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Reorganising routine suprapubic catheter care in Germany: a regional health services analysis, provider survey and economic modelling of a mobile decentralised care model

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Abstract

Background: Routine suprapubic catheter (SPC) changes are recurrent health-service contacts, often involving older, mobility-impaired or care-dependent patients. German evidence on where SPC changes occur, the resources used across the care pathway, and the potential for home-based delivery is fragmented. We analysed regional SPC care and modelled a physician-governed, nurse-led mobile decentralised care model (MDC).

Methods: We conducted a non-interventional health-services and economic study in Würzburg, Germany. Components were: (1) a retrospective full-year analysis of routine, administrative and cost data for all SPC-change presentations at University Hospital Würzburg (UKW) in 2025; (2) a census-style survey of regional urology provider units; and (3) scenario-based economic and organisational modelling of an mobile decentralised care model (MDC) for planned follow-up changes. Repeated hospital presentations were analysed using generalized estimating equations. Direct personnel and material resources and modelled ambulance transport resources were estimated; MDC scenarios varied tour size and key cost assumptions.

Results: At UKW, 1,143 SPC-change presentations involved 244 patients (mean age 70.0 years); 191 presentations (16.7%) occurred outside regular working hours and 187 (16.4%) involved medically organised transport. Direct hospital personnel and material resources were €55.49 per change in the base case. A full ambulance round trip was modelled at €175.97, yielding €231.46 for a hospital change with ambulance transport. Six of seven regional provider units responded, reporting at least 2,294 SPC changes in 2025; four of six rated the service economically unattractive and

none planned to increase provision. In the MDC, a single mobile visit cost €74.76; serial routing reduced direct modelled cost to €64.56 per change at six changes per tour. Compared with the hospital-plus-ambulance pathway, this represented a modelled resource difference of €166.90 (72.1%) per transport-dependent case.

Conclusions: The main resource opportunity in routine SPC care lies in redesigning the whole care pathway rather than reducing the technical cost of catheter replacement alone. A targeted MDC may complement existing services for transport-dependent patients and warrants prospective evaluation of safety, real-world costs, avoided transports, patient experience and quality of life.

Keywords: suprapubic catheter; health services research; health economics; home care; decentralised care; nursing; patient transport; Germany

Background

Long-term urinary catheterisation creates a recurrent care pathway rather than a single clinical event. Catheter users are frequently older and multimorbid, and changes, blockages, infections and other catheter-related problems can generate repeated contacts across primary, community and hospital care. German studies have documented substantial catheter use and marked heterogeneity in where catheter changes are performed, but the evidence base remains fragmented across settings [1-4]. In a nationwide survey of German nursing homes, urologists performed most suprapubic catheter changes in 88.3% of participating facilities, while the proportion of residents receiving catheter changes within the nursing home varied widely [4].

International studies suggest that the organisation surrounding long-term catheter care is an important determinant of health-service use and cost. In England, hospital use accounted for almost half of observed catheter-related service costs in a population-based analysis, and urgent or out-of-hours contacts were common [5]. A separate UK study found that many catheter-related emergency department presentations could be managed without specialist urological intervention and highlighted limited community support as a service-level contributor [6]. These findings indicate that transport, accessibility, service availability and escalation pathways can matter as much as the technical catheter procedure itself.

Suprapubic catheter changes are generally standardisable follow-up procedures in appropriately selected patients, but safe delivery requires trained staff, aseptic technique and a defined route for escalation when the tract, catheter passage or

clinical situation is not routine [7]. This creates a potential opportunity for a targeted home- or nursing-facility-based service, particularly for patients whose travel to a clinic or hospital requires substantial assistance or medical transport.

German routine and reimbursement data do not provide a complete cross-sector picture of how many routine SPC changes are performed, how much patient transport they generate, or how provider incentives influence capacity. We therefore analysed the regional SPC care pathway in the city and district of Würzburg. The objectives were to quantify hospital utilisation and direct resources, examine transport-associated resource use and repeated contacts, describe the perspective and capacity of regional urology providers, and use these empirical findings to develop and economically model a physician-governed, nurse-led mobile decentralised care model (MDC) for planned follow-up SPC changes.

Methods

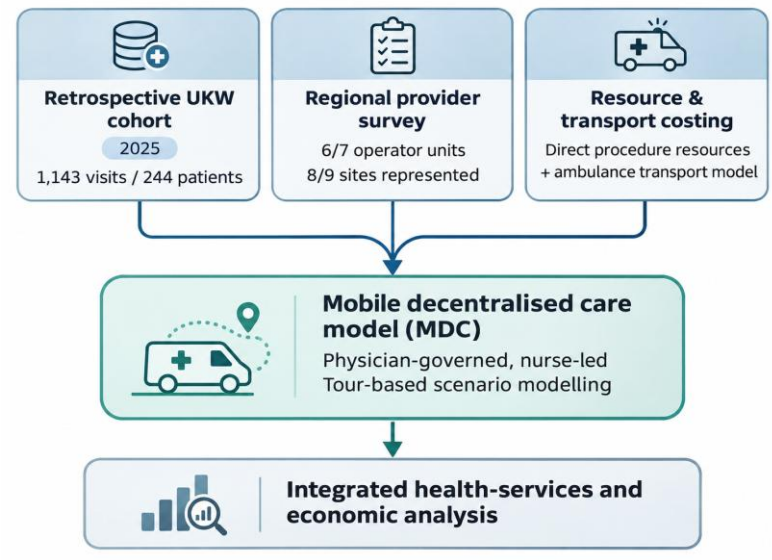
Study design and setting

This non-interventional health-services and economic study combined three components: a retrospective analysis of hospital routine data, a regional provider survey, and scenario-based modelling of an alternative mobile care pathway. The retrospective observation period was 1 January to 31 December 2025. The study was set in the city and district of Würzburg in northern Bavaria, Germany, a mixed urban-rural region centred on a university hospital. The observational reporting was informed by STROBE [8], and the reporting of resource use, cost assumptions and uncertainty was informed by CHEERS 2022 [9].

The hospital component was conducted at the Department of Urology and Paediatric Urology, University Hospital Würzburg (UKW), a tertiary university centre providing scheduled outpatient and 24-hour urgent urological care. No prospective recruitment, additional examination or alteration of patient treatment was performed.

The three analytical components and their synthesis into the MDC are summarised in Fig. 1.

Figure 1. Study design and analytical synthesis



Hospital population and variables

All statutory-health-insurance patients with a documented SPC change at UKW during 2025 were included. Each documented change was treated as a presentation-level service contact; repeated contacts were linked by a pseudonymised patient identifier. A patient-quarter was defined as one unique patient within one calendar quarter to describe recurrence under the quarterly outpatient reimbursement structure.

Variables included age, date and time of presentation, ambulatory versus inpatient disposition, transport mode, five-digit residential postcode, and repeated presentations. Direct identifiers were not included in the analysis dataset. Presentations outside predefined regular working hours were classified as safely identifiable emergency presentations because routine scheduled SPC changes were not performed during those periods. Presentations within regular working hours could include both scheduled and urgent contacts and were therefore not classified by urgency.

Direct resource and transport costing

Direct hospital resources were estimated from an internal process mapping of registration, preparation, SPC change and post-procedure activities. Staff time was valued using applicable 2025 employment tariffs and employer on-costs; materials were valued at internal procurement prices. The base-case direct hospital resource estimate was supplemented by minimum and maximum scenarios that varied staff time and optional material use.

Transport resources were estimated from regional 2025 ambulance tariffs obtained from the two principal providers serving the analysed pathway. For the covered 90% share of ambulance transports, the model used a 75%/25% provider distribution based on institutional information. Because patient-level road kilometres were unavailable, straight-line distances were multiplied by 1.3 to approximate road distance, a conservative detour factor within the range reported in geographic accessibility research [11]. Physician-inclusive emergency transports were not

monetised because comparable transport tariffs were unavailable. The resulting figures are resource estimates rather than observed insurer invoices.

Regional urology provider survey

Nine urology practice sites in the city and district were identified. Because two pairs of sites were operated jointly, these represented seven independent operator units. A census of all seven units was attempted using an emailed cover letter and standardised questionnaire, with one reminder by email or telephone for non-response.

The questionnaire asked whether SPC changes were performed, the number and typical frequency of changes in 2025, perceived economic attractiveness, estimated combined personnel and material effort for an uncomplicated routine change, organisational integration into practice workflow, and future willingness to provide SPC care. Analyses were performed at operator-unit level so that multi-site practices were not weighted twice. Reported costs are provider estimates and not standardised full-cost accounts. For an exploratory test of the economic-attractiveness hypothesis, responses classified as economically unattractive were compared with a 50% reference proportion using a one-sided exact binomial test.

Mobile decentralised care model

The MDC was developed only after analysis of the current pathway and provider survey. It was designed as a physician-governed, nurse-led delegation model for planned follow-up changes of an established SPC. The proposed target group comprises clinically stable patients with previous uncomplicated changes, prioritising people who are transport-dependent, mobility-impaired, care-dependent or living in

nursing facilities. New SPC placement, the first change after placement, an unclear tract, relevant bleeding, systemic infection signs, repeatedly difficult changes, or a need for imaging or intervention trigger exclusion or escalation. International SPC guidance supports competence-based catheter care by trained professionals and defined escalation processes [7,12].

The operational model assumes one qualified nurse per vehicle, a patient-specific physician order/delegation, physician availability for escalation, structured mobile documentation and serial routing across multiple planned visits. The single-visit base case included 45 minutes of on-site nursing time, materials, physician review/delegation time, travel time, vehicle full cost and coordination. The reference one-way road segment was 9.36 km, derived from the observed transport cohort. Tour distance was modelled as (n + 1) × 9.36 km for n planned changes. Home-health routing literature supports explicit modelling of travel and scheduling constraints when evaluating mobile services [13].

The operational base case was six SPC changes per tour. Scenario analyses varied the number of changes per tour and included a 30% overhead sensitivity. The MDC was compared with (a) the direct hospital SPC resource estimate without medical transport and (b) the hospital SPC resource estimate plus a modelled ambulance round trip for transport-dependent cases. These comparisons quantify modelled direct resources and do not represent a formal cost-effectiveness analysis.

Statistical analysis

Categorical variables were summarised as counts and percentages. Continuous variables were described using mean and standard deviation and, where relevant,

median, interquartile range and range. Distributional characteristics were assessed using graphical methods and Shapiro-Wilk tests. Missing values were not imputed.

Because patients could contribute repeated presentations, selected binary associations were analysed using generalized estimating equations (GEE) with binomial distribution, logit link, patient identifier as the cluster, an exchangeable working correlation structure and robust standard errors following Liang and Zeger [10]. Distance was scaled per 10 km. Two-sided p values <0.05 were considered statistically significant. Analyses were exploratory and no adjustment for multiple testing was applied.

Ethics, data protection and patient involvement

The Medical Ethics Committee of Julius-Maximilians-Universität Würzburg reviewed the study in accordance with the Declaration of Helsinki and §15 of the Bavarian Medical Professional Code and raised no ethical or legal objections to its conduct (reference 2026-326-dvhd; decision dated 7 August 2026). The Ethics Committee subsequently confirmed that individual informed consent was not required for the retrospective analysis of routinely collected, pseudonymised patient data. Hospital analyses used pseudonymised routine data stored on institutionally approved systems, and results were reported in aggregate. No prospective patient contact or intervention occurred.

Patient-reported experience was not part of the original empirical dataset. Given the service-redesign focus, patient experience and catheter-related quality of life were subsequently prespecified as priority outcomes for any prospective MDC pilot, informed by the published patient-experience literature.

Use of generative artificial intelligence

ChatGPT (OpenAI) was used to support English-language editing and formatting of the manuscript. OpenAI's image-generation functionality was used to support the graphical design of Figures 1–4 based on author-provided source diagrams, descriptions and numerical results. All figure content and numerical values were independently reviewed and verified by the authors against the original study materials. Generative AI was not used to generate, modify or statistically analyse the study dataset.

Results

Hospital utilisation and recurrent care

During 2025, 1,143 SPC-change presentations were recorded for 244 unique patients. Mean age at the first 2025 presentation was 70.0 years (SD 16.7), with a median of 73 years (IQR 62.8-84.0). Patients had a mean of 4.68 presentations (SD 4.24) during the year; 556 patient-quarters were observed, with a mean of 2.06 presentations per patient-quarter (SD 1.14). Of all presentations, 587 (51.4%) were additional contacts after a patient’s first presentation within the same quarter, demonstrating substantial recurrence within a quarterly care cycle.

Of 1,143 presentations, 191 (16.7%) occurred outside regular working hours and therefore met the operational definition of a safely identifiable emergency presentation. A total of 116 presentations (10.1%) occurred at weekends, 1,047 (91.6%) were managed as ambulatory contacts, and 96 (8.4%) were documented with inpatient admission.

Table 1. Hospital cohort and service-use characteristics

Characteristic	n / estimate	Distribution / proportion
Unique patients	244	-
Age at first 2025 presentation	70.0 ± 16.7 years	Median 73; IQR 62.8-84.0
SPC-change presentations	1,143	-
Presentations per patient	4.68 ± 4.24	Median 3; IQR 1-8; range 1-20
Patient-quarters	556	-
Presentations per patient-quarter	2.06 ± 1.14	Median 2; IQR 1-3; range 1-8
Outside regular working hours	191	16.7%
Weekend presentations	116	10.1%
Ambulatory management	1,047	91.6%
Inpatient admission	96	8.4%
Medically organised transport	187	16.4%

SPC, suprapubic catheter; IQR, interquartile range. Percentages refer to all 1,143 presentations unless stated otherwise.

Transport use and exploratory associations

Medically organised transport was documented for 187 presentations (16.4%): 179 by ambulance and eight with physician-inclusive emergency transport. The remaining 956 presentations had no documented medical transport; this category may include self-arrival as well as taxi or hired-car journeys not identifiable in the routine dataset.

Among the 191 safely identifiable emergency presentations, 94 (49.2%) involved ambulance or physician-inclusive transport compared with 93 of 952 (9.8%) presentations during regular hours. In patient-clustered GEE analysis, emergency presentations had sixfold higher odds of medically organised transport (OR 6.01, 95% CI 3.27-11.06; $p<0.001$) and higher odds of inpatient admission (OR 3.72, 95% CI 2.32-5.94; $p<0.001$). Each additional 10 km of straight-line residential distance was associated with lower odds of medically organised transport (OR 0.62, 95% CI 0.49-0.79; $p<0.001$), an association interpreted as a characteristic of the observed regional pathway rather than a causal effect. Detailed results of the exploratory GEE analyses, including odds ratios, 95% confidence intervals and p values, are provided in Additional file 1: Table S1.

Direct hospital and transport resources

The base-case direct hospital personnel and material resource estimate was €55.49 per SPC change; minimum and maximum scenarios were €39.69 and €86.67. For ambulance presentations, mean straight-line distance was 7.2 km, corresponding to an estimated 9.36-km road distance each way using the predefined factor. Modelled full round-trip costs were €183.70 for the Bayerisches Rotes Kreuz and €152.80 for the Arbeiter-Samariter-Bund. Weighting these providers yielded €175.97 per ambulance transport.

For a transport-dependent presentation, combining the €55.49 direct hospital resource estimate and the €175.97 modelled ambulance transport produced a pathway comparison value of €231.46 per SPC change.

Regional urology provider survey

Six of seven independent operator units responded (85.7%), representing eight of nine identified practice sites (88.9%). All six responding units performed SPC changes; five did so on multiple days per week. Reported annual volumes were 50, 100, 144, 400, approximately 600 and more than 1,000 changes. Using 1,000 as a conservative value for the open-ended response yielded a lower-bound total of 2,294 SPC changes in 2025 among responding units.

Four of six operator units (66.7%) rated SPC change as economically unattractive and two as cost-covering; none rated it economically attractive. The one-sided exact binomial test against a 50% reference proportion was not statistically significant ($p=0.344$), reflecting the small number of operator units. Estimated combined personnel and material effort for an uncomplicated routine change ranged from €6.75

to €40.00 (mean €24.04, SD €12.11; median €22.50). All six estimates exceeded the isolated 2025 German EBM reimbursement item GOP 02322 of €6.57, although other practice-level reimbursement components were not measured [14].

Organisational integration was rated good or very good by three units, neutral by one and burdensome by two. No unit planned to increase SPC provision; three intended to maintain current activity and three intended to reduce it.

Table 2. Regional urology provider survey findings

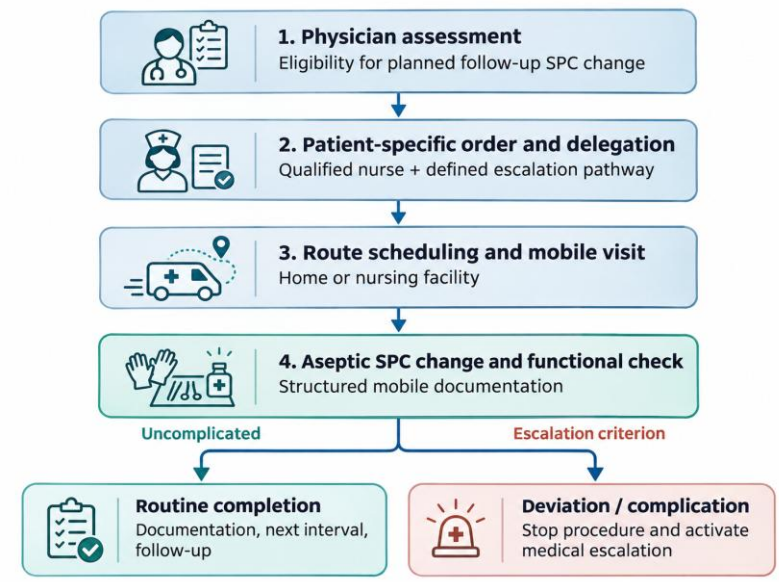
Measure	n / estimate	Proportion / distribution
Independent operator units identified	7	100%
Responding operator units	6	85.7%
Practice sites represented	8/9	88.9%
Units performing SPC changes	6	100% of respondents
Changes on multiple days/week	5	83.3%
Conservative reported 2025 volume	≥2,294	Lower bound
Economically unattractive	4	66.7%
Cost-covering	2	33.3%
Economically attractive	0	0%
Good/very good organisational integration	3	50.0%
Burdensome integration	2	33.3%
Plan same future volume	3	50.0%
Plan lower future volume	3	50.0%
Plan higher future volume	0	0%
Self-reported personnel + material effort	€24.04 ± €12.11	Median €22.50; range €6.75-€40.00

Analyses were conducted at independent operator-unit level. Annual volume is conservative because one response was >1,000 and one of seven operator units did not respond.

MDC structure and resource model

The empirical findings supported a selective MDC rather than universal relocation of SPC changes. The model retains physician responsibility for eligibility, patient-specific delegation and escalation, while a specifically trained nurse performs planned routine follow-up changes in the patient's home or nursing facility (Fig. 2).

Figure 2. Proposed mobile decentralised care pathway



For a non-bundled single mobile visit, the base-case direct modelled cost was €74.76, comprising €21.60 on-site nursing time, €20.64 materials, €3.55 physician review/delegation, €13.48 nursing travel time, €10.99 vehicle full costs and €4.50 coordination. Serial routing generated economies of density: modelled direct cost fell to €68.64 with two changes, €66.60 with three, €65.58 with four, €64.97 with five, €64.56 with six and €64.27 with seven changes per tour (Fig. 3). Six changes per tour were selected as the operational base case because the modelled nurse time commitment was 368.3 minutes (6.14 hours), leaving capacity for breaks, preparation and variability; an eighth change exceeded an eight-hour day before buffers. Detailed tour-size assumptions, modelled travel distances, nursing time requirements and direct costs per SPC change are presented in Additional file 1: Table S2.

Figure 3. Mobile cost per change by tour size



Compared with the €231.46 hospital-plus-ambulance pathway value, the six-change MDC base case was €166.90 (72.1%) lower in modelled direct resources (Fig. 4). A single mobile visit remained substantially lower at €74.76. By contrast, for a hospital change without documented medical transport, the MDC six-change scenario was €9.07 more expensive than the hospital direct-resource estimate (€64.56 vs €55.49). Thus, under the model assumptions, the mobile pathway became resource-saving once additional transport-related resources in the existing pathway exceeded €9.07 per case. A 30% overhead sensitivity increased the six-change MDC estimate to €83.93, which remained well below the hospital-plus-ambulance comparison value. A comprehensive overview of the hospital and mobile care resource scenarios, including minimum and maximum estimates and the overhead sensitivity analysis, is provided in Additional file 1: Table S3.

Table 3. Direct resource comparison across care scenarios

Care scenario	Resource estimate per change	Interpretation

Care scenario	Resource estimate per change	Interpretation
UKW SPC change, no documented medical transport	€55.49	Observed/modelled direct personnel + materials
MDC single mobile visit	€74.76	Upper reference for unbundled mobile delivery
MDC six-change tour	€64.56	Operational base case
UKW SPC change + modelled ambulance round trip	€231.46	€55.49 + €175.97
Difference: MDC six-change tour vs UKW + ambulance	-€166.90	72.1% lower modelled direct resources

Values are 2025 euros and modelled direct resources, not observed insurer expenditure or a formal cost-effectiveness result. UKW, University Hospital Würzburg; MDC, mobile decentralised care model.

Figure 4. Direct resource use across care scenarios

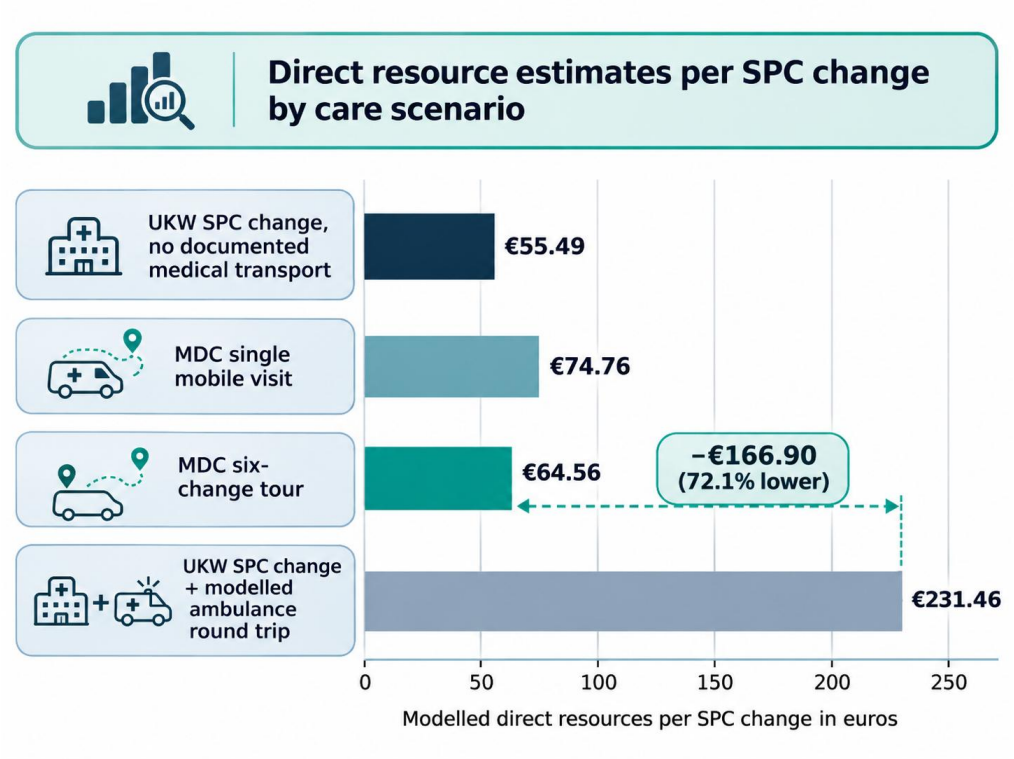


Table 4. Proposed mobile decentralised care model and pilot outcomes

Domain	Model specification	Pilot implication
Target population	Established SPC; planned routine follow-up; clinically stable	Prioritise transport-dependent, mobility-impaired, care-dependent or nursing-facility patients
Clinical exclusions / escalation	New placement; first change; unclear tract; relevant bleeding; systemic infection; difficult tract; need for imaging/intervention	Stop mobile procedure and activate physician/urology/emergency pathway
Workforce	One specifically trained nurse per vehicle	Patient-specific physician order/delegation and physician availability

Domain	Model specification	Pilot implication
Operational base	Six changes per serial tour	65.52 km modelled tour; 368.3 min nurse time
Core pilot safety outcomes	Technical success; immediate escalation; 7-day recontact; unplanned hospital/practice use	Prospective collection
Core system outcomes	Actually avoided transports; route length; travel time; km/change; staff time; full cost	Prospective collection
Patient experience outcomes	ICIQ-LTCqol; generic HRQoL; preference; perceived safety; continuity; waiting/travel burden; caregiver burden	Prespecified prospective outcomes

SPC, suprapubic catheter; ICIQ-LTCqol, International Consultation on Incontinence Questionnaire–Long-Term Catheter Quality of Life; HRQoL, health-related quality of life.

Discussion

Principal findings

This study shows that routine SPC care is a recurrent regional service pathway with a substantial transport and organisational component. More than 1,100 hospital SPC-change contacts were recorded in one year, more than half were repeat contacts within the same patient-quarter, and one in six involved medically organised transport. In parallel, regional urology practices reported at least 2,294 annual changes, demonstrating that the service is already distributed across hospital and ambulatory sectors but operates under different resource and reimbursement conditions.

The central health-services finding is that the technical SPC change itself was not the dominant resource item in transport-dependent hospital care. Direct hospital personnel and materials were estimated at €55.49, whereas a modelled ambulance round trip added €175.97. This distinction changes the redesign question: the

relevant unit is not merely the procedure, but the complete pathway required to bring a recurrent, often mobility-limited population to the procedure.

Context within existing evidence

The findings are consistent with international evidence showing that long-term catheter care generates recurrent, sometimes urgent health-service contacts and that hospital use can dominate total costs [5,6]. German nursing-home research further demonstrates that SPC changes are commonly performed by urologists and that the location of catheter care varies considerably between facilities [4]. Our study adds a regional pathway perspective by linking frequency, repeated use, transport, direct procedure resources, provider perceptions and a quantified alternative delivery model within the same analysis.

The strong association between out-of-hours presentation and medically organised transport reinforces the importance of separating planned routine care from escalation care. A mobile service should not attempt to replace emergency urological assessment; its potential lies in converting suitable recurrent follow-up changes into a predictable pathway with explicit criteria for escalation.

Provider capacity, incentives and the role of the MDC

The practice survey indicates that technical feasibility in ambulatory urology is not the main limiting factor: all responding units already performed SPC changes and half rated integration as good or very good. However, none planned expansion and half planned to reduce future activity. The isolated procedure-specific reimbursement was below every self-reported personnel-and-material estimate, although the comparison does not capture the full German practice reimbursement architecture. From a

service-design perspective, the result suggests limited incentive for simply shifting additional volume into existing practices.

The MDC therefore represents a complementary capacity model rather than a replacement for urology practices or hospital services. It targets patients whose travel burden is itself resource-intensive and keeps medical responsibility and escalation within an established urological framework. This aligns with the access concept of Penchansky and Thomas: the service changes spatial and organisational accessibility by moving a standardised follow-up procedure towards the patient rather than repeatedly moving the patient towards a facility [17]. In Donabedian's terms, the model primarily redesigns structure and process; prospective evaluation can then establish outcome quality [18].

Patient experience should be a core outcome of service redesign

Patient experience was not measured empirically in the present study, but the published evidence makes it a central outcome for any subsequent MDC evaluation. In a German study of long-term catheter users, catheter-related quality of life was affected by concerns including leakage, odour, urinary tract infection and painful catheter changes [19]. A 2025 nationwide Dutch survey including 303 SPC users found lower patient satisfaction and health-related quality-of-life scores among SPC users than among people using intermittent catheterisation after adjustment for confounders; pain, discomfort or soreness was particularly common among SPC respondents [20].

Qualitative work adds dimensions directly relevant to service organisation. Patients undergoing urethral or suprapubic catheter changes valued continuity, clarity about

who was responsible for catheter care, experienced and trained nurses, sufficient time, listening and reliable access to help [21]. Long-term catheter users also described effects on travel, social interaction, unpredictability, intimacy and body image [22]. These findings argue against evaluating a mobile pathway solely through technical success and cost.

A prospective MDC pilot should therefore include a prespecified patient-experience package alongside safety and resource outcomes. The ICIQ-LTCqol is a validated catheter-specific patient-reported outcome measure covering catheter function/concern and lifestyle impact [23]. It could be combined with a generic health-related quality-of-life instrument such as EQ-5D-5L, patient preference for home versus facility-based care, perceived safety, continuity of caregiver, waiting time, travel time, transport burden and caregiver burden. The MDC hypothesis is not that home care is inherently preferred by every patient; rather, it offers a testable opportunity to reduce access burden while preserving clinical governance.

Implementation and digital infrastructure

Mobile delivery depends on more than staff substitution. Tour density, routing, documentation, communication and escalation determine whether a model that appears efficient on paper remains efficient in practice. Home-health operations research emphasises that route design and scheduling constraints are core determinants of mobile-service performance [13]. Digital tools should initially support scheduling, mobile structured documentation and secure communication rather than add parallel workflows. Recent home-care implementation research shows that

limited functionality, poor integration, unstable infrastructure, inadequate training and insufficient user involvement can undermine mobile electronic-record solutions [24].

The German implementation pathway also requires a clear legal and reimbursement framework. Existing German delegation guidance recognises delegation of selected medical activities to qualified non-physician staff, but the precise legal and contractual position of routine SPC follow-up changes in a mobile model requires binding local clarification before implementation [15,16]. This is an implementation task, not a reason to disregard the modelled service opportunity.

Strengths and limitations

Strengths include a full-year hospital census rather than a sampled cohort, patient-level linkage of repeated contacts, a high regional provider-unit response, explicit separation of direct procedure resources from transport resources, and transparent scenario modelling. The GEE analysis accounted for within-patient correlation, and both minimum/maximum and overhead scenarios were used to avoid presenting a single modelled point estimate as certain.

The main limitations are the single-region design and reliance on routine data not collected specifically for health-services research. Taxi and hired-car journeys could not be identified, and ambulance costs were modelled from tariffs and estimated road distance rather than observed invoices and routes. The provider survey contained only six responding operator units and used self-reported resource estimates. The MDC itself has not yet been implemented, so real route geometry, clinical safety, full overheads, legal feasibility and actual payer expenditure remain to be established prospectively. Finally, patient experience was not empirically captured in the original

study; the literature-based patient-experience framework proposed here should therefore be tested rather than assumed.

Implications for research and service development

The immediate next step is a prospective pilot in a clearly selected transport-dependent population. Core outcomes should include technical completion without immediate urological escalation, unplanned practice or hospital contacts, seven-day medical recontacts, ambulance use, actually avoided transports, route length, travel time, kilometres per change, documentation completeness, staff time and real full costs. Patient experience and catheter-related quality of life should be measured concurrently rather than added as a secondary afterthought.

Beyond the pilot, the study highlights a broader data gap. German claims and routine systems capture fragments of SPC care but do not readily connect catheter-change frequency, care location, transport, provider resources and patient outcomes across sectors. A standardised pathway dataset linking these domains would allow replication across regions and more robust assessment of whether decentralised care produces durable health-system benefit. Decentralisation can generate benefits or unintended consequences depending on governance, financing and information systems, making prospective monitoring essential [25]. The ongoing German policy focus on overcoming sector boundaries provides a relevant health-system context for such pathway-based evaluation [26].

Conclusions

Routine SPC change is a high-frequency service process whose resource burden is strongly shaped by how patients reach care. In the Würzburg pathway, ambulance transport resources substantially exceeded the direct personnel and material resources of the hospital catheter change. Regional urology practices already provided substantial SPC activity but showed no appetite for expansion. A targeted physician-governed, nurse-led MDC reduced modelled direct resources markedly for transport-dependent cases through home delivery and tour-based routing. These findings justify prospective implementation research focused on safety, real-world full costs, avoided transport, patient experience and catheter-related quality of life.

List of abbreviations

BÄK: German Medical Association (Bundesärztekammer)

CHEERS: Consolidated Health Economic Evaluation Reporting Standards

CI: confidence interval

EBM: German Uniform Value Scale (Einheitlicher Bewertungsmaßstab)

GEE: generalized estimating equations

GOP: fee schedule item (Gebührenordnungsposition)

ICIQ-LTCqol: International Consultation on Incontinence Questionnaire–Long-Term Catheter Quality of Life

IQR: interquartile range

MDC: mobile decentralised care model

OR: odds ratio

SD: standard deviation

SPC: suprapubic catheter

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

UKW: University Hospital Würzburg

Declarations

Ethics approval and consent to participate

The Medical Ethics Committee of Julius-Maximilians-Universität Würzburg reviewed the study and raised no ethical or legal objections to its conduct (reference 2026-326-dvhd; decision dated 7 August 2026). The retrospective component involved the analysis of pseudonymised routine healthcare data collected between January and December 2025, without additional patient contact or intervention. Individual informed consent was not required for this retrospective analysis, as subsequently confirmed by the Ethics Committee.

Consent for publication

Not applicable; the manuscript contains no identifiable individual-level information.

Availability of data and materials

The individual-level hospital dataset is not publicly available because it contains pseudonymised health data and is subject to institutional data-protection restrictions. Aggregated data supporting the principal numerical results and the MDC model are included in this article and its supplementary material. Any further access would require approval by University Hospital Würzburg and applicable ethics/data-protection bodies.

Competing interests

The authors declare no competing interests.

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Authors' contributions

MS, CK and VS conceived the study, developed the study design, and curated and analysed the data. MD, FVMS and OH contributed to the health-economic analysis and development of the MDC model. MW and HK contributed to the interpretation of the findings. All authors contributed to drafting or critically revising the manuscript, read and approved the final version, and agreed to its submission for publication.

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Additional files

Additional file 1 (.docx): Supplementary methods and tables, including exploratory GEE results, tour-size modelling and sensitivity analyses.

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Figure legends

Figure 1. Study design and analytical synthesis

The study combined a full-year retrospective analysis of SPC-change presentations at University Hospital Würzburg, a census-style survey of regional urology operator units, and direct/transport resource modelling. These components were synthesised into the physician-governed, nurse-led mobile decentralised care model (MDC).

The graphical design of this figure was assisted by OpenAI's image-generation functionality using author-provided source material; the scientific content was verified by the authors.

Figure 2. Proposed mobile decentralised care pathway

The model is restricted to planned follow-up changes of established SPCs in selected clinically stable patients. Physician responsibility is retained for eligibility, patient-specific delegation and escalation. A trained nurse performs the mobile change and structured documentation. Any deviation from the expected routine pathway triggers cessation of the mobile procedure and medical escalation.

The graphical design of this figure was assisted by OpenAI's image-generation functionality using author-provided source material; the scientific content was verified by the authors.

Figure 3. Mobile cost per change by tour size

Direct modelled MDC cost per SPC change falls as shared travel and vehicle resources are distributed across serial visits. Six changes per tour were selected as the operational base case (€64.56 per

change); seven changes provided only marginal additional cost reduction and approached practical working-time limits.

The graphical design of this figure was assisted by OpenAI's image-generation functionality using author-provided source material; the scientific content was verified by the authors.

Figure 4. Direct resource use across care scenarios

Comparison of 2025 direct-resource estimates for an SPC change at UKW without documented medical transport, the six-change MDC base case, an unbundled single mobile visit, and a hospital change plus a modelled ambulance round trip. Values are modelled resources, not observed insurer expenditure.

The graphical design of this figure was assisted by OpenAI's image-generation functionality using author-provided source material; the scientific content was verified by the authors.

Supplementary Files

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- BMCHSRSupplementaryMaterial.docx