(Re)defining nurse and patient roles in routine postoperative neurosurgical care: empowering autonomy and strengthening collaborative roles

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Chapter 6
Improving postoperative care for neurosurgical patients by a standardized protocol for urinary catheter placement: a multicentre before-and-after implementation study

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Abstract

Introduction
Urinary catheterization, including indwelling and clean intermittent catheterization, is common in peri- and postoperative care. Despite guidelines, practice variation is significant. Inappropriate catheterization 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 catheterization in neurosurgical groups frequently subjected to catheterization.

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 program, and department-specific champions. Primary outcome was inappropriate catheterization, analysed with ordinal logistic regression. Secondary outcomes included total catheterizations, urinary tract infections, and length of hospital stay. Ethical approval was obtained. STROBE and SQUIRE checklists were used.

Results
Among 3,439 patients screened, 2,711 were included, with 544 in the after group. The percentage of patients without inappropriate indwelling catheterization increased from 46% to 57%, and the proportion without inappropriate clean intermittent catheterization 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 catheterization 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 catheterization in neurosurgical patients, aligning with patient-centred, less invasive healthcare. Ongoing education and adherence to standardized protocols are crucial. Future research should assess the long-term sustainability of these strategies.

What is already known on this topic
Urinary catheterization, including indwelling urinary catheterization (IDUC) and clean intermittent catheterization (CIC), is commonly used in peri- and postoperative care. Despite international guidelines, there is considerable variation in practice, leading to inappropriate catheterization 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 program, can significantly reduce inappropriate and overall catheter use in neurosurgical patients. It also highlights the importance of department-specific champions in improving adherence to standardized protocols.

How this study might affect research, practice, or policy
The findings underscore the potential of standardized protocols and continuous edu-

cation 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 peri- and postoperative care settings, urinary catheterization, which includes both indwelling urinary catheterization (IDUC) and clean intermittent catheterization (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, post-void residual, prolonged surgery, and prolonged bed rest. (1, 2) Postoperative urinary retention is defined as the patient's inability to void, while post void-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 peri- and postoperative urinary retention, post-void residual, prolonged postoperative bed rest, and operation duration in urinary catheterization 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 catheterization, 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 minimize their use to enhance the quality of patient care. Among these risks, urinary tract infections (UTIs) frequently occur: IDUC elevates infection rates by 5 to 10% for each day of use, while the CIC infection rates range from 0.5 to 20% per catheterization 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 minimizing both general and unnecessary catheterization 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 catheterization 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 to 4 hours, and the standard procedure encouraging early postoperative mobilization, provided there are no complications like cerebrospinal fluid leakage. (16)

Considering the challenges stemming from the absence of standardized practices and thresholds, combined with the identified risks of inappropriate catheterization, these

two patient cohorts provide a unique context for studying the reduction of inappropriate use, and refinement of standardized 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 peri- and postoperative IDUC and CIC. Before data was collected from 2018 to 2021. The strategy was introduced from January 1, 2022, to May 30, 2022. Data for the after period was collected from June 1, 2022, to December 31, 2022. To enhance the clarity and transparency of our study reporting, we utilized the STROBE and 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 categorized 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 urinary tract infections 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 standardize care and reduce variability in clinical decisions across different hospitals, we developed a uniform protocol for IDUC, CIC, and urinary tract infections 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 minutes, (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 ≥ 10^5 CFU/ml in the urine sediment, (b) leukocyte count > 5 leukocytes 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 program to the needs of their respective hospitals. Local champions collaborated with the research group in developing the educational program and participated in its delivery. The primary researcher held two-monthly meetings with these local champions to monitor compliance and provide feedback.

An educational program, 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 program 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 optimize the program'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 program 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 three-monthly meetings to address challenges and reinforce adherence. The training utilized 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 program 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 program 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, urinary tract infections and length of hospital stay.

Statistical analysis

Data were analysed with SPSS version v29.0. Descriptive analyses are presented as raw numbers and percentages. Continuous data are presented as means with standard deviations. 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 Chi-square 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 odds ratios (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% confidence intervals excluding 1 indicating statistical significance. Given that less than 5% of the data was 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 peri- and postoperatively. Additionally, the number of surgeries performed was impacted by the COVID-19 pandemic.

Ethics

Ethical approval was obtained on October 26, 2020, from the Medical Ethics Committee, accompanied by a waiver for patient consent. This provision was granted due to the study's engagement in quality improvement, which posed a negligible risk to patients, coupled with the impracticality of conducting the study without such a waiver. Local feasibility was approved by the local institutional review boards of all participating hospitals. The study protocol has been published previously. (25) The study is registered in the Netherlands Trial Register.

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.

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

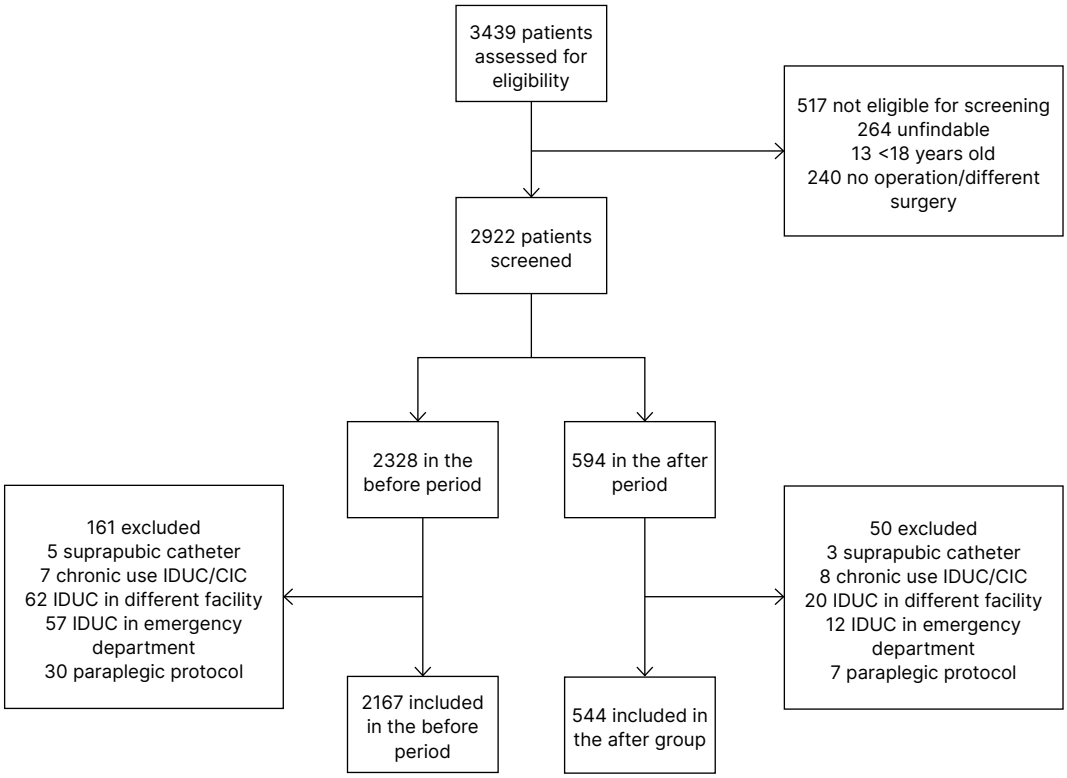


Table 1: Characteristics of neurosurgical patients before and after the implementation

	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)	
Spondylodsis	1321 (61.0)	304 (55.9)	1625 (59.9)	
Trauma/tumour debulking	451 (20.8)	135 (24.8)	586 (21.6)	

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 minutes in the before period, compared to 149.6 minutes 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 Chi-square test. The overall distribution did not show a significant difference (χ^2=5.37, p=0.068). However, when analyzed per surgery type, a significant shift was observed in the proportion of spondylodesis (χ^2=4.46, p=0.035) and trauma/tumor 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%.

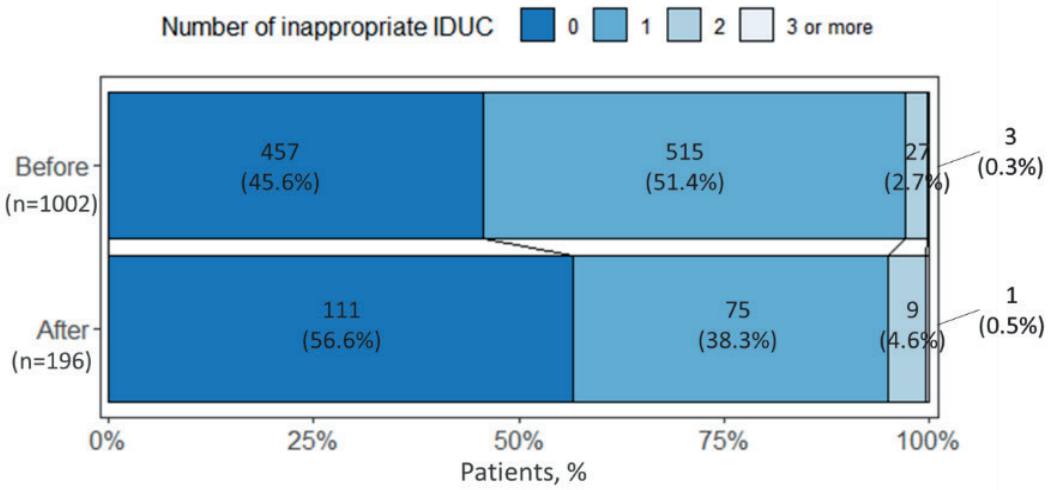
Table 2: Ordinal logistic regression analysis for total and inappropriate indwelling urinary catheterization and clean intermittent catheterization.

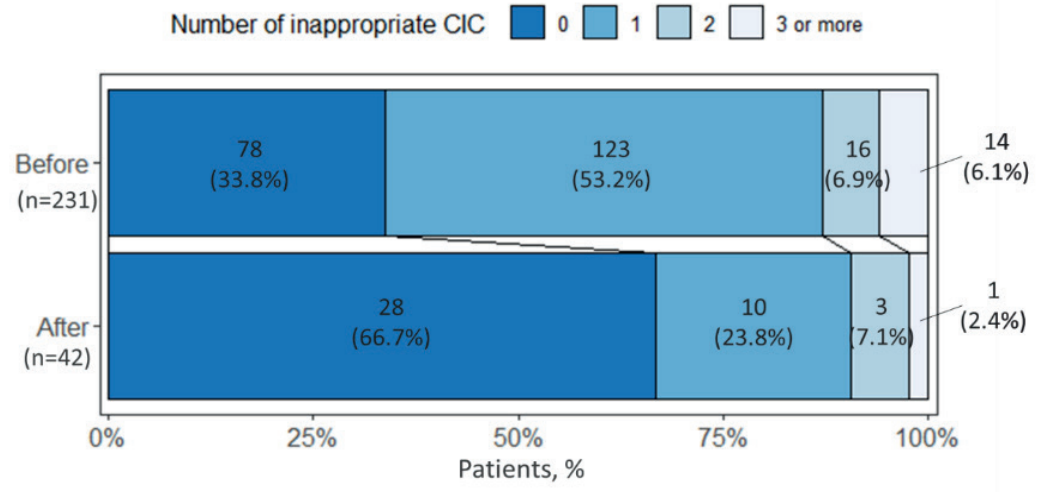
	Before *Mean* (SD)*	**After** *Mean* (SD)*	**Unadjusted common odds ratio** *(95% CI)*	**Adjusted** Common odds ratio** *(95% CI)+*
Number of inappropriate IDUC	0.58 (0.56)	0.49 (0.61)	0.68 (0.48-0.96)	0.72 (0.52-1.05)
Number of inappropriate CIC	0.85 (0.79)	0.45 (0.74)	0.28 (0.14-0.56)	0.25 (0.13-0.51)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

Legend: * Mean number of catheters per patient, ** Adjusted analyses included age, sex, type of surgery and hospital affiliation,+ 95% confidence intervals excluding 1 indicate statistical significance at alpha = 0.05 level. IDUC: indwelling urinary catheter CIC: clean intermittent catheterization

Figure 2: Distribution of inappropriate indwelling urinary catheterization (IDUC) and clean intermittent catheterization (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.





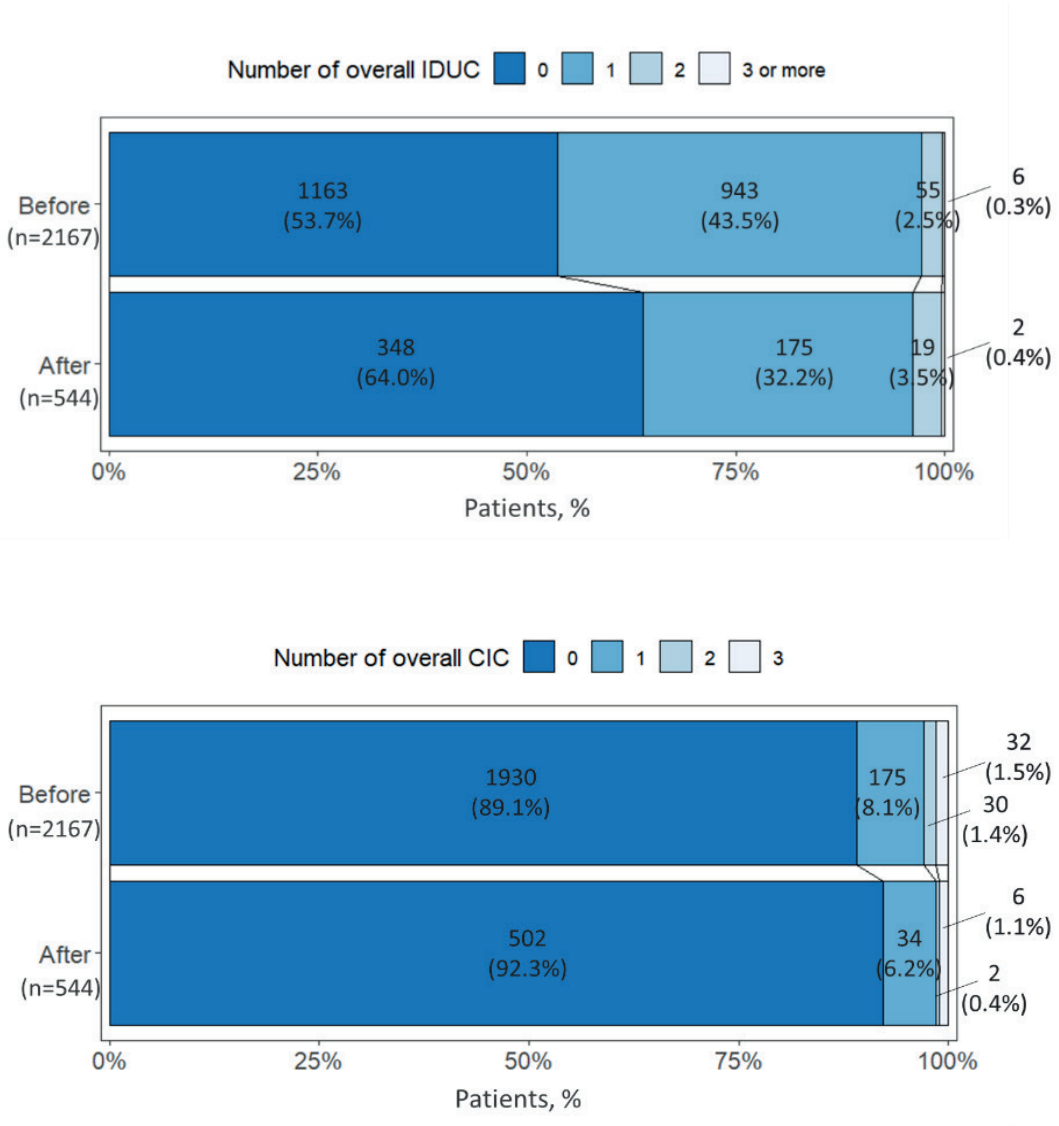
Legend

The colors represent the number of catheterizations a patient received:

- 0 (dark blue):
  No catheterization
- 1 (medium blue):
  One catheterization
- 2 (light blue):
  Two catheterizations
- 3 or more (very light blue): Three or more catheterizations

Figure 3: Distribution of total indwelling urinary catheterization (IDUC) and clean intermittent catheterization (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.



Legend

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Table 2 confirms these trends through ordinal logistic regression. The unadjusted OR of 0.68 (95% CI: 0.48–0.96) indicates that patients in the after group are significantly less likely to receive inappropriate IDUCs compared to the before group, as the 95% confidence interval excludes one. The adjusted OR of 0.72 (95% CI: 0.52–1.05) shows a similar trend but does not reach statistical significance. For inappropriate CIC placement, the unadjusted OR is 0.28 (95% CI: 0.14–0.56), and the adjusted OR is 0.25 (95% CI: 0.13–0.51), both indicating statistically significant reductions. For total catheter use, the unadjusted OR for IDUCs is 0.68 (95% CI: 0.55–0.82), and the adjusted OR is 0.61 (95% CI: 0.50–0.76), both showing statistically significant decreases. For CIC, the unadjusted OR of 0.68 (95% CI: 0.50–0.92) indicates a significant decrease, while the adjusted OR of 0.74 (95% CI: 0.51–1.02) 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: 0.55–0.82) and the adjusted OR of 0.61 (95% CI: 0.50–0.76) indicate a significant reduction. For CIC, the unadjusted OR of 0.68 (95% CI: 0.50–0.92) indicates a significant decrease, while the adjusted OR of 0.74 (95% CI: 0.51–1.02) suggests a non-significant trend towards reduced total CIC use.

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)

Legend: SD = standard deviation

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 standardized 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 organizational change. (26, 27)

The shift towards fewer inappropriate IDUCs and CICs reinforces current clinical guidelines and research advocating for minimizing 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 program 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 catheterization responsibilities, traditionally under the purview of physicians, into the nursing domain could enhance protocol adherence. (35) Complex patient conditions impact catheterization 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 hospitalization 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/tumor debulking surgeries, a slightly older patient population, and longer surgical durations, all of which can impact recovery time. These findings suggest that while optimizing catheterization reduces unnecessary interventions, hospital stay is influenced by multiple factors beyond catheter use. Additionally, a Chi-square test revealed a significant difference in the distribution of surgery types between the before and after groups, specifically for spondylodesis and trauma/tumor 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 generalizability 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, standardized protocols contributed to the reliability of the data.

Several limitations should be acknowledged. First, the shorter post-intervention 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 catheterization protocols across participating hospitals also posed a significant obstacle to uniform adherence. In particular, hospitals with pre-study protocols that diverged more remarkably from the study protocol—especially regarding thresholds for urinary retention volumes or residual urine levels and the criteria for catheterization—required greater adaptability from nursing staff compared to hospitals whose existing protocols were already more closely aligned. While we have adjusted in our analysis to accommodate these differences, the diversity of pre-study 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 localized adaptations to maximize 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.

Conclusion

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 toward patient-centred, less invasive healthcare practices. It underscores the importance of ongoing education, strict adherence to standardized protocols, and the integration of practices in both medical and nursing fields.

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