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ARTICLE

Barriers to urologic care following spinal cord injury

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Background: *Individuals with spinal cord injury (SCI) are at high risk for developing neurogenic bladder or neurogenic lower urinary tract dysfunction (NLUTD), which can lead to severe complications and negatively impact quality of life. Despite the critical need for timely urologic care, barriers to access remain poorly understood, particularly in resource-limited settings. This study aims to identify systemic and perceived barriers to urologic follow-up for individuals with SCI treated at an academic medical center.*

Methods: *A single-center, observational study was conducted on individuals presenting with a diagnosis code indicative of complete SCI at an academic hospital between October 2015 and October 2023. Data were extracted from electronic medical records using ICD-10 codes for SCI, and phone interviews were conducted to assess symptoms, quality of life, and perceived barriers to care. Descriptive statistics summarized the findings. Univariate and multivariate Firth logistic regression analyses were performed to analyze for possible covariates impacting the odds of follow-up or having obtained a urodynamics study.*

Results*: Of 213 records, 136 met the inclusion criteria. Among them, only 17 (13%) received a urology consultation during their hospital stay, and 28 (21%) had been seen in a urology clinic post-injury. Phone interviews with 42 patients revealed that 93% reported NLUTD symptoms, with a mean quality of life impact score of 7.3. Barriers identified included availability (71%), accessibility (45%), accommodation (69%), affordability (43%), and acceptability (31%) barriers. Firth logistic regression demonstrated that male sex was associated with lower odds (OR = 0.205, 95% CI: 0.048, 0.772, p = 0.02) of having obtained a urodynamics study.*

Conclusion: *Significant gaps in urologic care for individuals with SCI exist. Statistically significant variation in management via Firth logistic regression analyses also demonstrates potential disparities in follow-up and management. Addressing these challenges requires improved discharge planning, increased healthcare accessibility, and innovative care models such as telemedicine. Future research should explore broader geographic regions and interventions to improve outcomes.*

Key Words: Spinal cord injury, neurogenic lower urinary tract dysfunction, urologic care, healthcare disparities, rural urology

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Introduction

Individuals with spinal cord injury (SCI) are at high risk for developing neurogenic bladder or neurogenic lower urinary tract dysfunction (NLUTD).[1,2] NLUTD is a considerable cause of morbidity and mortality in individuals with SCI due to complications such as severe systemic infections, incontinence, vesicoureteral reflux, nephrolithiasis, and renal failure.[3,4] Additionally, NLUTD can negatively impact mental health and social well-being, thus adversely affecting these individuals' quality of life.[5,6]

SCI's were estimated to affect 20.6 million individuals globally in 2019.[7] More recent analyses, however, suggest a declining burden, with approximately 15.4 million people living with SCI in 2021 and a projected global incidence of 4.4 per 100,000 by 2050.[8] In contrast, the United States demonstrates comparatively high rates, with 2021 estimates of 11.4 new cases per 100,000 population and a prevalence of 270.6 per 100,000.[8]

Among individuals with SCI, up to 84% develop NLUTD, highlighting the magnitude of this issue.[2,9] The management of NLUTD and other SCI-related co-morbidities contributes significantly to healthcare costs, with annual expenditures exceeding $9 billion in the United States alone.[10,11] These costs are further compounded by the indirect economic burden of reduced productivity and long-term disability.

Timely and consistent urologic care is essential to mitigate complications and improve patient outcomes. Early interventions can significantly reduce the risk of renal failure and recurrent infections, which are among the leading causes of mortality in SCI patients.[3,4] Despite the recognized morbidity and mortality associated with NLUTD, along with the psychological and social consequences, specific barriers preventing individuals with SCI from accessing adequate and timely urologic care remain poorly understood.

Individuals with SCI are frequently faced with unique barriers to establishing and attending healthcare visits due to the nature of their injury, including inaccessible examination tables or a lack of adequate lifting aids.[12,13] Such obstacles conflict with Penchansky and Thomas's model of access to care, which emphasizes the importance of availability, accessibility, accommodation, affordability, and acceptability in healthcare delivery.[14]

Furthermore, previous studies have identified critical breakdowns in follow-up and management of individuals, specifically with spinal cord injury. One study found low rates of urological assessment within a year after injury (median ~55%),[15] with another reporting underutilization of urodynamics and renal imaging in traumatic SCI individuals, further underscoring a difficulty in obtaining appropriate management in this population.[16]

In resource-limited states, there are further unique challenges in healthcare delivery, particularly for vulnerable populations such as those with SCI. Typically, these states have a predominantly rural landscape and a shortage of healthcare providers, which exacerbate challenges of referral and follow-up, leaving patients with limited access to timely, specialized care. This study is the first to systematically assess barriers to urologic care for individuals with SCI who presented to an academic medical center in a resource-limited state, offering insights into a population that has been underrepresented in previous research.

Understanding the distinct obstacles individuals with SCI face in accessing urologic follow-up and management is essential to improving outcomes and informing broader healthcare policy. The purpose of this study was to identify both systemic and perceived barriers to urologic care among individuals treated for SCI at our academic medical center. To our knowledge, this is the first study to apply the Penchansky and Thomas model of healthcare access specifically to individuals living with SCI to evaluate which dimensions of access they perceive as most obstructive to receiving urologic care. By leveraging this established conceptual framework, we aim to provide a more nuanced understanding of care barriers in this population—insights that are essential to guiding targeted interventions and improving care delivery for one of the most medically vulnerable patient groups.

Methods

Study design

This is a single-center, observational study of consecutive patients who presented to an academic hospital that serves a predominantly rural and underserved population. Consecutive patients presenting with a primary diagnosis code of a complete lesion of the spinal cord from October 2015 to October 2023 were included. This cohort included only patients whose initial, acute management and admission for their SCI took place at this institution. The study was approved by the University of New Mexico Health Sciences Center Human Research Review Committee (HRRC #24-121). The retrospective review of electronic medical records was conducted with a waiver of informed

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consent. For the phone interviews, informed consent was obtained from all participants prior to data collection.

Facility billing data were used to identify individuals who presented to this hospital using International Classification of Diseases 10 codes (ICD-10) related to complete spinal cord lesion, including S14.11, S24.11, and S34.11. These ICD-10 codes were selected for their specificity in capturing complete spinal cord lesions, most associated with key neurogenic lower urinary tract dysfunction signs and symptoms.[17] Diagnoses of sacral spinal cord lesions were excluded, given that such patients generally exhibit low-risk features as compared to suprasacral lesions.[18,19] While the ICD-10 codes used were intended to extract exclusively complete SCI, there were some individuals whose ASIA exams indicated incomplete lesions. The decision was therefore made to include these individuals in the final cohort as they comprised a relatively low proportion of the entire cohort.

Inclusion and exclusion criteria

Inclusion criteria were as follows: (1) Individuals with a diagnosis code of complete lesion of the spinal cord in the cervical, thoracic, or lumbar regions, (2) Records available from the acute inpatient or surgical management of the patients' SCI, (3) Current age at time of the study greater than or equal to 18 years. Exclusion criteria were as follows: (1) Patients with a diagnosis of complete lesion of the spinal cord in the sacral region, (2) Individuals with a current age less than 18 years, (3) Patients without records available from the acute management of their SCI.

Data collection

The electronic medical record was reviewed, and data were manually extracted on: current age, age at time of SCI, sex, race, ethnicity, ASIA-impairment scale,[20] cause of SCI, and urologic care parameters, including receipt of an inpatient urology consult or outpatient referral, presence of a scheduled appointment at our urology clinic within 6 months of the patient's injury, and whether they had ever been seen at our urology clinic.

Phone interviews were administered to patients whose charts were reviewed and who met all inclusion and exclusion criteria. Informed consent was obtained before conducting the phone interviews, ensuring that participants understood the purpose of the study and how their data would be used. The questionnaire asked questions capturing: NLUTD symptoms such as urinary tract infections, kidney stones, incontinence, low voiding volume, urinary frequency or urgency, and loss of feeling that the bladder is full; the impact of NLUTD on their quality of life from 0 to 10 with 0 being does not interfere and 10 being completely interferes, current urologic management, and perceived barriers to receiving adequate timely care (Supplemental Material S1). Questions were adapted from validated frameworks, including the Penchansky and Thomas model of access to care[14,21] and Kullgren et al.'s report on Nonfinancial Barriers and Access to Care for U.S. Adults.[22] Up to three contact attempts were made for each participant before ceasing outreach.

Study data was collected and stored using Research Electronic Data Capture (REDCap) software hosted at The University of New Mexico in Albuquerque.[23]

Data analysis

Descriptive statistics were calculated for all variables as appropriate, including counts, percentages with 95% confidence intervals (CIs), medians, and interquartile range (IQR) using Microsoft Excel.

Differences between those who completed the phone interviews (responders) and those who did not (non-responders) were analyzed using Fisher's exact test for categorical data to account for small sample size and the Wilcoxon rank-sum test for continuous data to control for non-parametricity.

To assess the association between predictor variables and the likelihood of having been seen by a urologist or having undergone urodynamics, we employed Firth's penalized likelihood logistic regression, which is specifically designed to mitigate small-sample bias and address issues of separation often encountered in sparse data settings.[24–26]

We first conducted univariate Firth logistic regression models for each independent variable, including age at time of SCI, time since injury, sex, race (White vs. non-White or not reported), and ASIA level (A vs. other or not reported). Each model estimated the odds ratio (OR), 95% CI, and p-value using profile penalized likelihood methods. This step allowed us to evaluate the crude associations between each covariate and the outcome without adjusting for potential confounders.

We then constructed a multivariable Firth logistic regression model incorporating all five covariates to estimate adjusted odds ratios (aORs). This approach allowed us to account for potential confounding effects and evaluate the independent contribution of each predictor. CIs and p-values were likewise derived from the profile penalized likelihood method.

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All statistical analyses were performed in R (version 4.4.1).[27] Firth logistic models were fit using the 'logistf' package (version 1.26.1) in R.[28] Odds ratios and CIs were calculated by exponentiating the estimated coefficients and their respective confidence bounds. A p-value < 0.05 was considered statistically significant.

Results

A total of 213 records were initially identified. After excluding 77 records due to a lack of data from acute care of their SCI or due to erroneous diagnoses of SCI, 136 records were included for the final analysis.

Table 1 demonstrates the characteristics of our complete cohort. The complete cohort had a median age of 38.5 years (IQR: 28.5) with a median age at time of SCI and time elapsed since SCI of 33.0 years (IQR: 28.0) and 4 years (IQR: 4), respectively. Among these patients, 36 (26%) had cervical injuries, 69 (51%) had thoracic injuries, and 14 (10%) had lumbar injuries. 17 patients had unascertainable levels as no formal ASIA impairment score had been assigned. In total, 106 (78%) of these patients had ASIA-A injuries, while 9 (7%) were classified as ASIA-B, 3 (2%) as ASIA-C, and 1 (1%) as ASIA-D.

Most injuries (124, 91%) were secondary to trauma, with 2 (1%) due to cancer, 2 (1%) due to hematoma, 4 (3%) due to infection, and 4 (3%) due to other causes. Seventeen (13%) patients received an inpatient consultation from urology at the time of their injury, while 21 (15%) received a referral to the urology clinic during the encounter or at discharge from the hospital. 10 (7%) patients had an appointment scheduled at our urology clinic within 6 months of their injury, and 28 (21%) were seen at our urology clinic any time since their injury.

A total of 42 participants completed the over-the-phone interviews. Table A1 demonstrates the characteristics of interview responders and non-responders. The interviewed cohort had a median age of 31.5 years (IQR: 22.75) with a median age at time of SCI and time elapsed since SCI of 27.0 years (IQR: 24.5) and 4 years (IQR: 4), respectively. Among these patients, 7 (16%) had cervical injuries, 26 (62%) had thoracic injuries, and 6 (14%) had lumbar injuries. 3 patients had unascertainable levels as no formal ASIA impairment score had been assigned. In total, 35 (83%) of these patients had ASIA-A injuries, while 4 (7%) were classified as ASIA-B.

The Wilcoxon rank-sum test demonstrated statistically significant differences in both current age and age at the time of SCI between responders and non-responders ($p = 0.003$ for both). Fisher's exact test also identified a significant difference in the proportion of individuals who had been evaluated in our urology clinic since sustaining their SCI ($p = 0.02$). No other statistically significant differences were observed between groups (Table A1).

Of those who were interviewed, 39 (93%) participants reported experiencing symptoms of NLUTD, with an average impact of their lower urinary tract symptoms on quality of life of 7.3 (95% CI: 6.6, 8.0). 23 (55%) respondents reported using intermittent catheterization to manage their NLUTD, 11 (26%) utilized chronic indwelling catheters, 17 (40%) used medications, and 7 (17%) had suprapubic catheters.

25 (59%) respondents were currently managed by a urologist at least once a year, while 36 (86%) reported being seen by a urologist at least once after their injury. 14 (33%) reported having undergone urodynamic evaluation at some point after their injury. Of those managed by a urologist at least once a year, 11 (44%) were managed by providers outside our institution. Of those not managed by a urologist at least once a year, 4 (24%) received bladder management from a primary care provider, and 1 (2%) was managed by a physical medicine and rehabilitation specialist. The remaining 17 (40%) patients were not receiving active provider-driven bladder management.

Although both current age and age at the time of SCI differed significantly between responders and non-responders, only age at the time of injury was included in the regression models. Current age was excluded due to its likely collinearity with time since injury, which could introduce instability in model estimates. Similarly, visits to our institutional urology clinic were excluded from the models despite statistical differences between groups, as this variable is not independent of the outcome (i.e., ever having seen a urologist) and would introduce a tautological relationship. Univariate and multivariate Firth logistic regression analyses were performed for each covariate of interest. These models revealed no statistically significant association between time since injury, sex, race, or ASIA impairment scale and the odds of having ever been evaluated by a urologist following SCI (Supplementary Table S1). We did, however, see statistically significantly lower odds of males having received urodynamics than females in both the univariate (OR = 0.179, 95% CI: 0.042, 0.686, $p = 0.01$) and multivariate (OR = 0.205, 95% CI: 0.048, 0.772, $p = 0.02$) analyses for this event (Supplementary Table S1).

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TABLE 1. **Characteristics of the complete study cohort**

Descriptive Characteristic	Median (IQR)	n (136 Total)	Percent (%) (95% CI)
Current Age	38.50 (28.50)	/	/
Age at time of SCI	33.00 (28.00)	/	/
Time elapsed since SCI	4.00 (4.00)	/	/
Sex			
Male	/	97	71.32 (63.22, 78.26)
Female	/	39	28.68 (21.74, 36.78)
Race			
White	/	89	65.44 (57.12, 72.91)
Black/African American	/	7	5.15 (2.52, 10.24)
Asian	/	1	0.74 (0.13, 4.05)
American Indian/Alaskan Native	/	27	19.85 (14.02, 27.34)
Not Recorded	/	12	8.82 (5.12, 14.79)
Ethnicity			
Hispanic/Latino	/	59	43.38 (35.35, 51.78)
Not Hispanic/Latino	/	71	52.21 (43.87, 60.42)
Not Recorded	/	6	4.41 (2.04, 9.29)
SCI Level			
Cervical	/	36	26.47 (19.78, 34.46)
Thoracic	/	69	50.74 (42.43, 59.00)
Lumbar	/	14	10.29 (6.23, 16.54)
Unable to Ascertain	/	17	12.50 (7.95, 19.11)
ASIA Scale at Time of Injury			
A	/	106	77.94 (70.26, 84.09)
B	/	9	6.62 (3.52, 12.10)
C	/	3	2.21 (0.75, 6.28)
D	/	1	0.74 (0.13, 4.05)
Not Performed	/	17	12.50 (7.95, 19.11)
Cause of SCI			
Trauma	/	124	91.18 (85.21, 94.88)
Cancer	/	2	1.47 (0.40, 5.20)
Hematoma	/	2	1.47 (0.40, 5.20)
Infection	/	4	2.94 (1.15, 7.32)
Other	/	4	2.94 (1.15, 7.32)
Urologic Care			
Received Urology Consult at Time of Injury	/	17	12.50 (7.95, 19.11)
Received a Referral to Urology at Time of Injury or at Discharge	/	21	15.44 (10.33, 22.45)
Urology Appointment Scheduled at Our Clinic within 6 Months	/	10	7.35 (4.04, 13.01)
Seen at our Urology Clinic Ever Since Injury	/	28	20.59 (14.65, 28.15)

Note. SCI, spinal cord injury; ASIA, American Spinal Injury Association; IQR, interquartile range; CI, confidence intervals.

Table 2 summarizes the reasons for unmet need or delayed care. 30 (71%; 95% CI: 58%, 85%) respondents experienced an availability barrier, 19 (45%; 95% CI: 30%, 60%) experienced an accessibility barrier, 29 (69%; 95% CI: 55%, 83%) experienced an accommodation barrier, 18 (43%; 95% CI: 28%, 58%) experienced an affordability barrier, and 13 (31%; 95% CI: 17%, 45%) experienced an acceptability barrier.

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TABLE 2. **Individual reasons for unmet need or delayed care. Respondents could answer "yes" to multiple reasons, even within the same domain**

Reason for unmet need or delayed care	n (42 Total)	Percent (%) (95% CI)
Availability		
Unsure where or who to go to	20	47.62 (32.51, 62.72)
Couldn't get an appointment soon enough	24	57.14 (42.18, 72.11)
Accessibility		
Clinic too far from home	13	30.95 (16.97, 44.93)
Too hard to travel due to injury	15	35.71 (21.22, 50.21)
Accommodation		
Couldn't get there when the clinic was open	10	23.81 (10.93, 36.69)
Had to wait in the clinic too long	11	26.19 (12.89, 39.49)
Difficult to get ahold of the clinic	14	33.33 (19.08, 47.59)
Unable to accommodate patient's needs due to injury	15	35.71 (21.22, 50.21)
Affordability		
Worried about the cost	10	23.81 (10.93, 36.69)
Health plan wouldn't pay for the treatment	17	40.48 (25.63, 55.32)
Worried about paying the bill too soon	11	26.19 (12.89, 39.49)
Acceptability		
Location was unacceptable	5	11.90 (2.11, 21.70)
Negative attitudes with healthcare staff	11	26.19 (12.89, 39.49)
Negative attitudes of other patients	1	2.38 (−2.23, 6.99)

Discussion

This study consisted of a retrospective review to identify 136 patients treated at our academic medical center with a diagnosis of complete SCI, and a subsequent survey of 44 individuals with SCI who provided their insights on barriers to care. The findings highlight that individuals with SCI often experience delays in addressing their unique urologic needs and face more barriers to care compared to the general population, when compared to Kullgren et al.'s report on Nonfinancial Barriers and Access to Care for U.S. Adults.[22] Further statistical analysis failed to identify covariates having a statistically significant impact on an individual's odds of being seen by a urologist after their injury; however, males were shown to have a lower odds of receiving urodynamics in both univariate and multivariate Firth logistic regression models.

Clinical implications of delayed care

We observed a relatively low proportion of patients who were seen by urology during the acute phase of their injury. The majority of issues addressed during the acute phase of injury were related to non-NLUTD issues, such as genitourinary trauma or indwelling catheter issues. Furthermore, only a fraction of patients received referral to outpatient urology or were seen at our institution's urology clinic at any point since their injury. In the initial period following SCI, spinal shock often masks immediate concerns related to NLUTD, potentially delaying necessary evaluations.[29–31] Initial management decisions and education regarding bladder care may be provided by non-urologists at this stage. However, one study found that 90% of patients developed at least one unacceptable urodynamic parameter within a year following their SCI[32] and it is estimated that 70%–84% of patients with SCI experience some level of NLUTD.[1,2] Therefore, early outpatient assessment and management of NLUTD are crucial to minimizing complications.[3,4] Systemic identification and protocolized discharge planning, including referrals to specialized providers such as urologists,

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would be a potentially beneficial intervention to promote early identification of NLUTD and appropriate management.

While almost 60% of interviewed participants reported being managed by a urologist at least once a year, with almost 86% having seen a urologist at any point, only 33% reported having undergone a urodynamic evaluation. According to the AUA guidelines on NLUTD, index patients with suprasacral lesions of the spinal cord are considered unknown risk patients, and initial evaluation should include upper tract imaging, renal function assessment, and multichannel urodynamics.[19] Although clinicians have discretion in determining the need for urodynamic evaluation, its value in objectively assessing NLUTD is well-established and should be strongly encouraged.[33–35] Indeed, literature suggests that while clinicians may be inclined to initiate urodynamic testing upon presentation of symptoms, routine urodynamic evaluation in NLUTD often prompts management modifications, even in the absence of symptomatology, re-enforcing the importance of consistent protocols promoting assessment and management for these patients.[36–38]

Barriers and access to care

A previous study utilizing the Penchansky and Thomas model of access to care was conducted on a cohort of adults in the United States. While this study was not stratified by any condition such as SCI, they found that approximately 21% and 18% of all adults interviewed experienced some type of non-financial and financial barriers, respectively.[22] This is in stark contrast to our findings where approximately 31%–71% of respondents reported some barrier in the availability, accessibility, accommodation, and acceptability domains. The most frequently reported barrier was interestingly related to the availability domain (71% of respondents), with approximately 57% noting that they were concerned about being able to get an appointment soon enough. Given the significant sequelae of SCI, these patients are at heightened risk of morbidity and mortality from complications beyond NLUTD, including cardiovascular, respiratory, and gastrointestinal issues.[39] It may be important, therefore, to prioritize the needs of this population, with providers and institutions working closely with patients who have SCI to promote an appropriate continuum of care.

Additionally, 43% of respondents in this study noted some type of affordability barrier, in contrast to 18.5% in Kullgren et al.[22] A recent study found that cervical-level injuries were associated with decreased income and increased unemployment, although similar analyses for thoracic or lumbar injuries were not reported.[40] While SCI patients with low income or unemployment are likely to qualify for government-provided insurance, disparities in outcomes persist. One report found a higher risk of both psychological and cardiometabolic, but not musculoskeletal, comorbidities in publicly vs. privately insured individuals.[41] Additionally, A systematic review of outcomes for individuals with SCI based on socioeconomic status also found low income to be a significant predictor of death and higher odds of emergency room visits and pressure injuries, as well as increased pain intensity.[42] Moreover, a large study utilizing Medicare administrative data showed that only 24.6% of over 7000 individuals received adequate urologic surveillance, with 4.9% and 70.5% receiving no or only partial screening, respectively. The authors concluded that the majority of patients fail to receive the minimum recommended surveillance, leading to preventable complications.[43] These data highlight the need for targeted interventions to improve access to comprehensive healthcare for low-income and publicly insured individuals and implement policies that directly address the socioeconomic disparities contributing to poorer health outcomes for individuals with SCI. Future efforts should focus on multidisciplinary collaborations and policy changes that prioritize timely and equitable healthcare access for this vulnerable population.

Factors contributing to poor access and follow-up

Many states, including New Mexico, face a significant shortage of urology providers, further exacerbating access challenges for SCI patients. In a report by the American Urological Association on practicing urologists in 2023, New Mexico ranked third lowest in the nation in urologist-to-population ratio at 2.84 urologists per 100,000 population.[44] For comparison, New York, Massachusetts, and New Hampshire ranked the highest at 5.69, 5.54, and 5.38 urologists per 100,000, respectively.[44] A complementary Google trends analysis found that New Mexico was among the highest on their physician demand index at 83 on a scale from 0–100, with 100 representing an estimated demand for urologists that is 100% the magnitude of the highest perceived demand across all states.[45] This lack of access and strength of demand may be uniquely felt in small towns and rural communities where only 1.6% and 0.5% of urologists practice, respectively.[44] Additionally, the United States Health Resources and Services Administration designates all or part of all

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but one of New Mexico's 33 counties as medically underserved areas.[46]

While some previous literature suggests comparable health and quality-of-life outcomes for individuals with SCI in rural vs. urban environments,[47] the current findings and existing data on workforce distribution suggest that geographic barriers and provider scarcity remain perceived—and likely real—obstacles to urologic care. The combination of widespread healthcare underservice and a particularly acute shortage of urologists creates formidable barriers to timely and equitable care for individuals living with SCI in New Mexico.

Further exacerbating this issue is a broad historical pattern of patients lost to follow-up following traumatic injuries.[48–51] Social determinants of health and membership in vulnerable populations have previously been reported to influence this trend.[50] However, one report found that patients who received more referrals to specialists were more likely to be nonadherent with follow-up after trauma however this study defined "adherence" as attending all scheduled appointments after discharge.[51] Nevertheless, this presents an intriguing dilemma; while specialist referrals are necessary for comprehensive care, excessive referrals may inadvertently reduce adherence, possibly due to transportation challenges, appointment fatigue, or financial constraints. While it is outside the scope of this paper to postulate on how best to improve follow-up and adherence with discharge instructions, one potential solution is the development of wraparound clinics where patients may attend sequential appointments at the same location, which could reduce transportation and financial barriers, particularly pertinent to trauma patients and patients with SCI.[51,52]

While our analyses did not identify any covariates significantly associated with follow-up with urology providers, we did observe a notable difference in the likelihood of having undergone urodynamic studies. Specifically, males had significantly lower odds of receiving urodynamics compared to females in both univariate and multivariate models. This finding adds to a complex and evolving body of literature on disparities in urologic care following spinal cord injury (SCI).

In a 2014 study, Welk et al. evaluated the effects of sex, age, comorbidity burden, and marginalization index on referral patterns to urology. They found that females and individuals over the age of 65 were less likely to be referred for urologic evaluation.[15] A subsequent study by the same group examined the likelihood of undergoing urodynamics, renal imaging, or cystoscopy based on age, sex, comorbidities, socioeconomic status, and neurological lesion level.[16] Their findings indicated that individuals older than 65, those with higher comorbidity scores, and those with quadriplegia were less likely to undergo urodynamic testing. Similarly, renal imaging and cystoscopy were performed less frequently in individuals with quadriplegia compared to those with paraplegia.

Although our findings differ in some respects—particularly regarding sex-based differences in urodynamic testing—this discrepancy may be attributable to our smaller sample size (n = 42) relative to Welk's larger cohort (n = 1551). Nonetheless, our results suggest that meaningful disparities in urologic care following SCI may persist. Future research should aim to identify and address potential sources of bias in urologic evaluation and management in order to inform equitable medical decision-making and healthcare policy.

Future directions and research needs

While this study highlights barriers to urologic care for individuals with SCI at our academic medical center, further research should aim to provide a broader and more comprehensive evaluation of these challenges on a national and international scale. Understanding regional variations in care and identifying systemic trends will be essential in addressing disparities.[53] Future efforts should also examine the long-term consequences of inadequate or delayed follow-up for NLUTD, including its impact on morbidity, mortality, and quality of life.

Expanding telemedicine services and integrating multidisciplinary care models may address some of the logistical and systemic barriers identified, particularly in rural and underserved areas.[54–56] Additionally, programs like Project ECHO, a hub-and-spoke teleeducation model based in New Mexico, offer an innovative research endeavor to enhance primary care providers' access to evidence-based guidelines and improve their capacity to manage complex conditions like NLUTD in rural communities.[57–59] Advocacy for policies that reduce financial and systemic obstacles, such as expanded insurance coverage and incentives for urologists in high-need regions, will also be critical to improving access.[60]

By focusing on these areas and tracking outcomes such as renal function, infection rates, and urolithiasis, future research can guide the development of standardized protocols and inform systemic changes to ensure equitable and effective care.

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Limitations

This study has several important limitations. First, the relatively small sample size—limited to patients initially treated for SCI at a single academic medical center—constrains the generalizability of our findings and statistical power in our regression models. Although this institution is the only Level I trauma center in the state, patients with acute SCI may have received care at other hospitals, leading to potential sampling bias. Future research should aim to increase sample size through collaboration across institutions and integration of broader data sources. Second, the study had a low response rate; only approximately 32% of eligible patients completed the phone interview. This highlights ongoing challenges with long-term follow-up in this population, particularly as many non-respondents had disconnected numbers or listings tied to acute rehabilitation or long-term care facilities where they no longer resided. As a result, our ability to assess barriers to urologic care in the broader SCI population is limited and may yet be distinct from what is reported here. Third, the reliance on self-reported data introduces the potential for recall bias, particularly regarding historical barriers to care. Additionally, observed differences between responders and non-responders may introduce unmeasured confounding. While regression models accounted for measured covariates, the possibility of residual bias remains, and the reported estimates may not fully represent the underlying population. Lastly, these findings may not be generalizable to other regions, particularly those with greater healthcare infrastructure, as New Mexico's unique demographic profile and resource constraints likely influenced patterns of care and access observed in this cohort.

Conclusions

This study found low rates of urologic referral and follow-up for individuals with SCI who presented to an academic medical center, with these patients experiencing high rates of perceived barriers to care compared to previous reports of general U.S. adults. Existing literature has highlighted the importance of urologic assessment and management, including urodynamic evaluation in patients with NLUTD secondary to SCI. However, poor access to care, particularly in urology services, and generally high loss to follow-up in the traumatic injury population underscore a dilemma in improving the continuum of care for these patients. Our findings underscore the need for systematic, protocolized discharge planning and innovative care delivery models, such as telemedicine and wraparound clinics, to address the unique needs of this population. Additionally, addressing the critical shortage of urologists and enhancing healthcare accessibility in underserved regions like New Mexico are essential steps. Future research efforts should focus on expanding these findings to additional institutions and geographic regions to ensure equitable care for some of our most at-risk populations. By implementing these strategies, we can work towards reducing barriers and improving urologic outcomes for individuals with SCI, ultimately enhancing their quality of life and health outcomes.

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Author Contributions

Mark W. Shilling: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing—Original Draft, Visualization. Shawn L. Fernandez: Investigation, Data Curation, Writing—Review & Editing. George J. Ryan: Investigation, Data Curation, Writing—Review & Editing. Juila G. Kim: Investigation, Data Curation, Writing—Review & Editing. David C. Majure: Investigation, Data Curation, Writing—Review & Editing. Frances M. Alba: Conceptualization, Supervision, Writing—Review & Editing. Reza Ehsanian: Conceptualization, Methodology, Investigation, Writing—Review & Editing, Supervision, Project Administration. All authors reviewed the results and approved the final version of the manuscript.

Availability of Data and Materials

Raw data can be made available upon reasonable request to the corresponding author.

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Ethics Approval

This study included only patients who received their initial acute management and admission for spinal cord injury (SCI) at our institution. The study was approved by the University of New Mexico Health Sciences Center Human Research Review Committee (HRRC #24-121).

Informed Consent

The retrospective review of electronic medical records was conducted under a waiver of informed consent, and informed consent was obtained from all participants prior to the phone interviews.

Conflicts of Interest

The authors declare no conflicts of interest to report regarding the present study.

Supplementary Materials

The supplementary material is available online at https://www.techscience.com/doi/10.32604/cju.2025.070606/s1.

Appendix A

TABLE A1. **Characteristics of responders and non-responders**

Descriptive characteristic	Responders (42 Total) Median (IQR)	n	Percent (95% CI)	Non-Responders (94 Total) Median (IQR)	n	Percent (95% CI)	*p* value
Current Age	31.50 (22.75)	/	/	39.50 (30.25)	/	/	0.003*
Age at time of SCI	27.00 (24.50)	/	/	36.50 (29.50)	/	/	0.003*
Time elapsed since SCI	4.00 (4.00)	/	/	4.00 (3.00)	/	/	0.95
Sex							0.69
Male	/	29	69.05 (53.97–80.93)	/	68	72.34 (62.56–80.37)	
Female	/	13	30.95 (19.07–46.03)	/	26	27.66 (19.63–37.44)	
Race							0.06
White	/	35	83.33 (69.40–91.68)	/	54	57.45 (47.35–66.96)	
Black/African American	/	1	2.38 (0.42–12.32)	/	6	6.38 (2.96–13.23)	
Asian	/	0	0.00 (0.00–8.38)	/	1	1.06 (0.19–5.78)	
American Indian /Alaskan Native	/	4	9.52 (3.77–22.07)	/	23	24.47 (16.89–34.05)	
Not Recorded	/	2	4.76 (1.32–15.79)	/	10	10.64 (5.88–18.49)	
Ethnicity							0.21
Hispanic/Latino	/	23	54.76 (39.95–68.78)	/	36	38.30 (29.11–48.40)	
Not Hispanic/Latino	/	18	42.86 (29.12–57.79)	/	53	56.38 (46.30–65.96)	
Not Recorded	/	1	2.38 (0.42–12.32)	/	5	5.32 (2.29–11.85)	
SCI Level							0.11
Cervical	/	7	16.67 (8.32–30.60)	/	29	30.85 (22.42–40.79)	
Thoracic	/	26	61.90 (46.81–75.00)	/	43	45.74 (36.04–55.78)	
Lumbar	/	6	14.29 (6.72–27.84)	/	8	8.51 (4.38–15.90)	
Unable to Ascertain	/	3	7.14 (2.46–19.01)	/	14	14.89 (9.08–23.46)	
ASIA Scale at Time of Injury							0.44
A	/	35	83.33 (69.40–91.68)	/	71	75.53 (65.95–83.11)	

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TABLE A1. **(Continued)**

Descriptive characteristic	Responders (42 Total) Median (IQR)	n	Percent (95% CI)	Non-Responders (94 Total) Median (IQR)	n	Percent (95% CI)	*p* value
B	/	4	9.52 (3.77–22.07)	/	5	5.32 (2.29–11.85)	
C	/	0	0.00 (0.00–8.38)	/	3	3.19 (1.09–8.97)	
D	/	0	0.00 (0.00–8.38)	/	1	1.06 (0.19–5.78)	
Not Performed	/	3	7.14 (2.46–19.01)	/	14	14.89 (9.08–23.46)	
Cause of SCI							0.38
Trauma	/	38	90.48 (77.93–96.23)	/	86	91.49 (84.10–95.62)	
Cancer	/	1	2.38 (0.42–12.32)	/	1	1.06 (0.19–5.78)	
Hematoma	/	1	2.38 (0.42–12.32)	/	1	1.06 (0.19–5.78)	
Infection	/	0	0.00 (0.00–8.38)	/	4	4.26 (1.67–10.44)	
Other	/	2	4.76 (1.32–15.79)	/	2	2.13 (0.59–7.43)	
Urologic Care							
Received Urology Consult at Time of Injury	/	6	14.29 (6.72–27.84)	/	11	11.70 (6.66–19.75)	0.78
Received a Referral to Urology at Time of Injury or at Discharge	/	6	14.29 (6.72–27.84)	/	15	15.96 (9.92–24.67)	>0.99
Urology Appointment Scheduled at Our Clinic within 6 Months	/	3	7.14 (2.46–19.01)	/	7	7.45 (3.65–14.58)	>0.99
Seen at our Urology Clinic Ever Since Injury	/	14	33.33 (21.01–48.45)	/	14	14.89 (9.08–23.46)	0.02*
Symptoms of NLUTD	/	39	92.86 (80.99–97.54)				
NLUTD Impact on QoL							
0–3	/	3	7.14 (2.46–19.01)				
4–6	/	10	23.81 (13.48–38.53)				
7–10	/	29	69.05 (53.97–80.93)				
Current Form of Bladder Management†							
Intermittent Catheterization	/	23	54.76 (39.95–68.78)				
Chronic Indwelling Catheter	/	11	26.19 (15.30–41.07)				

(Continued)

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TABLE A1. **(Continued)**

Descriptive characteristic	Responders (42 Total) Median (IQR)	n	Percent (95% CI)	Non-Responders (94 Total) Median (IQR)	n	Percent (95% CI)	*p* value
Medications	/	17	40.48 (27.04–55.51)				
Suprapubic Catheter	/	7	16.67 (8.32–30.60)				
Follow-up Urologic Care							
Currently managed by a urologist at least once a year	/	25	59.52 (44.49–72.96)				
Seen by a urologist at any point after their injury	/	36	85.71 (72.16–93.28)				
Have had a urodynamics study at any point after their injury	/	14	33.33 (21.01–48.45)				

Note. IQR, interquartile range; SCI, spinal cord injury; ASIA, American Spinal Injury Association; NLUTD, neurogenic lower urinary tract dysfunction; QoL, quality of life. *p*-values represent results from the Wilcoxon rank sum test and Fisher's exact test as appropriate. Asterisks designate statistical significance. †: responders could list multiple forms of bladder management.

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