When Urinary Catheters Stay Too Long: The Hidden Link Between Constipation, Prolonged Indwelling Urinary Catheterisation, and Urinary Tract Infections in Neurosurgical Inpatients

Dr Kanza Tariq[1], Mr Siddharth Vankipuram[1], Mr Vishal Kakar[1], Mr Chrysotomos Alexandris[1], Mr George Prezerakos[1], Mr Laurence Watkins[1]

[1]National Hospital for Neurology and Neurosurgery, Queen Square, London, U.K.

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Abstract

Objective: Urinary catheterisation is widely used in neurosurgical perioperative care, yet inconsistent adherence to international guidelines has led to variable practice and increased risk of complications. Indwelling catheters are associated with a 5%–10% daily increase in urinary tract infection (UTI) risk, alongside non-infectious issues such as haematuria, pain, reduced mobility and prolonging hospital stays, placing added strain on patients and healthcare systems.

Over a 5 year period, a series of linked audits and quality improvement projects were conducted at the National Hospital for Neurology and Neurosurgery to address the high incidence of urinary tract infections. These initiatives focused on identifying root causes and implementing targeted interventions to disrupt the cycle and reduce infection rates.

Methods: This single-centre prospective quality improvement initiative comprised three sequential audits and six linked quality improvement projects (QIPs) conducted between January 2020 and December 2024. The projects examined UTI incidence in neurosurgical inpatients, inappropriate urinary catheterisation, early trial without catheter (TWOC), and constipation prevention strategies. Sample sizes, inclusion/exclusion criteria, and outcome measures varied by project. Interventions included locally tailored protocols, staff education, and the engagement of clinical champions.

Results: The initial audit showed a 94% UTI rate with indwelling catheters (IDUC) versus 4% with intermittent catheterisation (CIC), prompting targeted quality improvement interventions including nurse-led TWOC, early physiotherapy, and bowel care. These interventions reduced IDUC use from 25.6% in 2020 to 18.5% in 2023 and catheter associated UTI (CAUTI) rates to 45.5% by 2024. TWOC within 24 hours improved from initial 3% in 2021 to 93% in 2024. A linked QIP addressed constipation, increasing PRN laxative prescriptions from 1.2% to 60.4% in 2024, reducing urinary retention. Sustained gains required quarterly education and biannual data reviews and QI cycle re-evaluation.

Conclusion: This longitudinal quality improvement initiative led to safer catheter practices, with a marked reduction in UTI rates and inappropriate catheterisation. Key outcomes included earlier, predominantly nurse-led TWOCing and greater attention to modifiable risk factors such as opioid-induced constipation, resulting in measurable improvements in neurosurgical patient care.

Introduction

Continuous quality improvement (QI) plays a pivotal role in enhancing patient safety and clinical outcomes across surgical disciplines. In neurosurgery, where procedural intricacy and the potential for severe complications are high, QI requires a structured and iterative approach—one that involves identifying system inefficiencies, applying evidence-informed interventions, and assessing their long-term impact. Effective QI initiatives not only aim to reduce preventable harm but also to optimise recovery, resource utilisation, and overall patient experience.

One frequently overlooked yet fundamental aspect of neurosurgical perioperative care is urinary catheterisation. Both indwelling urinary catheterisation (IDUC) and clean intermittent catheterisation (CIC) are commonly employed to manage postoperative urinary retention, monitor output, or accommodate patients with low consciousness. International guidance outlines clinical scenarios warranting catheter use, including acute retention, significant post-void residual volumes, and intraoperative indications such as extensive fluid shifts. However, real-world application often diverges from protocol due to variations in institutional policy, clinical judgment, and inconsistent staff training—leading to discrepancies in practice and heightened patient risk[1].

IDUC, in particular, is associated with time-dependent risks, most notably catheter-associated urinary tract infections (CAUTIs), with a cumulative infection risk of 5%–10% per day the catheter remains in situ due to the rapid formation of biofilm on both inner and outer catheter surfaces, primarily from extraluminal organisms, shielding microbes from host immunity and antibiotic. CAUTIs account for a substantial proportion of nosocomial infections and are linked to increased antibiotic use, prolonged hospital stays, and elevated morbidity. Additional complications include mechanical trauma, haematuria, and reduced mobility—each contributing to delayed rehabilitation and greater healthcare costs[2].

Despite the routine nature of catheter insertion, inappropriate use remains widespread. Up to half of hospitalised patients who receive urinary catheters may not meet evidence-based criteria for insertion. Moreover, the lack of consensus regarding optimal timing for catheter removal—often left to physician discretion rather than protocol—further perpetuates avoidable complications[3].

Given these concerns, structured efforts to rationalise catheter use, improve staff education, and enforce timely removal are critical. This is especially true in neurosurgical care, where any setback can severely affect neurological recovery and functional outcomes.

Over five years, the National Hospital for Neurology and Neurosurgery implemented a structured, multi-phase quality improvement initiative to tackle the persistently high rates of catheter-associated urinary tract infections (CAUTIs). Through a series of interlinked audits & QIPs and targeted interventions, the initiative systematically

identified root causes, refined practices, and promoted sustainable changes thus reducing inappropriate catheterisation, CAUTIs and embedding long-term improvements in patient safety across a complex neurosurgical setting. This essay outlines the development, implementation, and outcomes of the project.

Methodology

Nine quality improvement initiatives were developed in response to persistently high rates of catheter-associated urinary tract infections (CAUTIs) among neurosurgical inpatients. Each project followed a structured, sequential methodology, with subsequent initiatives shaped and informed by the findings of the preceding QIPs.

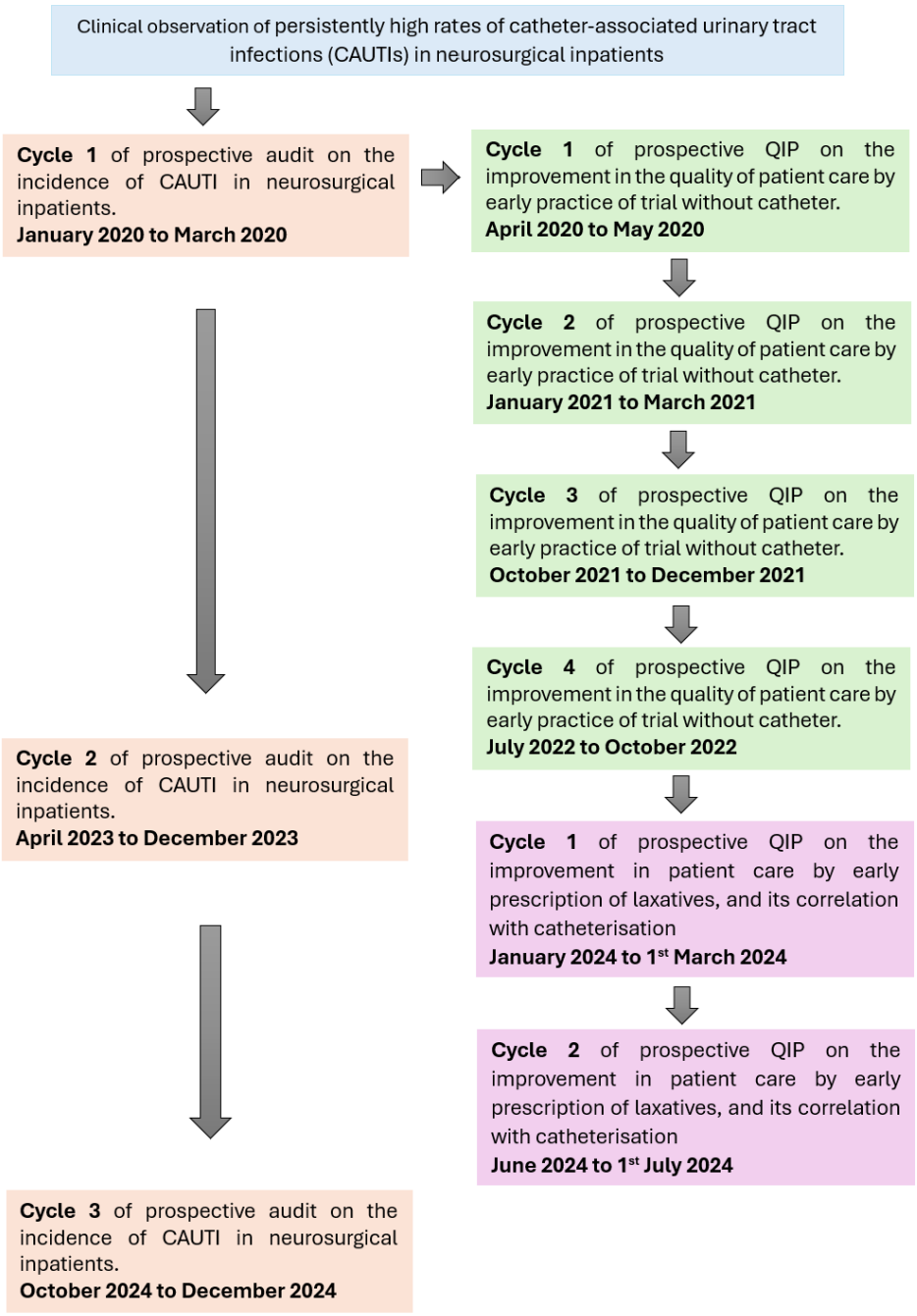

Fig 1 Methodology of the QII: a series of linked audits and quality improvement projects to address the high incidence of CAUTIs

In alignment with the CDC/NHSN guidance, 'CAUTI' was accepted as a urinary tract infection in a patient who has had an indwelling urinary catheter in place for a minimum of two consecutive days at the time of diagnosis or within the preceding 24 hours. Diagnosis required a urine culture showing ≥10^5 colony-forming units per millilitre (CFU/mL) with no more than two bacterial species, along with at least one relevant clinical symptom—such as fever above 38°C, lower abdominal or flank tenderness, acute confusion, delirium or, if the catheter has been removed, urinary urgency, frequency, or painful urination. The project excluded infections caused by yeast.

Cycle 1 of prospective audit on the incidence of CAUTI in neurosurgical inpatients.
Selection time period: 1st January 2020 to 31st March 2020
Inclusion Criteria: Neurosurgical inpatients requiring intermittent or indwelling catheterisation with acute urinary tract infection as per NHSN CAUTI definition
Exclusion Criteria: Neurosurgical inpatients not requiring catheterisation and without acute urinary tract infection.
Standard: NICE guidelines infection prevention and control QS61 - Minimise the risk of catheter-associated infections through safe and timely catheter management. **NICE guideline QS121** - Preventing anti-microbial prescription by prevention of hospital acquired UTI
Primary outcome: Rate of CAUTI
Secondary outcome: Rate of indwelling catheterisation

Cycle 1 of prospective QIP on the improvement in the quality of patient care by early practice of trial without catheter.
Selection time period: 1st April 2020 to 31st May 2020
Inclusion Criteria: Neurosurgical inpatients requiring indwelling urinary catheterisation.
Exclusion Criteria: Neurosurgical inpatients not requiring indwelling urinary catheterisation.
Primary outcome: Reduction in inappropriate catheterisation.
Secondary outcome: Reduction in total catheterisations, CAUTIs and duration of hospitalisation.

Cycle 2 of prospective QIP on the improvement in the quality of patient care by early practice of trial without catheter.
Selection time period: 1st January 2021 to 1st March 2021
Inclusion Criteria: Neurosurgical inpatients requiring indwelling urinary catheterisation.
Exclusion Criteria: Neurosurgical inpatients not requiring indwelling urinary catheterisation.
Primary outcome: Reduction in inappropriate catheterisation.
Secondary outcome: Reduction in total catheterisations, CAUTIs and duration of hospitalisation.

Cycle 3 of prospective QIP on the improvement in the quality of patient care by early practice of trial without catheter.
Selection time period: 1st October 2021 to 31st December 2021
Inclusion Criteria: Neurosurgical inpatients requiring indwelling urinary catheterisation.
Exclusion Criteria: Neurosurgical inpatients not requiring indwelling urinary catheterisation.
Primary outcome: Reduction in inappropriate catheterisation.
Secondary outcome: Reduction in total catheterisations, CAUTIs and duration of hospitalisation.

Cycle 4 of prospective QIP on the improvement in the quality of patient care by early practice of trial without catheter.
Selection time period: 1st July 2022 to 1st October 2022
Inclusion Criteria: Neurosurgical inpatients requiring indwelling urinary catheterisation.
Exclusion Criteria: Neurosurgical inpatients not requiring indwelling urinary catheterisation.

Cyle 2 of prospective audit on the incidence of CAUTI in neurosurgical inpatients.
Selection time period: 1st April 2023 to 1st December 2023
Inclusion Criteria: Neurosurgical inpatients requiring intermittent or indwelling catheterisation with acute urinary tract infection as per NHSN CAUTI definition
Exclusion Criteria: Neurosurgical inpatients not requiring catheterisation and without acute urinary tract infection.
Standard: NICE guidelines infection prevention and control QS61 - Minimise the risk of catheter-associated infections through safe and timely catheter management. **NICE guideline QS121** - Preventing anti-microbial prescription by prevention of hospital acquired UTI
Primary outcome: Rate of CAUTI
Secondary outcome: Rate of indwelling catheterisation.

Cycle 1 of prospective QIP on the improvement in patient care by early prescription of laxatives, and its correlation with catheterisation.
Selection time period: 1st January 2024 to 1st March 2024
Inclusion Criteria: All neurosurgical inpatients
Exclusion Criteria: All day cases and outpatients, non-neurosurgical patients
Primary outcome: Frequency of laxative prescription as an administer-on-requirement (PRN) medication at time of patient admission.
Secondary outcome: Duration of patient catheterisation. Overall rate of indwelling catheterisation.

Cycle 2 of prospective QIP on the improvement in patient care by early prescription of laxatives, and its correlation with catheterisation.
Selection time period: 1st June 2024 to 1st July 2024
Inclusion Criteria: All neurosurgical inpatients
Exclusion Criteria: All day cases and outpatients, non-neurosurgical patients
Primary outcome: Frequency of laxative prescription as an administer-on-requirement (PRN) medication at time of patient admission.
Secondary outcome: Duration of patient catheterisation. Overall rate of indwelling catheterisation.

Cyle 3 of prospective audit on the incidence of CAUTI in neurosurgical inpatients.
Selection time period: 1st October 2024 to 31st December 2024
Inclusion Criteria: Neurosurgical inpatients requiring intermittent or indwelling catheterisation with acute urinary tract infection as per NHSN CAUTI definition
Exclusion Criteria: Neurosurgical inpatients not requiring catheterisation and without acute urinary tract infection.

Standard: NICE guidelines infection prevention and control QS61 - Minimise the risk of catheter-associated infections through safe and timely catheter management. **NICE guideline QS121** - Preventing anti-microbial prescription by prevention of hospital acquired UTI
Primary outcome: Rate of CAUTI
Secondary outcome: Rate of indwelling catheterisation

Ethics and Research Governance: All the linked audits and QIPs of the initiative were undertaken following approval and registration by the Quality and Safety Department of the Trust. Patient data were evaluated anonymously to ensure confidentiality and data protection.

Results and Interventions

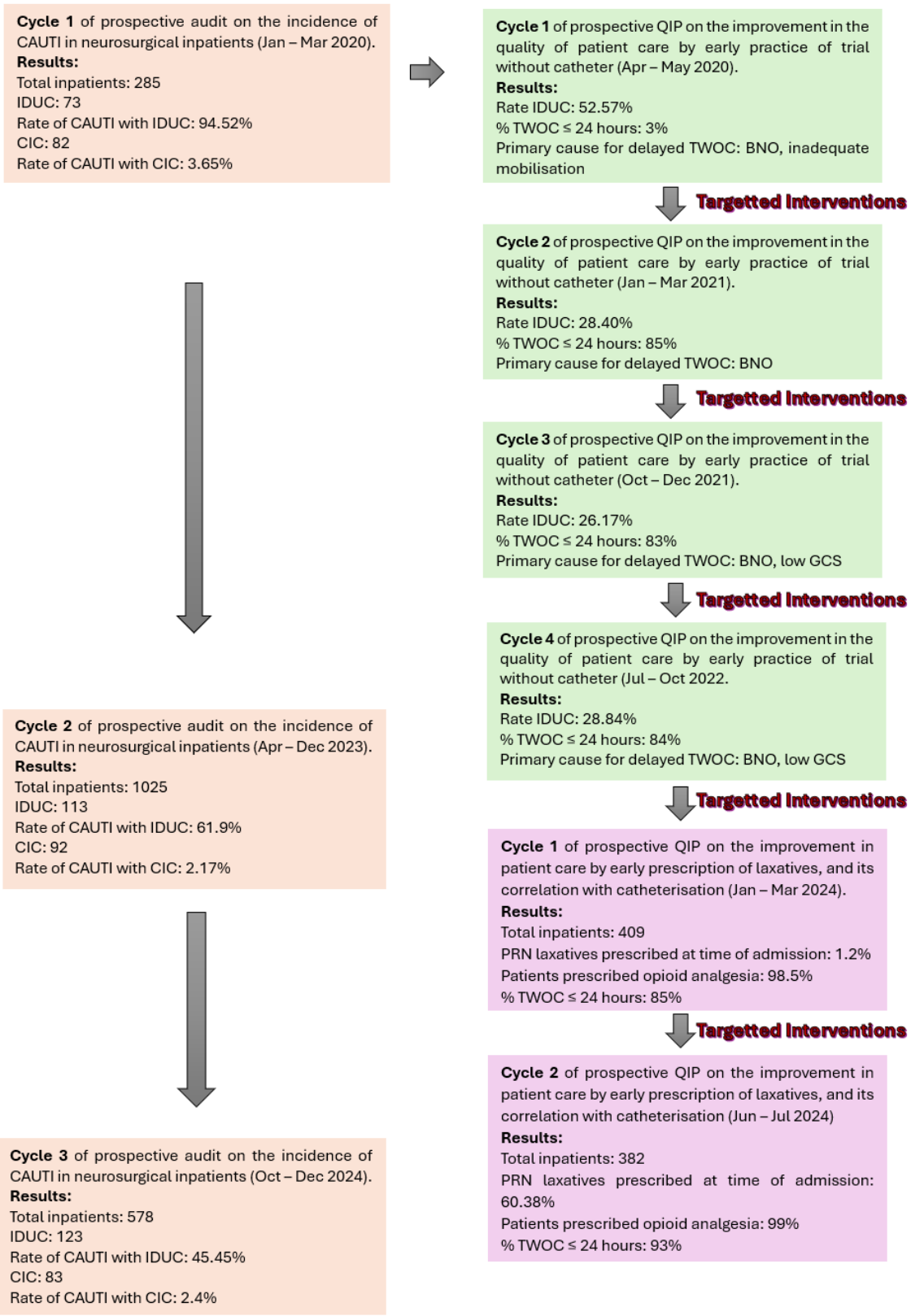

Fig 2 Overview of the main results

The initial audit (Jan - Mar 2020) explored incidence of CAUTI in 285 neurosurgical inpatients of whom 155 required catheterisation of which 45.96% had IDUC. The rate of CAUTI was found to be 3.65% with clean intermittent catheterisation (CIC) and 94.52% with indwelling urinary catheterisation (IDUC).

These findings prompted a subsequent QIP exploring the catheterisation practices in neurosurgical wards of the hospital (Apr – May 2020). It was found that 85.51% IDUCs were placed intraoperatively. Only 3% of the patients underwent trial without catheter (TWOC) up to the first 24 hours and it was mostly due to the patient's own request or the doctors' orders. 31% of the patients were TWOCed between 2-3 days and 94% of these were following written orders from the doctor and 6% due to patients wishes for catheter removal or to be taught intermittent self-catheterisation (ISC). 32% were TWOCed between days 4-6 and 13% at days 7-10. The reasons for delayed TWOCing in decreasing order of frequency were awaiting opening of bowls, inadequate mobilisation, risk of retention, incontinence, low GCS, awaiting bladder training and delayed re-assessment of primary problem such as retention.

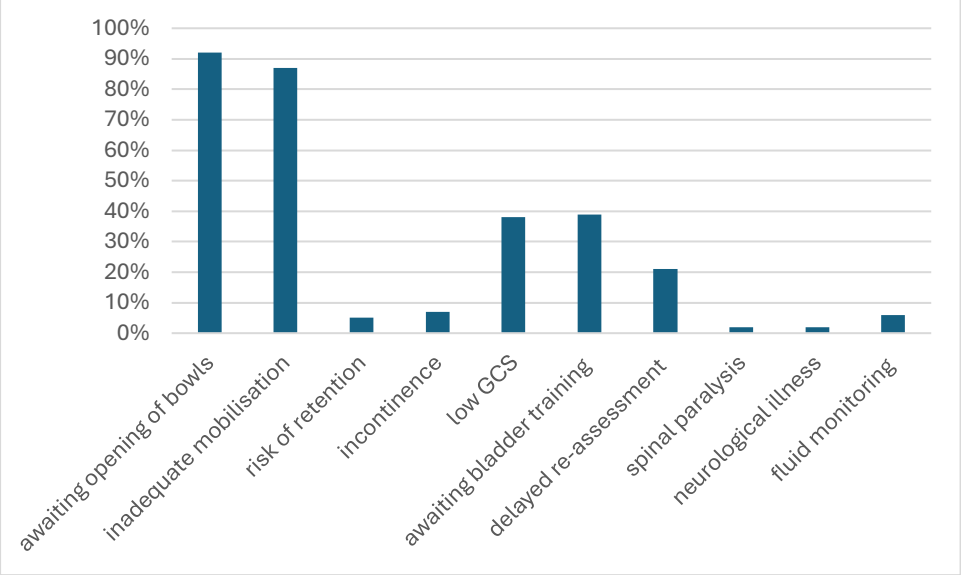

Fig 3 Documented causes of delay in first trial without catheter.

Interventions: Using co-production, a multifaceted, evidence-informed intervention strategy was developed and implemented. This strategy was grounded in international best practices and adapted to target both the technical and behavioural components of CAUTI prevention, the cornerstone of which lay in avoiding unnecessary catheter use and ensuring prompt removal when clinically appropriate.

1. Designated nurse champions were assigned to each ward and the postoperative recovery area to lead quality improvement compliance and local adaptation.

2. Urology specialist nurses provided a structured training curriculum for the entire clinical team covering aseptic technique, catheter insertion, closed drainage maintenance, infection prevention and appropriate catheter use.

3. Catheter necessity was evaluated daily to support early removal and prevent unnecessary continued use. Multidisciplinary ward rounds included specific daily reviews of all patients with catheters to evaluate the need for continued use.

4. A nurse-led protocol was introduced to empower nursing staff to independently remove catheters once indications had resolved.

5. To address training access challenges caused by shift work, educational sessions were repeated and locally tailored for broader participation.

6. A multidisciplinary working group—comprising surgeons, neurologists, nurses, microbiologists, and urologists—developed a consensus protocol defining appropriate catheter use thresholds. IDUC use was considered inappropriate when used in cases where surgical procedures lasted less than 180 minutes, anticipated bedrest was under 24 hours, postoperative urinary retention was below 400 mL, or where any volume of urinary residual was present without other indications. CIC was deemed inappropriate when urinary retention volumes were under 500 mL or postvoid residuals below 200 mL. These cut-offs were determined using bladder ultrasound assessments to ensure objective, consistent practice. Nurse champions actively contributed to both the development and delivery of the protocol and the overall QIP.

7. The lead researcher met with nurse champions every 3 months to review compliance, gather feedback, and address barriers.

8. All staff received initial training, followed by refresher sessions every 3 months to reinforce learning and address practical issues.

9. Quality improvement cycles and outcome data were analysed and repeated every 6 months to guide iterative improvement.

10. All required urinary management equipment—bladder scanners, incontinence aids, external devices—was made readily accessible on each unit.

11. Supplies supporting non-invasive urinary management were made as easy to obtain as traditional catheter kits.

12. Only staff with verified training and demonstrated competence were permitted to insert catheters.

13. Staff received training in proper urine sample collection, handling, and timely delivery to the microbiology lab.

14. When appropriate, staff were encouraged to consider intermittent catheterisation or external urinary devices before placing indwelling catheters.

15. Strict adherence to hand hygiene was reinforced before catheter insertion and before and after any contact with the catheter system.

16. Long-term indwelling catheters were permitted only in specific cases, with clinical justification, and not as a measure.

17. Careful handling of drainage bags was stressed to prevent cross-contamination, including avoiding floor contact and using proper PPE.

18. All catheters inserted during surgery were removed immediately postoperatively at the conclusion of the case or in the recovery area unless specifically indicated otherwise.

19. The project embodied co-production. Staff were encouraged to speak up about inappropriate practices.

20. Open discussions with patients and families were promoted to explain catheter-related risks and support shared decision-making.

21. Posters and other visual cues were displayed in clinical areas to reinforce catheter care protocols.

22. Postoperative laxative use was standardised to reduce constipation-related urinary retention.

23. Referrals to physiotherapy and occupational therapy were initiated earlier to support timely mobilisation and voiding.

24. Delays in catheter removal solely due to unpassed bowel movements were no longer considered acceptable.

25. Standard timing for postoperative catheter removal was set at 8 a.m. within 24 hours post-surgery, with reassessment and bladder scan by midday.

26. Patients with normal consciousness and good hand function were offered intermittent self-catheterisation rather than continuing with an indwelling catheter.

27. Clinicians were required to document a clear catheter plan—beginning in recovery—in the electronic health record (EPIC).

Ongoing monitoring of outcomes: By 2022 84% patients were TWOCed within 24 hours and mostly in post-operative recovery area or nurse-led. By end of 2023 overall catheterisation rate dropped to11% and of IDUC to 18.5%. The rate of UTI in IDUC dropped to 61.9%. Over the years, the most reason for delayed TWOCing remained awaiting opening of bowls. This led to a subsequent QIP exploring the incidence of constipation in neurosurgical inpatients (Jan – Mar 2024). It was discovered that at baseline, only 1.2% of patients were prescribed PRN laxatives on admission, despite 98.5% being on opioid analgesia. Majority of these patients developed constipation.

Interventions: In alignment with co-production principles, clinical champions played a key role in reinforcing constipation prevention strategies, fostering shared ownership and sustained practice across the multidisciplinary team.

1. Prescribe PRN laxatives at the point of admission to ensure proactive bowel management and reduce the risk of postoperative constipation.

2. All patients prescribed opioid analgesia should also receive a concurrent laxative prescription, following the same principle as co-prescribing proton pump inhibitors with steroids.

3. Regular interdisciplinary education sessions were delivered to clinical teams—including medical, nursing, physiotherapy, occupational therapy, and pharmacy staff—

emphasising the importance of routine PRN laxative prescribing and fostering a shared responsibility for best practice.

4. Visual reminders, such as educational posters, were displayed in ward areas and staff offices to reinforce this prescribing practice.

5. Nursing staff were encouraged to consistently prompt prescribers to initiate PRN laxative orders for all neurosurgical patients, regardless of bowel activity, recognising the universal risk of opioid-induced constipation.

Ongoing monitoring of outcomes: By late 2024, 60.4% of patients had laxatives prescribed on admission, correlating with improved bowel function and potentially reducing urinary retention with 93% patients being TWOCed within 24 hours and the incidence of UTI in IDUC dropping to 45.45%.

It was also found that to maintain compliance educational interventions had to be repeated every 3 months and data monitoring had to be undertaken minimally biannually.

Discussion

This multi-phase quality improvement initiative (QII), conducted between 2020 and 2024, significantly reformed urinary catheter practices in neurosurgical care. By targeting both technical protocols and behavioural culture, the project achieved sustained reductions in inappropriate catheterisation and catheter-associated urinary tract infections (CAUTIs). The duration of catheterisation emerged as the strongest modifiable risk factor—underscoring the urgency of timely removal. This is in keeping with findings in other surgical specialities[4-7]. Implementing nurse-led trial without catheter (TWOC) protocols shifted removal timing decisively: from 3% of patients within 24 hours in 2020 to 93% by 2024. This is also in keeping with past research exploring effective strategies for reducing CAUTI in surgical specialties[2, 3, 8].

Beyond catheter management, the QII addressed a critical but overlooked contributor to urinary retention—opioid-induced constipation. Introducing routine PRN laxative prescribing elevated early bowel function, enabled earlier mobilisation, and further reduced catheter reliance. This systems-based, multi-disciplinary strategy yielded a drop in CAUTI rates among patients with indwelling catheters from 94% to 45.5%, highlighting the power of integrated care pathways.

Education and sustained engagement were foundational. Local nurse champions led ward-level implementation, while regular teaching and feedback cycles helped overcome challenges such as staff turnover and variable protocol adherence. This is in keeping with national guidance on the subject of CAUTI prevention[9], as well as past published studies[10-12].

This initiative exemplifies how data-driven, co-produced interventions can drive meaningful clinical transformation—even in complex, high-acuity environments like neurosurgery. By shifting from reactive to preventative care, aligning practice with evidence, and empowering nursing leadership, the project delivered durable improvements in patient safety, efficiency, and care experience.

Ultimately, this work demonstrates that catheter-related harm is not an inevitable complication, but a preventable outcome—given the right systems, leadership, and commitment to quality.

Impact of the quality improvement initiative

This initiative has had a profound impact on neurosurgical patient welfare—the stark reduction in infection rates and unrequired catheterisation enhanced patient comfort, accelerating recovery, and empowering patients through earlier mobility and reduced reliance on invasive devices. By keeping co-production at its heart it brought together multidisciplinary teams—neurosurgeons, microbiologists, nurses, and allied health professionals—under a unified, patient-centred goal. Most importantly, it placed patients at the centre of care decisions. By preventing avoidable infections and shortening hospital stays, the project also delivered significant cost savings to the NHS.

Wider applicability

The findings and strategies from this single-centre initiative hold broad applicability for neurosurgical centres across the UK, where similar challenges in catheter overuse, postoperative urinary retention, and opioid-induced constipation are prevalent. By aligning with national guidelines and leveraging nurse-led protocols, digital documentation, and multidisciplinary engagement, this model offers a scalable, evidence-informed blueprint for improving patient safety and reducing catheter-associated harm in neurosurgical units nationwide.

Conclusion

In conclusion, this longitudinal quality improvement initiative led to safer, more effective catheter practices, with a significant reduction in both UTI rates and inappropriate catheter use. Key outcomes included earlier, predominantly nurse-led TWOCing and a proactive focus on modifiable risk factors such as opioid-induced constipation and early involvement of physiotherapy team, which collectively enhanced patient recovery and safety. These results underscore the value of reducing inappropriate and overall catheterisation in neurosurgical patients, aligning with a patient-centred model of care. Continued education, adherence to standardised protocols, and robust audit-feedback mechanisms will be essential to maintaining progress.

Future Work

Future efforts should focus on embedding digital education tools, and evaluating long-term patient outcomes and cost-effectiveness. Key to this will be the integration of robust documentation systems that capture catheter indications, insertion and removal timelines, and daily maintenance practices in a standardised format. Embedding catheter reminders and stop orders into electronic health records may further support

timely removal and prevent unnecessary use. Future research should explore the durability of these improvements over time, as clinical champions may change jobs, and replaced by newer team members, assess cost-effectiveness, and examine staff engagement and perceptions to inform refinements in implementation strategy.

Supplementary Data

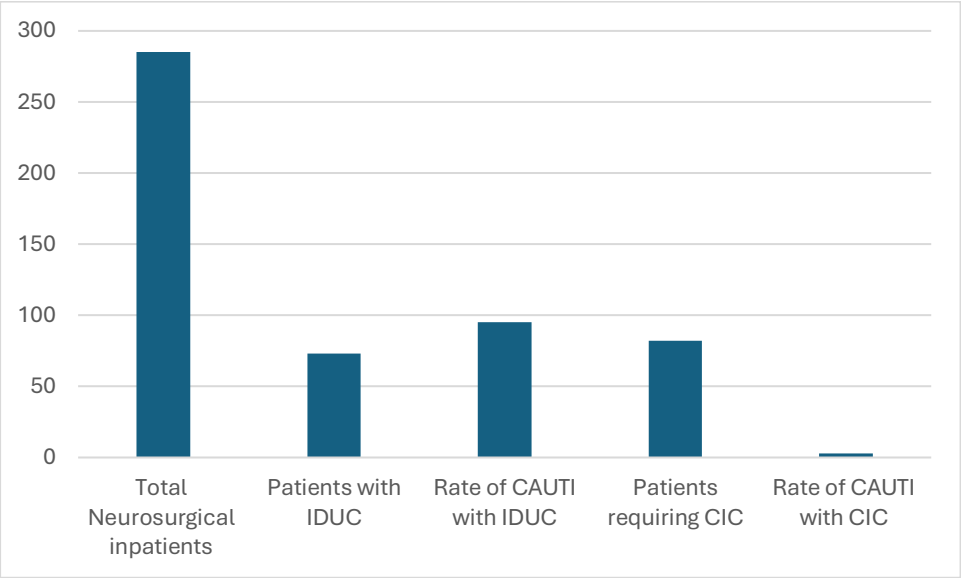

Fig 4 Findings of cycle 1 of prospective audit on the incidence of CAUTI in neurosurgical inpatients (Jan – Mar 2020)

	Cycle 1: 1st April 2020 to 31st May 2020	Cycle 2: 1st January 2021 to 1st March 2021	Cycle 3: 1st October 2021 to 31st December 2021	Cycle 4: 1st July 2022 to 1st October 2022
Patients in 5 N/S Wards	407	419	399	423
After Exclusion	214	119	107	122
Cranial Pathologies	120	67	60	68
Spinal Pathologies	88	49	44	50
Neurological Disorders	6	3	3	4
Intraoperative Catheterisation	183	105	94	103
Catheterisation due to Severe Neurological Disorder	10	6	5	6
Catheterisation due to Initial Confusion + Low GCS	7	4	5	5
Catheterisation due to one episode of Incontinence	2	4	3	5
Catheterisation due to one episode of Urinary Retention	2	0	0	0
Catheterisation due to Unstable Spinal injury	0	0	0	1
Catheterisation due to 24 Hour Urine Test	0	0	0	2

Table 1 Findings cycle 1 – 4 of prospective QIP on the improvement in the quality of patient care by early practice of trial without catheter.

	≤ 24hr TWOC	48 - 72 hr TWOC	4 - 6 days TWOC	7 - 10 days TWOC	11 - 20 days TWOC	21 - 30 days TWOC	> 30 days TWOC
Cycle 1: 1st April 2020 to 31st May 2020	3%	31%	32%	13%	8%	6%	7%
Cycle 2: 1st January 2021 to 1st March 2021	85%	4%	3%	2%	0%	0%	2%
Cycle 3: 1st October 2021 to 31st December 2021	83%	5%	4%	2%	0%	0%	2%
Cycle 4: 1st July 2022 to 1st October 2022	84%	5%	5%	2%	0%	2%	2%

Table 2 Findings cycle 1 – 4 of prospective QIP on the improvement in the quality of patient care by early practice of trial without catheter.

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