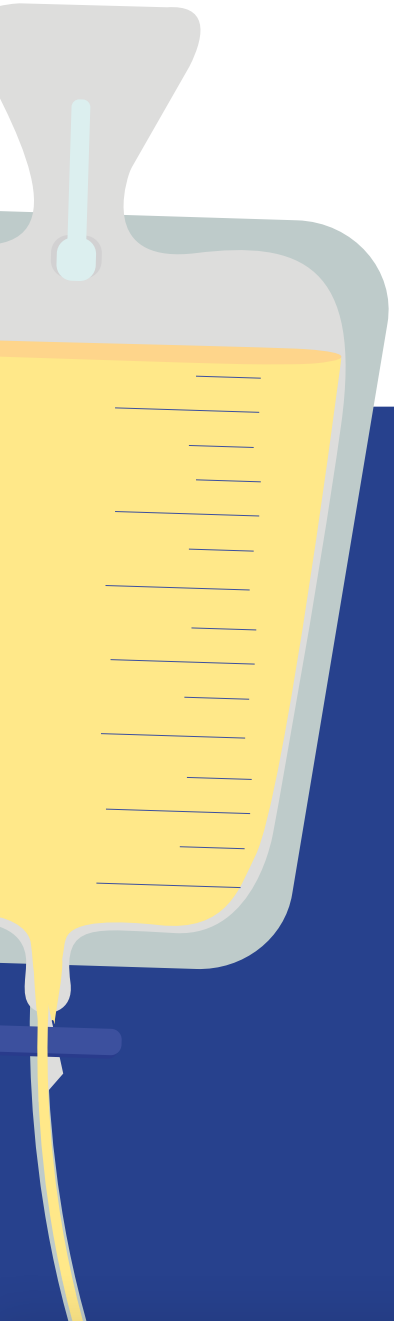
Future roll outs could also explore the role of carers and patients themselves in noticing the stickers and prompting staff to discuss their catheters.

It is likely that the intervention led to improvements in patient outcomes

Given the relationship between catheter dwell time and CAUTIs and other complications of catheterisation, it is likely that the intervention led to improvements in patient outcomes.

Cost-comparison analysis indicated that this intervention was cost-saving at two of the three trusts

Cost-comparison analysis indicates that this intervention, in the first and subsequent years, is cost-saving at King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust, and it is cost-incurring at The Royal Wolverhampton Trust.



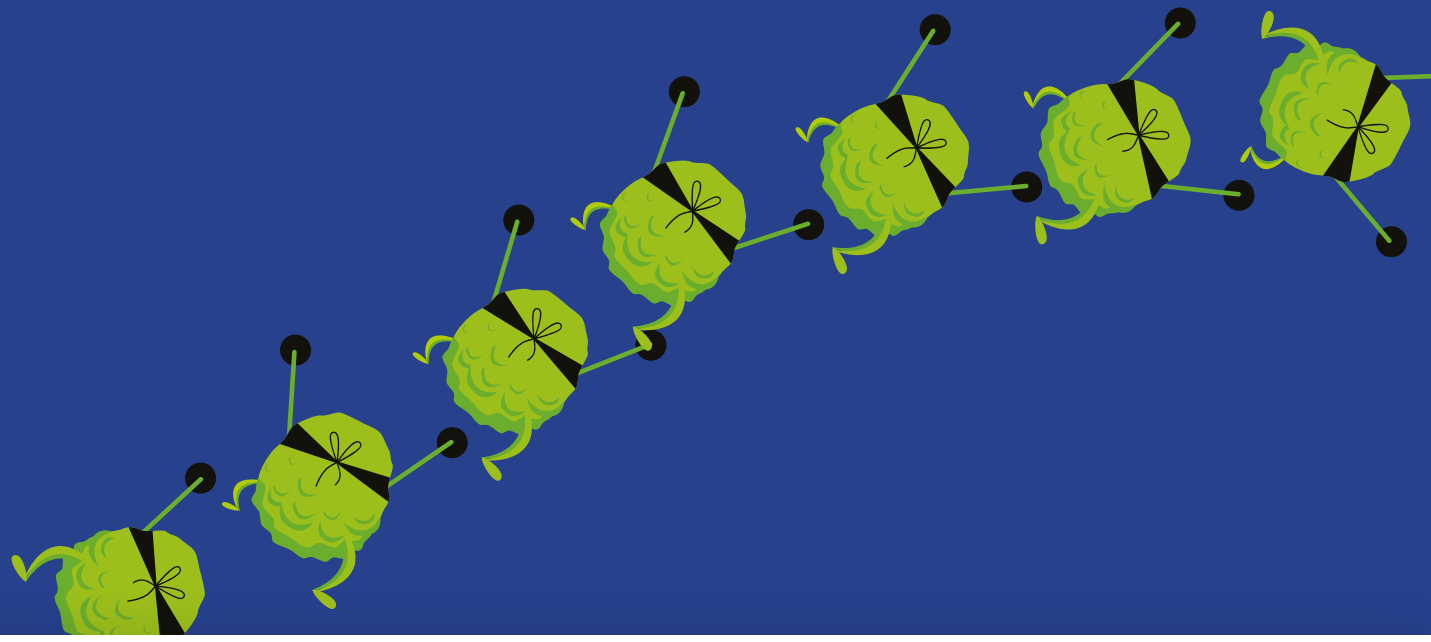
Final reflections from the project team

This pilot has shown that simple, low-cost, behavioural interventions appear to be effective in improving catheter checking behaviours in settings where catheter management practices are not optimised.

We recommend implementing this intervention in wards that exhibit suboptimal catheter management practices, in order to improve patient outcomes and save money.

For future rollouts the following challenges must be considered and addressed:

- **Clarify the impacts of daily catheter audits.** It was not possible to know whether the daily auditing of whether stickers were present on catheters influenced the success of the intervention.
- **Ensure materials work across all ward settings, or can be tailored.** The intervention materials did not work in ward contexts; for example, wards that did not have whiteboards were not able to use the magnets. Materials need to either be universally applicable or easily tailored to different ward environments, such as working with both digital and physical whiteboards.
- **Develop sustainable behaviour change.** Maintaining consistent practice in busy hospital environments is difficult. The project team supported wards to maintain intervention momentum through regular check-ins with the auditors and ward visits accompanied with chocolates and branded mugs to raise awareness. In future interventions, ongoing support systems need to be incorporated to maintain intervention momentum.



Thanks to the Health Foundation for funding this project, in particular, Darshan Patel the Research Manager, and their patience in supporting the project through many delays (including allowing us to pause the entire project throughout the Covid pandemic).

Revealing Reality worked in partnership with the Health Innovation Network South London (HIN) across the entire project. HIN supported with technical knowledge and opening doors to healthcare environments and professionals for Revealing Reality develop and test the ideas. Thanks to Anna Buylova, the Lead Health Economist at the HIN South London, for her work conducting the economic analysis. The team from Revealing Reality oversaw the testing phase pre-intervention and during the intervention and closely liaised with the staff who were carrying out the work in the wards.

Thanks to the NHS Infection Control teams who were involved in many aspects of the project – from the discovery phase research to co-design of the interventions and the implementation protocols. We would also like to thank our key points of contact at each of the trusts who have helped to support the project from its conceptualisation and implementation:

King's College Hospital, King's College Hospital NHS Foundation Trust, London

- Ashley Flores
- John Ramos

Queen Elizabeth Hospital, Lewisham and Greenwich NHS Trust, London

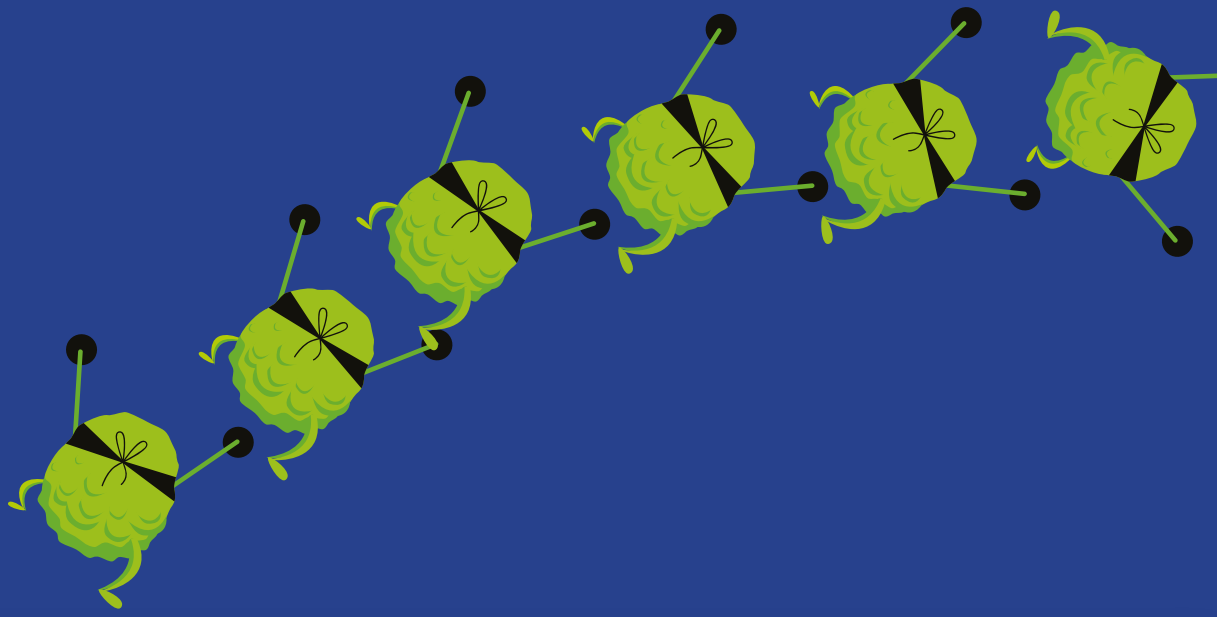
- Fiona Bernard
- Sheila Howard
- David Eboh

New Cross Hospital, The Royal Wolverhampton NHS Trust, West Midlands

- Sue Harper
- Kim Corbett

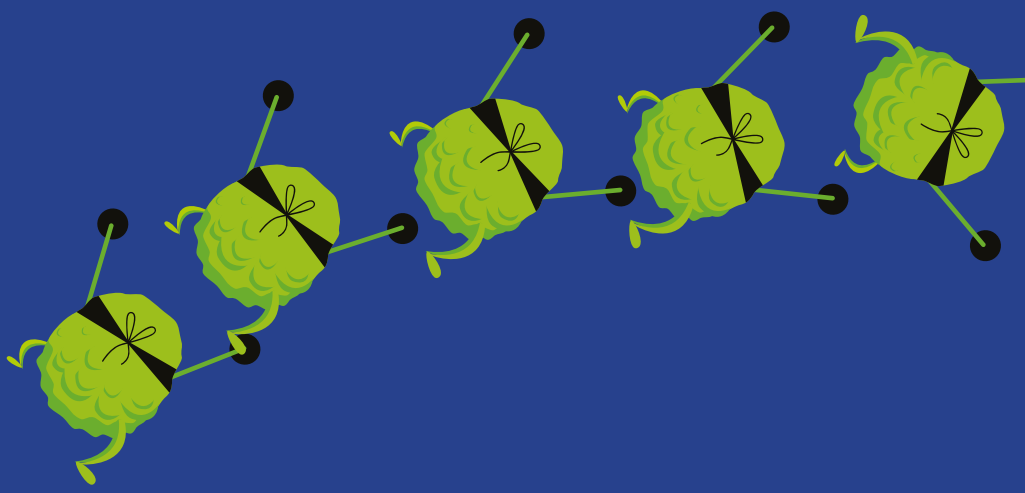
Thanks to Adrian Hopper and Dan Berry who came up with the original idea for this project. Thanks also to Adam Flitton for his input on the design of the sticker and behavioural science expertise.

Finally, thank you to the staff on all the wards involved: Byron and Donne (King's College Hospital), 18 and 19 (Queen Elizabeth Hospital) and C18 and C19 (New Cross Hospital).



While the staff survey data designed to capture change in staff perceptions and attitudes in catheter care has not been reported in this report due to small sample sizes, the full set of data tables for each trust can be found in the corresponding Excel documents for reference.

Also attached is a copy of the survey questions.



Phase 2 of the project was the Design phase in which an intervention comprising a number of components was co-designed with hospital trusts.

The goal of this phase was to develop a bundle of high-quality behavioural interventions to minimise CAUTI rates in healthcare settings.

It aimed to tackle the overarching challenge from the Phase 1 Explore phase that there is no consistent system for tracking catheters and notifying staff and patients when they need to be removed. The design question was, how do we use simple behaviour change interventions to increase checking behaviours and prevent infection?

The design process involved several stages

PRIORITISING CHALLENGES

Defining key behaviours and attitudes that the intervention could address

1 Seeing all catheters as temporary

When staff see a catheter, they should question whether it still needs to be there.

2 Documentation should enable staff to easily question every catheter

We've been exploring how we could use simplified documentation to prompt reviews, including what the **optimum data fields** are to increase checking behaviour.

DIVERGENT THINKING

Exploring a range of possibilities, focused on behaviour nudges and supporting campaigns

CONVERGENT THINKING

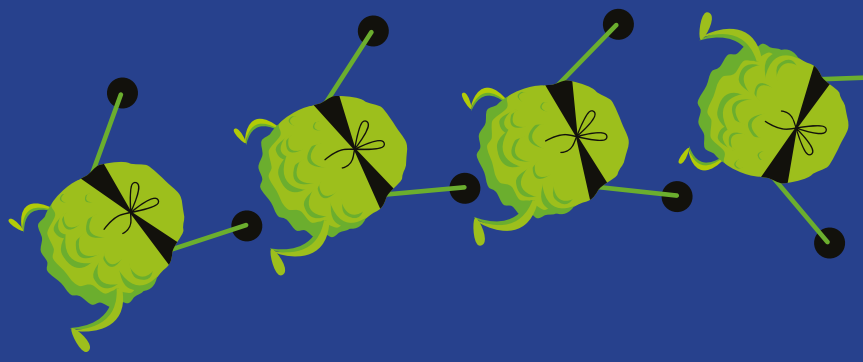
Collaborating with trusts to zero-in on an approach that we all agree on, and validating that it will work in situ

REFINING

Working with trusts to iron out details, and validate materials will work in situ

Reflections on the process of co-design with Trusts

Co-design sessions needed to be well structured and facilitated to enable trusts to think divergently, as they often found it harder to come up with a range of ideas and were often wedded to specific ideas. It was important to remind trusts of the specific goals and challenges the intervention was aiming to overcome, as sometimes ideas were aiming to solve other issues, which could have overcomplicated the materials.



Methods

A cost-comparison analysis was undertaken to evaluate the resource impact of implementing this intervention. The objective was to assess the health economic case for change of continuing to integrate the intervention at a trust level.

Costs incurred along the pathway, including intervention-related costs, are compared to costs of the pre-existing pathway (current standard of care) to derive an incremental cost difference between the two. Datasets were available for two wards at three trusts.

Key outcomes included in the analysis

NHS perspective is used for the health economic evaluation in line with NICE recommendation[10]. While NICE does not set the budget for the NHS, its objective is to issue guidance that represents an efficient use of available NHS resources. The health economic evaluation considers data provided by Revealing Reality on catheter dwell hours per week before and after the intervention at each trust and intervention components (stickers, posters, design, staff briefing and training, etc.). There were limitations to the data provided on indwelling catheter hours requiring the data to be truncated, which are detailed in the data considerations section below.

Additionally, a targeted systematic literature review (SLR) was conducted to source risk estimates associated with each additional day that a catheter remains in situ. The outcome chosen as clinically meaningful was the probability of acquiring a catheter-associated urinary tract infection (CAUTI) and adverse events associated with acquired CAUTI (i.e. bloodstream infection, pain and death). The systematic literature review suggested that risks of CAUTI increase non-linearly with each additional day (24 hours) a catheter remains in situ. From the Kaplan Meier survival curve[11] which indicated that each extra day incrementally increased the risk of CAUTI, we estimated this relationship to be linear for additional days 1-3 and exponential from additional day 3 onwards.

The approach taken to conduct a health economic evaluation starts with defining a "decision problem". This requires answering a set of questions, including specifying the population, and defining the comparators, the outcomes, the evaluation perspective and the time horizon. The decision problem is detailed Table 1.

Horizon

While the data used for analysis is for 20 weeks before and 20 weeks after the intervention (17 weeks for one trust), the economic evaluation horizon is one year and all outcomes based on weekly averages have been extrapolated to the annual horizon.

Element	Details
Population	Patients on a hospital ward with urinary catheter in situ
Intervention	Catheter care intervention
Comparators	Standard care (pre-implementation)
Perspective	NHS
Time horizon	One year

[10] National Institute for Health and Care Excellence Assessing resource impact process manual: guidelines

[11] Letica-Kriegel, A. S., Salmasian, H., Vawdrey, D. K., Youngerman, B. E., Green, R. A., Furuya, E. Y., ... & Perotte, R. (2019). Identifying the risk factors for catheter-associated urinary tract infections: a large cross-sectional study of six hospitals. BMJ open, 9(2), e022137.

Key outcomes: Indwelling catheter hours, (estimated) catheter associated urinary tract infections (CAUTI), NHS staff time

Costs and Resource Use

The economic analysis considered costs and resource use associated with patients on a hospital ward with urinary catheters in situ. Costs associated with the key outcomes were sourced from the NHS Cost Collection, Personal Social Services Research Unit (PSSRU) and through conducting a review of relevant literature (Table 2).

The costs included in the analysis can be categorised into one-off set-up costs, fixed costs, and variable costs. One-off and fixed costs tend to be actual costs that need to be apportioned or allocated to care pathways, while variable costs tend to be a result of resource use incurred in the delivery of care which can change in proportion to, for example, the number of patients seen and the treatment needed.

Set-up costs could include activity such as printing of stickers, posters, design of animations and staff briefings. Costs associated with the intervention itself, such as time spent on staff briefing, staff training, design/printing of intervention related materials were provided by Revealing Reality.

Fixed costs include NHS staff costs. NHS staff costs at various pay bands with overheads, corporate overheads, estate costs were obtained from NHS Cost collection and by applying these staff costs to the duration a specific task is performed.

Set up and fixed costs are indicative of the overall spend to commission the intervention going forward and to understand the impact of this intervention on resources. Any funding previously received, or budget allocated to the pilot initiative is excluded from the analysis.

Variable costs relate to costs that change depending on consumption. For example, the use of NHS resources may have a cost that is incurred each time a service is used such as treating CAUTI or adverse events associated with it. These were estimated from conducting a systematic literature review as follows:

- Eligible cohort size = overall population of England x probability of healthcare-associated infection x probability that healthcare-associated infection is UTI x probability that urinary infection is due to catheters
- Costs of treating 1 incidence of catheter induced urinary tract infection = [total cost of treating healthcare associated infection per annum x probability of UTI x probability UTI is CAUTI + costs of treating of UTI after hospital discharge]/eligible cohort size

Where costs were available for 2022/23 period only, those were adjusted for inflation using 3.5% per annum to derive the figures for 2023/24, in line with NICE recommendations to use the HM Treasury rate.

Element	Associated costs	Details
CAUTI (including CAUTI associated adverse events)	**£3,333**	Systematic literature review calculated as [£1 billion (costs of treating healthcare associated infection per year) x 0.172 (percentage of all healthcare infections that are UTI) x 0.495 (estimated that UTI is CAUTI)]/eligible cohort size
Intervention Design components	**£8,000**	Revealing Reality, for 3 trusts (costs of £2,666.67 per trust)
Intervention consumables (stickers, posters, magnets, mugs, etc)	**£176**	Provided by Revealing Reality and NHS Cost Collection (NHS Pay Bands 3-7 staff time completing specific task relating to intervention)
Set up and training for catheter audit and logging (initial intervention)	**£2,496.90**	NHS Cost Collection (Band 7 infection control manager staff time completing specific tasks relating to intervention)
Set up and training for catheter audit and logging (future period/ roll out)	**£651.90**	NHS Cost Collection (Band 7 infection control manager staff time completing specific tasks relating to intervention)

Sensitivity Analysis

Sensitivity analysis can be used to consider uncertainty in the model. For example, if the risks of CAUTI are higher or lower than the base case or if there is a variation in costs of treating a CAUTI. Sensitivity analysis also highlights the main drivers of intervention costs.

Specifically, deterministic sensitivity analysis (DSA) is applied to investigate how sensitive the results are to any uncertainty in the key input parameters. Parameters can be changed individually, and the results analysed to determine to what extent the change has an impact on the output values. The range of variation of each parameter is assumed to be +/-20% as is standard in economic evaluation, apart from the risks of CAUTIs which were taken from existing evidence, which are varied by +/-50%.

Findings

The results presented in Tables 3-5 summarise the incremental changes in key outcomes and associated total resource use resulting from implementing the intervention.

A minus sign before a value in the incremental difference column indicates improvements or cost savings due to the intervention; conversely, a positive value in that column indicates outcomes deteriorated with implementing the intervention or that additional costs were incurred.

The analyses indicate that implementation of this intervention results in 12.5 and 7.2 CAUTI averted annually at King's College Hospital NHS Trust (KCH) and Lewisham and Greenwich NHS Trust (L&G), respectively. Accounting for the related costs, the intervention is cost-saving at both trusts in the first year with overall savings of £33,660 at KCH and £16,110 at L&G. These savings are more pronounced in subsequent years due to lower set-up costs.

For the Royal Wolverhampton NHS Trust, analysis shows that the intervention is cost-incurring at £12,454 in the first year- this is due to the catheter dwell hours being higher following the intervention [as discussed elsewhere in this report], resulting in an additional 1.33 incidence of CAUTI annually. The intervention remains cost-incurring in subsequent years.

Accounting for uncertainty in parameters, sensitivity analysis results indicate that the intervention remains cost saving at King's College Hospital NHS Trust in the first year, range of (-£54,496; -£12,824) and cost saving in subsequent roll-out years (-£60,853; -£19,181).

Table 3 King's College Hospital NHS Trust-Key outcomes and healthcare resource use results for Catheter Care

Outcomes	Standard of care[12]	Intervention	Incremental difference
Average dwell days/week	**13.087**	**8.279**	**-4.810**
Number of CAUTIs averted/annualised	**–**	**12.502**	**-12.502**
NHS resource impact/annualised	**–**	**-£41,672**	**-£41,672**
Total Costs of first year of intervention	**–**	**£8,012**	**£8,012**
Total Costs of subsequent years of intervention	**–**	**£1,655**	**£1,655**
Total Resource Impact (first year)	**–**	**£33,660**	**-£33,660**
Total Resource Impact (subsequent years)	**–**	**£40,017**	**-£40,017**

Table 4 Lewisham and Greenwich NHS Trust-Key outcomes and healthcare resource use results for Catheter Care

Outcomes	Standard of care[12]	Intervention	Incremental difference
Average dwell days/week	**13.017**	**10.233**	**-2.780**
Number of CAUTIs averted/annualised	**–**	**7.237**	**-7.237**
NHS resource impact/annualised	**–**	**-£24,122**	**-£24,122**
Total Costs of first year of intervention	**–**	**£8,012**	**£8,012**
Total Costs of subsequent years of intervention	**–**	**£1,655**	**£1,655**
Total Resource Impact (first year)	**–**	**£16,110**	**-£16,110**
Total Resource Impact (subsequent years)	**–**	**£22,467**	**-£22,467**

Table 5 The Royal Wolverhampton NHS Trust-Key outcomes and healthcare resource use results for Catheter Care

Outcomes	Standard of care[12]	Intervention	Incremental difference
Average dwell days/week	**6.492**	**7.004**	**0.513**
Number of CAUTIs averted/annualised	**–**	**1.330**	**1.330**
NHS resource impact/annualised	**–**	**£4,422**	**£4,422**
Total Costs of first year of intervention	**–**	**£8,012**	**£8,012**
Total Costs of subsequent years of intervention	**–**	**£1,655**	**£1,655**
Total Resource Impact (first year)	**–**	**-£12,454**	**£12,454**
Total Resource Impact (subsequent years)	**–**	**-£6097**	**£6,097**

Similarly, sensitivity analysis results for Lewisham and Greenwich NHS Trust indicate that the intervention is cost-saving in the first year, range (-28,171; -£4,049) and cost-saving in subsequent years of roll-out (-£34,528; -£10,406).

At the Royal Wolverhampton NHS Trust, the intervention remains cost-incurring in the first year with budget impact in the range of (£10,233; £14,675) and cost incurring in subsequent years of roll-out with a budget impact of (£3,876; £8,318). For the service to be cost-neutral or cost-saving, catheter dwell hours would need to decrease by 7.9% or more on average.

Data considerations

There were several data considerations which were addressed before the health economic analysis commenced.

Catheter overlapping dwell time (i.e., a catheter inserted before the intervention commenced but removed thereafter) were not excluded. Such real-world scenario is indicative of replicating the intervention elsewhere.

King's College Hospital NHS Trust: Data were not collected for the two weeks at the end of the intervention period. No catheters were recorded as being put in or taken out, possibly due to staff shortages. In the final week of the intervention the average dwell hours were significantly above the mean (30 days vs 8 days). To address potential noise in the dataset, the last 3 weeks of the intervention period observations were excluded, resulting in the period of 17 weeks. To draw appropriate comparisons, health economic analysis truncated the pre-intervention period observations, excluding the final 3 weeks of data.

Lewisham and Greenwich NHS Trust: Data points were available for 22 weeks pre-intervention and 24 weeks during the intervention period. In line with the initial analysis plan, this was truncated at 20 weeks for both, excluding the last weeks of observations.

The Royal Wolverhampton NHS Trust: Data points were available for 21 weeks pre-intervention and 23 weeks during the intervention period. In line with the initial analysis plan, this was truncated at 20 weeks for both, excluding the last weeks of observations.

Interpretations and recommendations

Base-case results indicate that this intervention in the first and subsequent years is cost-saving at King's College Hospital NHS Trust and Lewisham and Greenwich NHS Trust, and it is cost-incurring at The Royal Wolverhampton NHS Trust. These results are based on the data provided and existing published evidence available to conduct health economic analysis.

The analysis only considers incremental costs and resource use from the NHS perspective. Business case analysis would need to consider other factors when deciding whether this intervention should be continued or rolled out more widely. For example, with robust data, an analysis could consider which factors contributed to the divergence of results for South London versus Wolverhampton and implications for the adoption nationwide.

We recommend caution in interpretation of the results based solely on the data from a pilot study. Further assessment of additional metrics, such as actual (rather than estimated) numbers of CAUTIs, data on staff capacity, bed days, ward occupancy rates and length of stay would improve robustness of the analysis and provide a more comprehensive picture.

[12] Standard of care refers to the accepted and recommended practices for treating a particular physical or mental health condition, set nationally by the National Institute of Clinical Excellence (NICE) and is used as a benchmark for comparing the benefits and costs of new treatment options

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