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Improving postoperative care for neurosurgical patients by a standardised protocol for urinary catheter placement: a multicentre before-and-after implementation study

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ABSTRACT

Introduction Urinary catheterisation, including indwelling and clean intermittent catheterisation, is common in perioperative and postoperative care. Despite guidelines, practice variation is significant. Inappropriate catheterisation risks include urinary tract infections and reduced mobility, leading to prolonged hospital stays and increased antibiotic use. This study aims to improve postoperative care through appropriate catheterisation in neurosurgical groups frequently subjected to catheterisation.

Methods We conducted a multicentre, before-and-after study in four Dutch hospitals from June 2021 to January 2023, including adult neurosurgical patients who underwent pituitary gland tumour or spinal fusion surgery. Exclusion criteria included conditions requiring chronic catheter use. A multifaceted strategy was implemented, focusing on a uniform protocol, an educational programme and department-specific champions. The primary outcome was inappropriate catheterisation, analysed with ordinal logistic regression. Secondary outcomes included total catheterisations, urinary tract infections and length of hospital stay. Ethical approval was obtained. Strengthening the Reporting of Observational Studies in Epidemiology and SQUIRE checklists were used.

Results Among 3439 patients screened, 2711 were included, with 544 in the after group. The percentage of patients without inappropriate indwelling catheterisation increased from 46% to 57%, and the proportion without inappropriate clean intermittent catheterisation rose from 34% to 67%. Additionally, overall catheter use decreased: the percentage of patients not receiving an indwelling catheter increased from 54% to 64%, while those not requiring clean intermittent catheterisation rose from 89% to 92%. Infection rates and hospital stay were similar (1.4% and 1.3%; 4.9 and 5.1 days, respectively).

Conclusions Implementing a uniform protocol may significantly reduce inappropriate and overall catheterisation in neurosurgical patients, aligning with patient-centred, less invasive healthcare. Ongoing education and adherence to standardised protocols are crucial. Future research should assess the long-term sustainability of these strategies.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Urinary catheterisation, including indwelling urinary catheterisation and clean intermittent catheterisation, is commonly used in perioperative and postoperative care. Despite international guidelines, there is considerable variation in practice, leading to inappropriate catheterisation and associated risks such as urinary tract infections, pain and prolonged hospital stays.

WHAT THIS STUDY ADDS

⇒ This study demonstrates that a multifaceted strategy, including the implementation of a uniform catheter protocol and an educational programme, can significantly reduce inappropriate and overall catheter use in neurosurgical patients. It also highlights the importance of department-specific champions in improving adherence to standardised protocols.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings underscore the potential of standardised protocols and continuous education in enhancing patient care and reducing unnecessary medical interventions. This approach could be applied to other areas of healthcare to promote patient-centred, less invasive practices and improve overall healthcare quality.

INTRODUCTION

In perioperative and postoperative care settings, urinary catheterisation, which includes both indwelling urinary catheterisation (IDUC) and clean intermittent catheterisation (CIC), is a commonly used nursing intervention. International guidelines provide distinctions between appropriate and inappropriate indications for IDUC and CIC for healthcare settings across the continuum of care.[1] These indications include conditions, such as postoperative urinary retention, postvoid residual, prolonged surgery and prolonged bed rest.[1 2] Postoperative urinary retention is defined as the patient's inability to void, while postvoid residual refers to the volume of urine remaining in the bladder after urination.[3] An extended duration of surgery is an additional indication for IDUC, primarily to prevent potential incontinence or overdistention of the bladder due to large volumes of intravenous fluids administered during anaesthesia and to monitor fluid balance on an hourly basis.[1]

Despite these distinct indications in the guidelines, a significant challenge arises from the lack of clarity regarding the specific thresholds for perioperative and postoperative urinary retention, postvoid residual, prolonged postoperative bed rest and operation duration in urinary catheterisation protocols that necessitate IDUC or CIC.[4 5] This ambiguity has led hospitals to often adopt their own protocols, resulting in different thresholds between institutions. In addition, previous research has identified several other causes for inappropriate catheterisation, including inconsistent adherence to guidelines, variability in clinical decision-making and inadequate staff training, further contributing to the inconsistency in clinical practice.[6 7]

Given the inherent risks associated with IDUC and CIC, it is crucial to minimise their use to enhance the quality of patient care. Among these risks, urinary tract infections (UTIs) frequently occur: IDUC elevates infection rates by 5%–10% for each day of use, while the CIC infection rates range from 0.5% to 20% per catheterisation event.[8] Non-infectious complications also occur, including pain, discomfort and haematuria, which can reduce patient mobility.[9 10] These risks not only lead to increased antibiotic consumption but could also result in prolonged hospital stays.[11]

Extensive research has focused on minimising both general and unnecessary catheterisation across various healthcare settings, such as intensive care units, emergency rooms, general wards and nursing homes.[12 13] However, such efforts have not been applied in the field of neurosurgery. This gap is critical, given the routine practice of catheterisation in the postoperative care of neurosurgical patients, such as those undergoing surgeries for pituitary gland tumours or spinal fusion.[14 15] These particular neurosurgical patient groups are of interest because of the relatively short duration of their surgeries, usually 2–4 hours, and the standard procedure encouraging early postoperative mobilisation, provided there are no complications like cerebrospinal fluid leakage.[16]

Considering the challenges stemming from the absence of standardised practices and thresholds, combined with the identified risks of inappropriate catheterisation, these two patient cohorts provide a unique context for studying the reduction of inappropriate use and refinement of standardised practices with respect to IDUC and CIC. The aim of this study is to improve postoperative care through accurate IDUC and CIC in patients who underwent pituitary gland tumour and spinal fusion surgery.

METHODS

Design and setting

We conducted a multicentre before-and-after study in four hospitals (one university hospital, two large teaching hospitals and one general hospital) to analyse clinical outcomes following the introduction of a multifaceted strategy aimed at reducing inappropriate perioperative and postoperative IDUC and CIC. Data for the before period were collected from 2018 to 2021. The strategy was introduced from 1 January 2022 to 30 May 2022. Data for the after period were collected from 1 June 2022 to 31 December 2022. To enhance the clarity and transparency of our study reporting, we used the Strengthening the Reporting of Observational Studies in Epidemiology and Standards for QUality Improvement Reporting Excellence (SQUIRE) checklists.[17 18]

Population

Adult patients admitted to the neurosurgical wards who underwent either transsphenoidal pituitary gland tumour surgery or spinal fusion surgery under general anaesthesia were considered for inclusion. Patients were categorised into three groups based on the type of surgery performed: (1) pituitary surgery, (2) spondylodesis and (3) trauma or tumour debulking. Patients were excluded based on the following criteria: (a) presence of a suprapubic catheter, (b) chronic IDUC or CIC prior to hospital admission, (c) first IDUC in another hospital/long-term care facility, (d) first IDUC in an emergency department, (e) IDUC or CIC according to spinal cord injury (paraplegic) protocol and (f) transfer to intensive care unit or hospice care.

Data collection

Data were collected from June 2021 to January 2023 through medical record review. This process was tailored to institutional preferences, allowing for either remote or on-site data gathering. The primary researcher, in collaboration with three nurses and a research assistant, extracted data pertaining to patients' clinical trajectories and complications during their hospital stay. This included information related to IDUC, CIC, urinary retention, urinary residuals and UTIs sourced from both medical and nursing records. Data on surgical duration were collected and defined as the time from anaesthesia induction to the patient's return to the recovery room. Antibiotic prophylaxis was not part of the study protocol, and data on antibiotic use in participating hospitals were not systematically recorded. To ensure data integrity, the primary researcher and nursing team routinely cross-checked the recorded data. The primary researcher aided in cases of ambiguity or missing information in the medical records. Uncertainties were discussed and, if necessary, a second researcher was consulted. Additionally, to ensure quality control, the second researcher reviewed the data on three separate occasions during the data collection process.

Multifaceted strategy

To standardise care and reduce variability in clinical decisions across different hospitals, we developed a uniform protocol for IDUC, CIC and UTIs within the surgical department, recovery unit and neurosurgical nursing ward. This protocol established clear definitions for appropriate and inappropriate practices, aiming to guide clinical decision-making. The content of the newly established protocol was formulated based on protocols used in the academic hospital, relevant international and national guidelines and was validated by two independent urologists from the academic hospital.[5 19] The protocol specified that IDUCs were deemed inappropriately placed under the following conditions: (a) surgical duration <180 min, (b) expected bedrest <24 hours, (c) postoperative urinary retention <1000 cc or (d) any volume of urinary residual. For CIC, inappropriate use was defined as (a) urinary retention <500 cc in females and <750 cc in males or (b) urinary residual <200 cc. The specified volumes were determined using ultrasound bladder scans that were approved and validated by each hospital.[20] To diagnose a UTI, three criteria had to be met: (a) bacterial count of $\geq 10^5$ CFU/mL in the urine sediment, (b) leucocyte count >5 leucocytes in the urine sediment and (c) at least one clinical symptom, such as painful or frequent urination, fever exceeding 38.0°C, flank pain, general malaise or delirium.[21]

To support the implementation and sustainability of the protocol, we enlisted local champions from each department in each hospital. These champions were selected for their leadership roles and played a pivotal part in ensuring adherence to the protocol, addressing practical challenges and tailoring the programme to the needs of their respective hospitals. Local champions collaborated with the research group in developing the educational programme and participated in its delivery. The primary researcher held 2 monthly meetings with these local champions to monitor compliance and provide feedback.

An educational programme, designed for healthcare professionals (specifically nurses), served as the foundation for disseminating the newly established protocol. It included modules on the new protocol, guideline adherence, catheter insertion techniques and infection prevention, all tailored to the specific needs of postoperative neurosurgical patients. This programme was developed by the research group at the start of the study and further adjusted during implementation, with the help of local champions, to accommodate logistical preferences and the specific circumstances of individual hospitals. Tailoring was applied to optimise the programme's relevance and effectiveness for the target audience, as research suggests that context-specific strategies are more likely to improve implementation outcomes.[22]

The educational programme was disseminated using a combination of real-life and online training sessions, which were conducted by the primary researcher in collaboration with a research team nurse. To ensure thorough understanding and adherence, implementation included initial training sessions for all relevant staff, followed by 3 monthly meetings to address challenges and reinforce adherence. The training used various tools, including interactive slide decks, instructional videos and printed materials, which were distributed via email and uploaded to a dedicated online platform accessible to all staff within each hospital. The programme was further integrated into daily routines through participation in team meetings and continuous support provided by department-specific newsletters and educational posters placed in team stations. To sustain adherence over time, the programme included regular refresher sessions and continuous engagement by local champions who monitored compliance and addressed any emerging issues.

Outcomes

The primary outcomes were the proportions of inappropriate IDUC and CIC. Secondary outcomes included the proportions of total inserted IDUCs and CIC, UTIs and length of hospital stay.

Statistical analysis

Data were analysed with SPSS version V.29.0. Descriptive analyses are presented as raw numbers and percentages. Continuous data are presented as means with SDs. We analysed the primary outcomes (appropriate/inappropriate IDUC and CIC insertion) on an ordinal scale, counting the number of catheters a patient received during admission to the neurosurgical department, and grouping them as 0 (no catheter), 1 (1 catheter inserted), 2 (2 catheters inserted) and 3 (3 or more catheters inserted). The grouping of catheter use was a pragmatic decision based on the expected distribution of catheter use among patients. To assess differences in the distribution of surgery types between the before-and-after groups, a χ^2 test was performed. Additionally, all regression analyses were adjusted for age, sex, type of surgery and hospital to account for potential confounding. Two analyses were performed for the ordinal outcome using ordinal logistic regression: one unadjusted and one adjusted for the aforementioned variables. Similarly, the secondary outcomes, comprising the total number of IDUCs and CICs inserted, were also analysed with ordinal logistic regression, following the same method used for the primary outcomes. These analyses generated common ORs to describe the likelihood of differences in catheter use categories between the after group and the before group. We opted for ordinal logistic regression instead of simple binary logistic regression to increase statistical power.[23] Statistical significance was determined at the alpha=0.05 level, with 95% CIs excluding 1 indicating statistical significance. Given that less than 5% of the data were missing, the exclusion of patients with missing values was deemed to have a minimal impact on the analysis.[24] Prior to the study, no formal power calculation was conducted due to the uncertainty regarding the frequency of IDUC insertions and CICs perioperatively

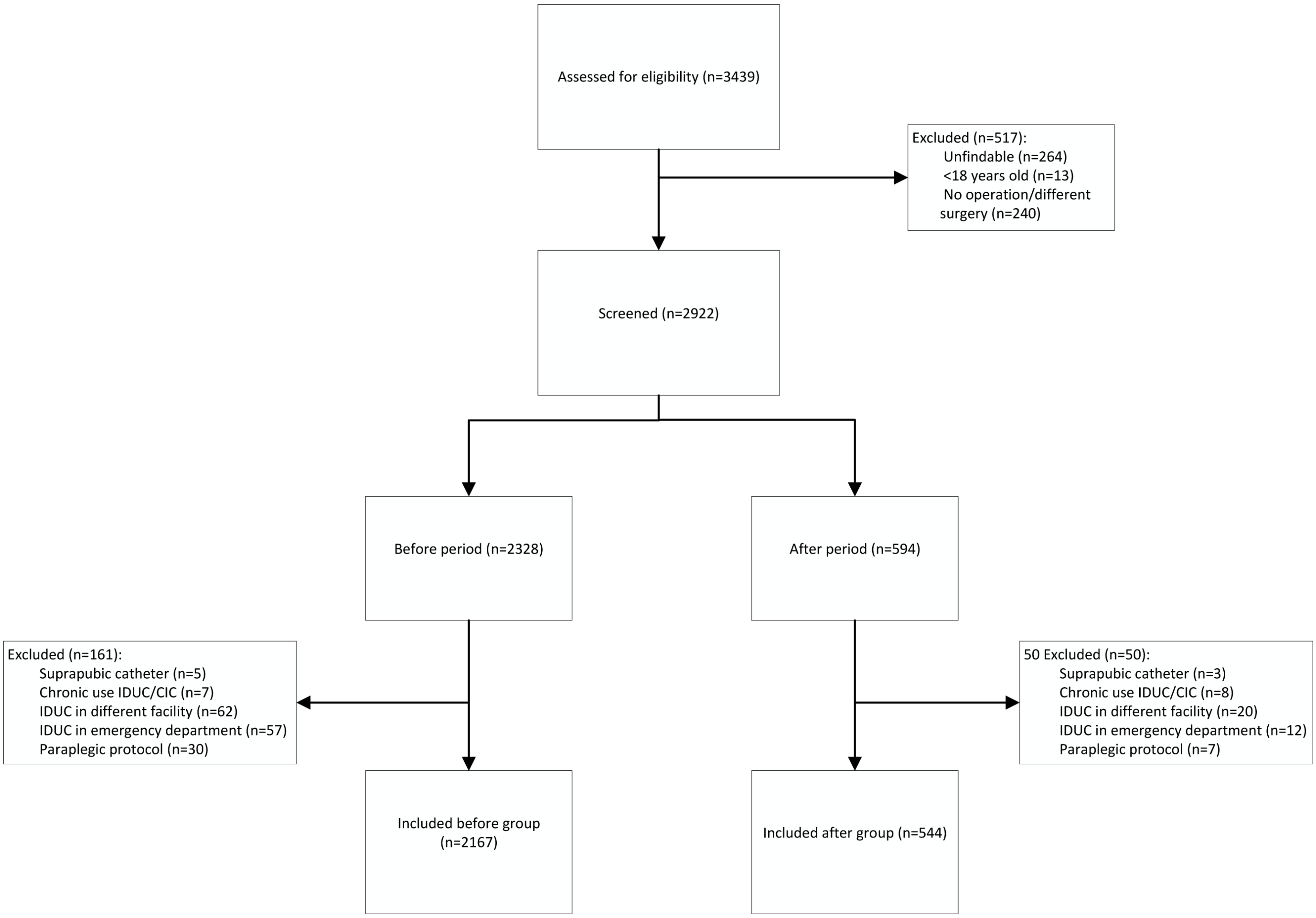

Figure 1 Flow chart of patient selection for the before-and-after study groups. CIC, clean intermittent catheterisation; IDUC, including indwelling urinary catheterisation.

and postoperatively. Additionally, the number of surgeries performed was impacted by the COVID-19 pandemic.[25]

RESULTS

A total of 3439 patients were admitted for either transsphenoidal pituitary gland tumour surgery or spinal fusion surgery and 2922 patients underwent screening (figure 1). After exclusions, the before group comprised 2167/2711 (80%) patients, while the after group consisted of 544/2711 (20%) patients.

The characteristics of the study population are presented in table 1, comparing the before (n=2167) and after (n=544) periods. The gender distribution shifted from 45.7% male and 54.3% female in the before period to 42.3% male and 57.7% female during the after period. The mean duration of surgery was 146.8 min in the

Table 1 Characteristics of neurosurgical patients before and after the implementation

	Before (n=2167)	After (n=544)	Total (n=2711)	Missing
Gender, n (%)				0
Male	991 (45.7)	230 (42.3)	1221 (45.0)	
Age, mean (SD)	59.1 (15.1)	60.8 (15.1)	59.4 (15.1)	0
Body mass index, mean (SD)	27.1 (5.2)	27.2 (5.1)	27.1 (5.2)	27
Duration of surgery in minutes, mean (SD)	146.8 (92.0)	149.6 (99.5)	147.4 (93.6)	15
Surgery type, n (%)				0
Pituitary	395 (18.2)	105 (19.3)	500 (18.4)	
Spondylosis	1321 (61.0)	304 (55.9)	1625 (59.9)	
Trauma/tumour debulking	451 (20.8)	135 (24.8)	586 (21.6)	

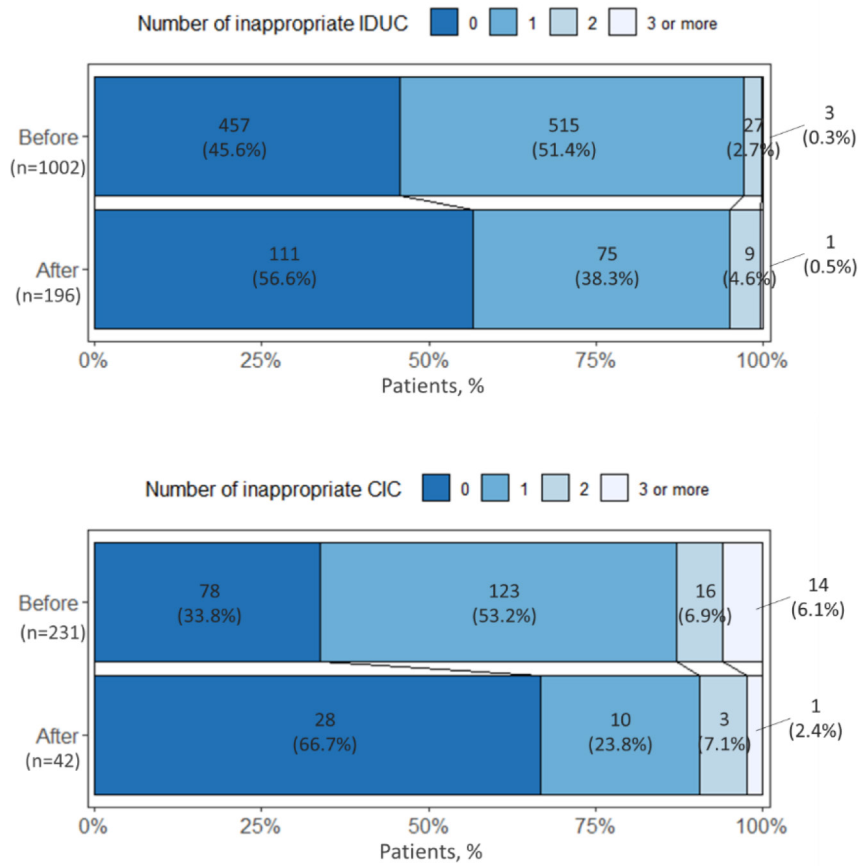

Figure 2 Distribution of inappropriate indwelling urinary catheterisation (IDUC) and clean intermittent catheterisation (CIC). The bar charts illustrate the distribution of inappropriate IDUC (top) and inappropriate CIC (bottom) in the before-and-after groups. The numbers inside the bars represent the absolute number of patients, while percentages indicate the proportion of patients within each group. The colours represent the number of catheterisations a patient received: 0 (dark blue): No catheterisation; 1 (medium blue): 1 catheterisation; 2 (light blue): Two catheterisations; 3 or more (very light blue): 3 or more catheterisations.

before period, compared with 149.6 min during the after period. Regarding the types of surgery, pituitary surgeries accounted for 18.2% of the patients in the before group and 19.3% in the after group; spondylodesis accounted for 61.0% (before group) and 55.9% (after group); and trauma or tumour debulking comprised 20.8% (before group) and 24.8% (after group). To assess whether the distribution of surgery types differed significantly between the before-and-after groups, we performed a χ^2 test. The overall distribution did not show a significant difference (χ^2=5.37, p=0.068). However, when analysed per surgery type, a significant shift was observed in the proportion of spondylodesis (χ^2=4.46, p=0.035) and trauma/tumour debulking surgeries (χ^2=3.88, p=0.049), while the distribution of pituitary surgeries remained unchanged (χ^2=0.27, p=0.61).

The Grotta chart in figure 2 visually represents the distribution between appropriately and inappropriately IDUC and CIC, highlighting a trend towards more appropriate catheter placements in the after group. The percentage of patients without inappropriate IDUC increased from 45.6% to 56.6%, while those with one inappropriate IDUC decreased from 51.4% to 38.3%. For CIC, the improvement was even more pronounced: the percentage of patients without inappropriate CIC more than doubled, rising from 33.8% to 66.7%, and those with one inappropriate CIC decreased from 53.2% to 23.8%. When examining more instances of catheter use, there was a slight increase in patients with two inappropriate IDUCs, from 2.7% to 4.6%, and two inappropriate CICs, from 6.9% to 7.1%.

Figure 3 shows a reduction in overall catheter use. The percentage of patients without any IDUC increased from 53.7% to 64.0%, and those with one IDUC decreased from 43.5% to 32.2%. However, the proportion of patients with two or more IDUCs slightly increased, from 2.5% to 3.5%. Similarly, for CIC, the percentage of patients not requiring any CIC rose from 89.1% to 92.3%, while those receiving one CIC decreased from 8.1% to 6.2%.

Table 2 confirms these trends through ordinal logistic regression. The unadjusted OR of 0.68 (95% CI: 0.48 to 0.96) indicates that patients in the after group are significantly less likely to receive inappropriate IDUCs compared with the before group, as the 95% CI excludes one. The adjusted OR of 0.72 (95% CI: 0.52 to 1.05) shows a similar trend but does not reach statistical significance.

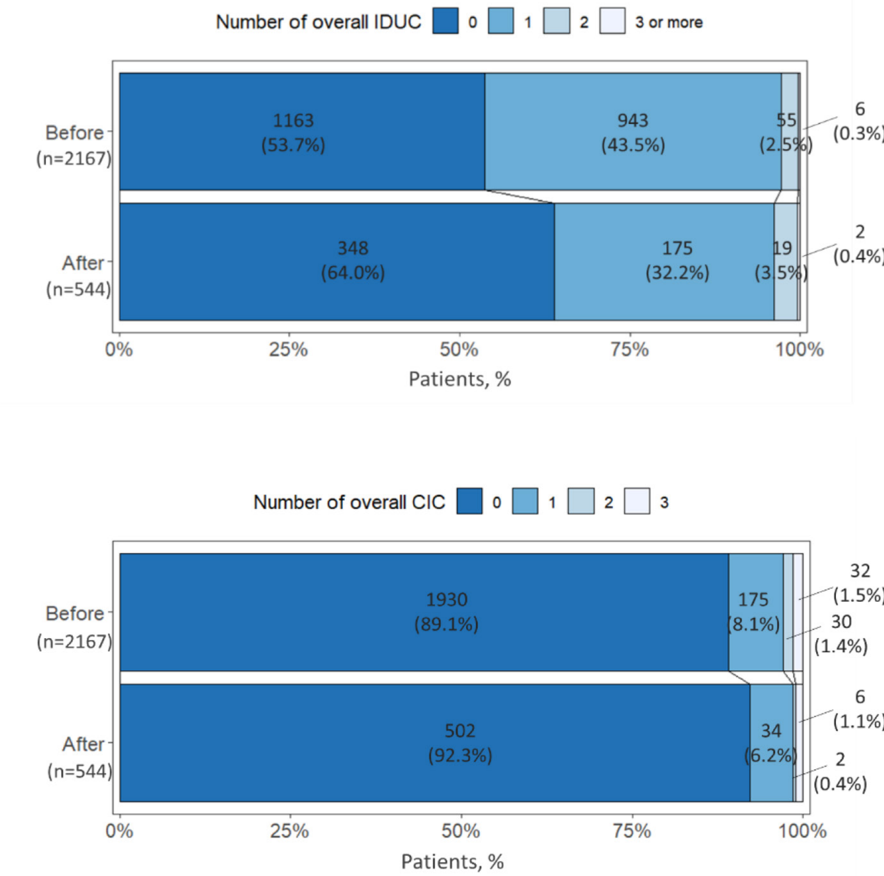

Figure 3 Distribution of total indwelling urinary catheterisation (IDUC) and clean intermittent catheterisation (CIC). The bar charts display the overall distribution of total IDUC (top) and total CIC (bottom) in the before-and-after groups. The numbers inside the bars indicate the absolute number of patients, and percentages show the proportion of patients within each group. The colours represent the number of catheterisations a patient received: 0 (dark blue): No catheterisation; 1 (medium blue): 1 catheterisation; 2 (light blue): 2 catheterisations; 3 or more (very light blue): 3 or more catheterisations.

For inappropriate CIC placement, the unadjusted OR is 0.28 (95% CI: 0.14 to 0.56), and the adjusted OR is 0.25 (95% CI: 0.13 to 0.51), both indicating statistically significant reductions. For total catheter use, the unadjusted OR for IDUCs is 0.68 (95% CI: 0.55 to 0.82), and the adjusted OR is 0.61 (95% CI: 0.50 to 0.76), both showing statistically significant decreases. For CIC, the unadjusted OR of 0.68 (95% CI: 0.50 to 0.92) indicates a significant decrease, while the adjusted OR of 0.74 (95% CI: 0.51 to 1.02) reflects a non-significant trend. In addition to reductions in inappropriate catheter use, the total number of catheters used is lower in the after group. For IDUC, both the unadjusted OR of 0.68 (95% CI: 0.55 to 0.82) and the adjusted OR of 0.61 (95% CI: 0.50 to 0.76) indicate a significant reduction. For CIC, the unadjusted OR of 0.68 (95% CI: 0.50 to 0.92) indicates a significant

Table 2 Ordinal logistic regression analysis for total and inappropriate indwelling urinary catheterisation and clean intermittent catheterisation

	Before mean* (SD)	After mean* (SD)	Unadjusted common OR (95% CI)	Adjusted† common OR (95% CI)‡
Number of inappropriate IDUC	0.58 (0.56)	0.49 (0.61)	0.68 (0.48 to 0.96)	0.72 (0.52 to 1.05)
Number of inappropriate CIC	0.85 (0.79)	0.45 (0.74)	0.28 (0.14 to 0.56)	0.25 (0.13 to 0.51)
Number of total IDUC	0.49 (0.56)	0.40 (0.57)	0.68 (0.55 to 0.82)	0.61 (0.50 to 0.76)
Number of total CIC	0.15 (0.50)	0.10 (0.40)	0.68 (0.50 to 0.92)	0.74 (0.51 to 1.02)

*Mean number of catheters per patient.
†Adjusted analyses included age, sex, type of surgery and hospital affiliation.
‡95% CIs excluding 1 indicate statistical significance at alpha=0.05 level.
CIC, clean intermittent catheterisation; IDUC, indwelling urinary catheter.

Table 3 Urinary tract infections and length of hospital stay			
	Before (n=2167)	After (n=544)	Total (n=2711)
Urinary tract infection, n (%)	31 (1.4)	7 (1.3)	38 (1.4)
Male	7 (22.6)	4 (57.1)	11 (29.0)
Female	24 (77.4)	3 (42.9)	27 (71.1)
Length of hospital stay in days, mean (SD)	4.9 (6.9)	5.1 (7.6)	4.9 (7.0)

decrease, while the adjusted OR of 0.74 (95% CI: 0.51 to 1.02) suggests a non-significant trend towards reduced total CIC use.

UTI rates and the average length of hospital stay during the before-and-after periods are presented in table 3. In the before period, the UTI rate was 1.4%, which decreased to 1.3% in the after period. The mean hospital stay duration was 4.9 days in the before period and increased slightly to 5.1 days during the after period.

DISCUSSION

In this multicentre study, implementing a standardised protocol significantly reduced the inappropriate and overall use of IDUC and CIC in patients undergoing pituitary gland tumour and spinal fusion surgery. Unadjusted odds were significant across all categories; however, adjusted odds remained significant only for inappropriate CIC and overall IDUC. This finding is consistent with previous research, indicating that targeted strategies can effectively change behaviours and contribute to organisational change.[26 27]

The shift towards fewer inappropriate IDUCs and CICs reinforces current clinical guidelines and research advocating for minimising unnecessary urinary catheter use to reduce the risk of catheter-related bloodstream infections and other complications.[9 12] This reduction is crucial for the quality of care and patient safety and reflects the healthcare sector's broader transition towards less invasive, conservative and patient-centred care practices.[28–30] However, our study noted a slight increase in patients with two or more inappropriate IDUCs and CICs, suggesting a subgroup with complex needs not fully addressed by the strategy. This finding highlights the need for further research to refine strategies for such patients.[31] The impact on total CIC was less pronounced, yet there was still a modest and promising improvement, as evidenced by the increase in the percentage of patients not requiring CIC. This finding aligns with the literature that suggests a floor effect in certain patient populations, where further reductions are limited by clinical necessity.[32]

The reduction in inappropriate catheter use underscores the importance of strategies that prevent direct harm to patients, including physical injuries and psychological distress caused by unnecessary interventions.[33] The educational programme and local champions were critical in improving adherence to the revised protocol. However, several factors might have influenced the extent of the reduction. Clinician adherence to new protocols may vary, influenced by individual preferences, experiences and perceptions of guideline efficacy.[34] Integrating catheterisation responsibilities, traditionally under the purview of physicians, into the nursing domain could enhance protocol adherence.[35] Complex patient conditions impact catheterisation needs, possibly explaining the limited reduction in perceived inappropriate use.[36] The necessity to conduct part of the training online due to COVID-19 might have led to suboptimal adherence to the new protocol. Online training, while accessible and scalable, often lacks the interactive components and immediate feedback inherent to in-person training, which are critical for ensuring comprehensive understanding and practical application of new guidelines.[37] Existing practices and institutional culture at various hospitals can affect the implementation of new strategies, with longstanding practices posing challenges to adopting new guidelines.[38]

The stable duration of hospital stays in our study is promising, echoing findings from previous research. Studies have reported that strategies aimed at reducing catheter usage do not prolong hospitalisation and are associated with a decrease in catheter-associated UTIs.[39 40] This reinforces the potential of such measures to enhance patient outcomes without compromising the quality of care.[41] A possible explanation for the unchanged hospital stay in our study, despite the reduction in both total and inappropriate IDUC and CIC use, lies in differences between the before-and-after groups. The after group included a higher proportion of trauma/tumour debulking surgeries, a slightly older patient population, and longer surgical durations, all of which can impact recovery time. These findings suggest that while optimising catheterisation reduces unnecessary interventions, hospital stay is influenced by multiple factors beyond catheter use. Additionally, a χ^2 test revealed a significant difference in the distribution of surgery types between the before-and-after groups, specifically for spondylodesis and trauma/tumour debulking surgeries. However, given that our adjusted analyses accounted for surgery type, alongside age, sex and hospital affiliation, the observed reductions in catheter use are unlikely to be solely driven by shifts in surgical case distribution.

Strengths and limitations

Our study has several strengths. First, our study's multicentre approach, involving four hospitals, enhances the generalisability of our findings. The inclusion of university, teaching and general hospitals suggests that our results may be applicable across a broad spectrum of clinical environments and patient populations. Second, the detailed data collection by a team of researchers, nurses and assistants ensures the accuracy and consistency of our patient data. Third, standardised protocols contributed to the reliability of the data.

Several limitations should be acknowledged. First, the shorter postintervention period, primarily due to the COVID-19 pandemic, may have limited the full impact of the intervention. This was further compounded by the prolonged uncertainty regarding whether the study could proceed, as well as the cancellation of surgeries during the pandemic, which disrupted normal clinical workflows and potentially delayed the implementation of the new protocol. Second, the challenge of varying pre-existing catheterisation protocols across participating hospitals also posed a significant obstacle to uniform adherence. In particular, hospitals with prestudy protocols that diverged more remarkably from the study protocol—especially regarding thresholds for urinary retention volumes or residual urine levels and the criteria for catheterisation—required greater adaptability from nursing staff compared with hospitals whose existing protocols were already more closely aligned. While we have adjusted in our analysis to accommodate these differences, the diversity of prestudy practices may have influenced adherence to the newly implemented protocol. Third, although the implementation plan was conducted as intended, certain limitations may have influenced its feasibility. Variations in hospital logistics and the ongoing impact of the COVID-19 pandemic posed challenges to reaching all staff. Staff shift patterns made it difficult to ensure complete attendance at training sessions. To address this, we focused on repeated sessions and localised adaptations to maximise participation. Nevertheless, it is possible that not all staff members, including newly hired and existing staff, were able to fully complete the educational program during the study period.

Future research

Future efforts should focus on developing a clear, measurable action plan to sustain the outcomes observed in this study. This plan could include strategies such as ongoing training, regular audits and structured feedback loops to reinforce adherence to the protocol over time. Additionally, future research should evaluate the long-term sustainability of these strategies, particularly under varying hospital conditions and external challenges such as pandemics. Expanding this intervention to other surgical specialties could enhance patient care across various clinical contexts, and its principles may be applicable to other areas of healthcare, such as intravenous line placements or interdisciplinary task distribution. To conclude, future studies should also systematically evaluate staff engagement and experiences during the implementation phase.

CONCLUSIONS

This multicentre study demonstrates that implementing a uniform urinary catheter protocol in multiple hospitals through an educational programme leads to improved postoperative quality of care in neurosurgical patients after pituitary gland tumour or spinal fusion surgery. By significantly reducing total IDUC and inappropriate CIC, this study aligns with the trend towards patient-centred, less invasive healthcare practices. It underscores the importance of ongoing education, strict adherence to standardised protocols and the integration of practices in both medical and nursing fields.

Multiple hospitals through an educational programme lead to improved postoperative quality of care in neurosurgical patients after pituitary gland tumour or spinal fusion surgery. By significantly reducing total IDUC and inappropriate CIC, this study aligns with the trend towards patient-centred, less invasive healthcare practices. It underscores the importance of ongoing education, strict adherence to standardised protocols and the integration of practices in both medical and nursing fields.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Medical Ethics Committee Leiden The Hague Delft (N20.152). Ethical approval was obtained on 26 October 2020, from the Medical Ethics Committee of the Leiden

University Medical Centre, along with a waiver for patient consent. This waiver was granted because the study focused on quality improvement, posed negligible risk to patients and would have been impractical to conduct without it. Local feasibility was approved by the institutional review boards of all participating hospitals. The study is registered in the Netherlands Trial Register.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. The data consist of deidentified participant data and can be requested from Jeanne-Marie Nollen at j.m.nollen@lumc.nl, ORCID ID: 0000-0002-1241-5380. Reuse of the data is permitted but should be discussed and agreed on with the researchers beforehand. The study protocol has been previously published (ISSN: 2640-1002). Statistical codes used in the study are also available on reasonable request from the same contact.

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