

Increasing medical complexity among inpatients in urology over time

A comparative retrospective chart review

Liam Power¹, Kaveh Masoumi-Ravandi¹, Gabriella Ilie^{1,2,3}, Andrea Lantz Powers¹, Ross Mason¹, Ashley Cox¹

¹Department of Urology, Dalhousie University, Halifax, NS, Canada; ²Department of Radiation Oncology, Dalhousie University, Halifax, NS; ³Department of Community Health and Epidemiology, Dalhousie University, Halifax, NS, Canada

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ABSTRACT

INTRODUCTION: This study aimed to evaluate temporal trends in the medical complexity of urologic inpatients and investigate their implications for clinical care delivery.

METHODS: A retrospective comparative chart review was conducted for urologic inpatients admitted to a tertiary care center during two time periods: 2006–2007 and 2019–2020. A random sample of 150 patient charts from each cohort (N=300) was analyzed using a structured data extraction protocol in REDCap. Indicators of medical complexity included comorbidities, polypharmacy, and healthcare resource utilization. Statistical analyses comprised independent-samples t-tests, logistic regression, and multiple linear regression modeling.

RESULTS: Analysis of 300 patient records revealed a significant increase in medical complexity in the contemporary cohort compared to the historical cohort. Patients admitted in 2019–2020 exhibited higher Charlson comorbidity index scores, a greater number of chronic conditions, and increased polypharmacy. Utilization of home care services and specialist consultations during hospitalization was also more prevalent in the contemporary cohort. Although length of stay (LOS) remained comparable between cohorts, open abdominal surgery and the number of prescription medications were significant predictors of prolonged LOS ($p < 0.05$).

CONCLUSIONS: The medical complexity of urologic inpatients has escalated over time, driven by increased comorbid burden and healthcare system interactions. Despite advances in surgical techniques that would traditionally reduce LOS, these improvements may be counterbalanced by the growing complexity of patient populations. Interventions, such as pre-admission optimization and integrated multidisciplinary care, are essential to address the challenges posed by this evolving clinical landscape.

INTRODUCTION

Medical complexity arises from multiple interacting factors, including biologic, social, environmental, and economic influences. These factors contribute to multimorbidity, polypharmacy, and complex management and functional needs.^{1,2} Aging is a key driver of medical complexity, as risk factors for chronic disease accumulate over an individual's lifetime. As such, frailty and medical complexity are closely related and often concomitant.^{3,4} While many complex patients are frail, the role of age in complexity may also be contextual, as patients of various ages can be perceived by physicians to be complex for a multitude of different reasons.⁵ Ultimately, medical complexity is context-dependent by nature, and so too are the challenges it may pose for any individual patient's care.

Rigid thresholds for medical complexity are challenging to establish; however, many markers of medical complexity are generally accepted in the literature. These include multimorbidity, polypharmacy, multiple physician or specialist involvement in care, and being a resident of a long-term care facility.⁶ Multimorbidity is further associated with increased length of stay (LOS) among medical inpatients, particularly when there is multisystem involvement.⁷ Overall, complex patients exhibit increased healthcare resource utilization, interact with the healthcare system more frequently, and are at higher risk of poor outcomes as a result of their complex management needs.⁸

In general, patient complexity is thought to be increasing over time, and is significant in the Canadian population, wherein 1/4 people >40 years old have two or more chronic medical conditions, and 1/4 people >65 years old are taking at least 10 prescription medications.⁹⁻¹¹ As such, the identification of complex patients and development of management strategies for their care is paramount to providing safe and effective care for our patients.

Previous work examining the complexity of patients followed by medical subspecialists and primary care physicians revealed high levels of overall medical complexity, with significant variability between specialties.⁶ This suggests that while the prevalence of medical complexity may be generally high, it is important to analyze patient complexity within populations treated by a particular specialty service. For urologists, in particular, data suggests that we must be prepared to care for a relatively complex population; patients >65 years old constituted 35% of all inpatient surgeries in the U.S. in 2010, while >65% of inpatient surgeries done by urologists served this demographic.¹² Furthermore, acute urologic presentations to the emergency department have been shown to have increased over time in the Canadian setting, with older patients more likely to require admission to hospital, highlighting the need to better characterize the complexity of this population.¹³

The primary aim of this study was to assess whether medical complexity of urologic inpatients has changed over time, and the associated impacts on clinical care. The secondary aim was to develop a model of factors impacting LOS for this population. Specifically, we hypothesize that medical complexity has increased in this population over time, leading to more complex care needs and hospital stays.

METHODS

Study design

This study was a comparative retrospective chart review. REDCap was used to design a data capture tool and complete structured chart reviews of electronic medical records for all participants. A complete list of included variables is provided in the online Appendix (available at cuaj.ca).

Comorbid burden was assessed using the Charlson comorbidity index (CCI), a validated tool for predicting 10-year survival in patients with multimorbidity. A checklist of chronic diagnoses as recommended by Tonelli et al was applied.^{14,15}

Patient selection and inclusion criteria

We identified all urologic inpatients admitted to the Queen Elizabeth II Hospital in Halifax, NS, through our institutional Discharge Abstract Database (DAD). Two cohorts were selected: September 2006 to March 2007 (historic cohort) and September 2019 to March 2020 (contemporary cohort). We included all patients admitted during these periods. From each cohort, a random sample of 150 patients was selected for detailed chart review using REDCap.

We chose the September-to-March timeframe to capture a representative inpatient load while minimizing seasonal biases, such as summer slowdowns and holiday-related variations. The 2006–2007 cohort represented the earliest available DAD data, while the 2019–2020 cohort was the most recent period before COVID-19-related operational disruptions.

Data analysis

Baseline descriptive statistics were reported as counts, means, medians, standard deviations (SD), and percentages, with 95% confidence intervals (CI) where applicable. Categorical variables were analyzed using logistic regression. T-tests were performed to compare scalar variables between cohorts. Chi-squared tests were used to compare proportions where appropriate. Multiple linear regression identified significant predictors of LOS. Statistical significance was set at $p < 0.05$ for all analyses. Statistical analyses were conducted using SPSS version 29 (IBM Corp., 2022, Armonk, NY, U.S.).

RESULTS

Participants

There were similar numbers of overall admissions in each cohort (historic=1580; contemporary=1497). A total of 300 charts were randomly selected for review (150 each for historic and contemporary cohorts). Both cohorts were comparable in terms of sex composition (historic female=29%, male=71%; contemporary female=25%, male=75%). Patients in the historic cohort were younger (63 years, SD 15 vs. 65 years, SD 14, respectively), but this difference was not statistically significant ($p=0.077$).

Markers of complexity

Multiple key markers of complexity were significantly increased in the contemporary compared to the historic cohort, including body mass index (BMI), number of prescription medications, number of non-urologist physicians seen in the year prior, number of hospital

Table 1. Markers of complexity and characteristics of admission among urologic inpatients from Nova Scotia, Canada (N=300)

	Historic (2006–2007) n=150	Contemporary (2019–2020) n=150	p*
Complexity profile			
Age at admission (years)	150, 63/65 (15) [57–74]	150, 65/67 (13) [57–74]	0.077
BMI (kg/m ²)	106, 28/28 (4.8) [25–32]	119, 29/28 (6.1) [26–33]	0.049*
# of prescription medications at admission	150, 3.4/3.0 (2.8) [1.0–5.0]	150, 4.3/4.0 (3.4) [1.0–6.0]	0.005*
# of non-urology physician specialists seen in year prior	150, 1.3/1.0 (0.76) [1.0–2.0]	150, 2.0/2.0 (1.3) [1.0–3.0]	<0.001*
# of hospital admissions in the year prior to admission	150, 0.29/0.0 (0.66) [1.0–2.0]	150, 0.61/0.0 (1.2) [1.0–3.0]	0.002*
# of hospital admissions in the month prior admission	150, 0.11/0.0 (0.40) [0.0–0.0]	150, 0.12/0.0 (0.42) [0.0–0.0]	0.4
# chronic disease diagnoses	150, 1.7/2.0 (1.3) [1.0–3.0]	150, 2.04/2.0 (1.7) [1.0–3.0]	0.030*
CCI score	150, 3.5/4.0 (2.3) [2.0–5.0]	150, 4.05/3.0 (2.8) [2.0–5.0]	0.038*
Admission characteristics			
Number of non-uro physician services consulted	150, 0.23/0.0 (0.80) [0.0–0.0]	150, 0.51/0.0 (1.10) [0.0–1.0]	0.007*
Number of interdisciplinary services consulted	150, 0.25/0.0 (0.55) [0.0–0.0]	150, 0.33/0.0 (0.70) [0.0–0.0]	0.14
LOS (days)	150, 3.7/2.0 (9.0) [1.0–4.0]	150, 4.2/2.0 (7.0) [1.0–4.0]	0.3

Note. Summary statistics are presented as n, mean/median, standard deviation is presented in round brackets, and interquartile range (IQR) is presented in squared brackets, and n (%) for categorical data. *One-sided t test, p<0.05. BMI: body mass index; CCI: Charlson comorbidity index; LOS: length of stay.

Table 2. Logistic regression analysis for markers of medical complexity: Comparison between contemporary and historical cohorts (N=300)

Marker of complexity	Odds ratio (95% CI)	Historic n (%)	Contemporary n (%)	p
Home care prior to admission	5.04 (1.4–18)	3 (2.0%)	14 (9.3%)	0.010*
LTC prior admission	1.0 (0.20–5.04)	3 (2.0%)	3 (2.0%)	1.000
Admission in month prior	1.2 (0.5–2.8)	11 (7.3%)	13 (8.7%)	0.8
Admission in year prior	1.7 (1.0–2.8)	32 (21%)	47 (31%)	0.049*
Non-urology specialist seen in year prior	1.3 (0.58–2.7)	134 (89%)	137 (91%)	0.7
Therapeutic anticoagulation	0.93 (0.44–2.0)	16 (11%)	15 (10.0%)	1.000

Odds ratios calculated through logistic regression. *2-tailed p-value, p<0.05. CI: confidence interval; LTC: long-term care.

admissions in the year prior, number of chronic disease diagnoses, and CCI scores (Table 1). The number of hospital admissions in the month prior did not differ significantly between cohorts (p>0.05).

Patients in the contemporary cohort had significantly higher odds of having formal home care services prior to hospital admission (odds ratio [OR] 5.04, 95% CI 1.4–18, p=0.010). Contemporary patients also had significantly higher odds of having an admission to hospital in the year prior (OR 1.7, 95% CI 1.00–2.8, p=0.033). The proportion of patients admitted from long-term care facilities was the same between cohorts (n=3, 2%, respectively). Additional ORs for markers of complexity are shown in Table 2.

Characteristics of admission

Transurethral resections were the most common procedures among both cohorts (historic n=38, 25% vs. contemporary n=34, 23%). The proportion of open abdominal surgeries performed was significantly higher in the historic cohort (historic n=35, 23% vs. contemporary n=19, 13%, $\chi^2(1)=6.6$, p=0.010). The breakdown of surgical procedures is shown in Table 3. Surgical categorization schemes can be found in the online Appendix (available at cuaj.ca).

Patients in the contemporary cohort had significantly higher odds of having a physician specialist service consulted during admission (OR 2.9, 95% CI 1.6–5.2, p<0.001). Odds of unplanned procedures (takeback operation room or interventional radiology procedures), escalation of care to a higher level, or interdisciplinary consults were not significantly different (Table 4).

Average LOS was similar between the two cohorts (historic=3.7 vs. contemporary=4.2 days, p=0.3), despite increased medical complexity in the contemporary cohort. This stability in LOS may reflect advancements in clinical protocols, improved care coordination, and enhanced hospital efficiency over time. Multiple linear regression was used to determine significant drivers of LOS using the entire cohort (n=300). The model explained 51% of variance in LOS ($R^2=0.51$, adjusted $R^2=0.501$), and was statistically significant ($F[7, 292]=44.86$, p<0.001).

Having had open abdominal surgery was associated with a 4.1-day increase in LOS compared to those who did not ($\beta=4.1$, standard error [SE] 0.903, p<0.001). Each additional prescription medication at admission was associated with a 0.55-day increase in LOS ($\beta=0.55$, SE 0.12, p<0.001). LOS increased by 5.4 days for each physician service consulted during admission ($\beta=5.4$, SE

0.37, $p \leq 0.001$). For each specialist seen in the year prior to admission, LOS decreased by 0.79 days ($\beta = -0.79$, SE 0.33, $p = 0.016$). Cohort, age at admission, and CCI scores were not significant determinants of LOS. Two models were run, one with sex included and one without. Sex was not a significant factor in the former, and the latter was the most parsimonious and is reported here. The full model summary is shown in Table 5.

Patients in the contemporary cohort had significantly lower odds of a simple discharge home (i.e., discharged directly to their original residence without new home care supports or intervening transfer to another hospital/care setting) (OR 0.31, 95% CI 0.15 – 0.62, $p < 0.001$).

DISCUSSION

This comparative retrospective chart review of 300 urologic inpatients demonstrates a significant increase in the medical complexity of urologic inpatients over time when comparing cohorts from 2006–07 to 2019–20. This increase was associated with greater healthcare resource utilization and more complex care needs. Patients in the contemporary cohort had higher BMIs, more chronic diagnoses, and a greater degree of polypharmacy. Correspondingly, their CCI scores were also significantly higher.

Before admission, the contemporary cohort exhibited higher healthcare utilization, seeing more non-urology specialists and experiencing more frequent hospital admissions. They were five times more likely to receive home care services prior to admission, highlighting an increased reliance on healthcare services. Within the hospital, these patients required more physician specialist consultations and faced greater challenges in achieving a straightforward discharge.

Interestingly, age did not differ significantly between cohorts, suggesting that increased complexity is not solely attributable to aging. Before our study timeframe, an analysis of patients enrolled in Medicare in the U.S. revealed that urology was the third most frequently seen service among patients >65 years old, and as previously noted, urologists perform a disproportionate number of surgeries on patients in this age range overall.^{12,16} In the present study, however, the lack of significant increase in age in the context of increasing medical complexity and care needs suggests that our study’s findings underscore a broader shift in the clinical complexity of patients requiring urologic care, independent of demographic changes.

Tonelli et al characterized the medical complexity of patients seen among medical specialists and primary

Table 3. Types of interventions performed during admission

Intervention type	Historic (2006–2007)		Contemporary (2019–2020)		Total
	n	%	n	%	
Transurethral resections	38	25%	34	23%	72
Open abdominal surgery	35	23%	19	13%	54
Cystoscopic procedure (non-resection)	20	13%	23	15%	43
Other open surgery ^a	13	8.7%	8	5.3%	21
Ureteroscopy ± intervention	12	8.0%	12	8.0%	24
None	11	7.3%	17	11%	28
Laparoscopic surgery	10	6.7%	10	6.7%	20
Percutaneous stone surgery	6	4.0%	6	4.0%	12
Other ^b	3	2.0%	11	7.3%	16
IR procedures	2	1.3%	8	5.3%	8
Robotic surgery	0	0.0%	2	1.3%	2
Total	150		150		300

^aIncludes artificial urinary sphincter placement/removal, sling procedures, inguinal, penile, and crural surgeries. ^bIncludes sacroneuromodulator placement, suprapubic catheter placement.

Table 4. Logistic regression analysis for admission characteristics/outcomes: Comparison between contemporary and historical cohorts

Admission characteristic	Odds ratio (95% CI)	Historic n (%)	Contemporary n (%)	p
Unplanned OR	1.3 (0.47–3.6)	7 (4.7%)	9 (6.0%)	0.4
Unplanned IR	2.06 (0.61–7.0)	4 (2.7%)	8 (5.3%)	0.19
Escalation of care	1.7 (0.40–7.2)	3 (2.0%)	5 (3.3%)	0.4
Non-urology service consult	2.9 (1.6–5.2)	20 (13%)	46 (31%)	<0.001*
Interdisciplinary consult	1.04 (0.60–1.8)	33 (22%)	34 (29%)	0.5
Simple discharge home	0.31 (0.15–0.62)	138 (92%)	117 (78%)	<0.001

Odds ratios calculated through logistic regression. *2-tailed p-value, $p < 0.05$. *Simple discharge home = discharged directly from hospital to place of prior residence without the establishment of new home care resources. CI: confidence interval.

care physicians using nine markers of patient complexity, including multiple comorbid diagnoses, higher numbers of prescription medications and polypharmacy, multiple physician or specialist involvement in care, being a resident of a long-term care facility, and admission to hospital.⁶ When analyzing 2.5 million patients over a one-year timeframe, nearly one-third had multiple comorbid diagnoses, with a median of three prescription medications per patient, and the overall complexity of patients was found to vary significantly between

Table 5. Multiple linear regression for drivers of length of stay among urologic inpatients

Factor	Unstandardized coefficients		Standardized coefficients	t	Sig.	95% CI for B		Collinearity statistics	
	B	Std. Error				Beta	Lower bound	Upper bound	Tolerance
(Constant)	2.9	1.7	–	1.7	0.092	-0.47	6.3	–	–
Cohort	-0.29	0.69	-0.018	-0.41	0.7	-1.7	1.08	0.89	1.1
Open abdominal surgery (yes/no)	4.1	0.90	0.20	4.5	<0.001*	2.3	5.9	0.90	1.1
Age at admission	-0.028	0.030	-0.050	-0.93	0.4	-0.088	0.032	0.57	1.8
# of prescription Rx at admission	0.55	0.12	0.22	4.7	<0.001*	0.32	0.78	0.80	1.3
# of physician specialists seen in the year prior	-0.80	0.33	-0.11	-2.4	0.016*	-1.4	-0.15	0.76	1.3
CCI	-0.15	0.18	-0.048	-0.84	0.4	-0.49	0.20	0.52	1.9
# of inpatient physician services consulted during admission	5.4	0.37	0.65	15	<0.001*	4.7	6.2	0.85	1.2

Dependent variable = length of stay (days). *Statistically significant. CCI: Charleson comorbidity index; CI: confidence interval.

specialties.⁶ Our findings suggest that urologists are caring for a relatively complex patient population when compared to other medical subspecialists.

Despite these complexities, LOS remained similar between cohorts (4.2 vs. 3.7 days, $p=0.3$). The reduced need for open abdominal surgeries in the contemporary cohort may have counterbalanced the effects of increased comorbidities. Indeed, while the type of interventions performed between cohorts was similar overall, the proportion of open abdominal surgeries was significantly smaller in the contemporary cohort (13% vs. 25%), which was found to be a key driver of LOS in our regression analysis, accounting for an additional four days in hospital. We propose that increased medical complexity and care needs may mitigate potential reductions in LOS expected with less invasive surgical approaches. This is supported by previous work showing poorer outcomes for patients with frailty regardless of degree of operative stress, including for relatively low levels, such as in cystoscopy.¹⁷

While the number of open abdominal surgeries decreased in the contemporary cohort, there was not a proportional increase in laparoscopic or robotic surgeries, reflecting the transition to less-invasive approaches, as one might expect. Multiple factors likely contribute to this difference, including changes in operative indications for prostate cancer and increasing prevalence of active surveillance over time. Additionally, more patients underwent interventional radiology procedures or had medical (i.e., non-operative) admissions in the contemporary cohort, helping to account for this difference.

Interestingly, non-urology physician specialist involvement had opposing effects on LOS, dependent on the timing of specialist involvement relative to admission. Each non-urologist a patient had seen in the year prior to admission decreased LOS by 0.79 days, while each specialist service consulted during admission contributed 5.4 days to LOS in our regression analysis. This suggests that pre-admission optimization of non-urologic care may have a protective role for urologic inpatients. The difference in the scale of these effects is likely due to the time necessary to correct and observe acute issues in the inpatient setting compared to issues dealt with through outpatient followup.

Polypharmacy was prevalent among both cohorts, but contemporary patients had significantly higher numbers of prescription medications on admission (4.3 vs. 3.4). In our regression analysis, each prescription medication at the time of admission contributed 0.55 days to LOS. Both polypharmacy and multimorbidity present a challenge to traditional single-disease treatment approaches, which may not account for multiple drug interactions and impacts on other comorbid conditions.^{18,19} Collaboration with multidisciplinary colleagues, in particular clinical pharmacists, offers a means of reducing drug-related adverse events, decrease LOS, and improve emergency department visits and re-admission rates in a cost-efficient manner for increasingly complex patients.^{20,21}

Clinical implications

Our findings highlight critical areas for intervention. Strategies such as pre-admission optimization, interdisciplinary care models, and closer outpatient monitoring could mitigate hospital resource use. Incorporating clinical pharmacists to manage polypharmacy could reduce adverse drug events, emergency department visits, and readmissions.

Limitations

Our study has several important limitations. Firstly, as a retrospective chart review, the quality of our data is dependent on the availability and reliability of data in the electronic medical record. Overall, nearly all data points we set out to collect were reliably available; however, important socioeconomic variables, such as income, cultural and gender identity, and languages spoken, were not available to be incorporated into our analysis. While the distribution of surgeries/procedures performed was similar between cohorts overall, the contemporary cohort included only two cases of robot-assisted laparoscopic surgery, which may be an under-representation of current real-world urologic practice.

CONCLUSIONS

In this comparative retrospective chart review, the medical complexity of urologic inpatients was shown to have increased over time and is not simply explained by caring for an aging population. Contemporary urologic inpatients have a larger burden of comorbid chronic disease, and a greater degree of polypharmacy requiring more non-urologist physician involvement in care. This increase in complexity appears to mitigate potential decreases in LOS expected from a transition toward less invasive surgical approaches over time. Efforts to optimize chronic disease management prior to admission, and the incorporation of multidisciplinary roles such as clinical pharmacists, may help to improve the outcomes and economics of delivering care to the increasingly complex patient population under the care of urologists. A future prospective study is needed to better identify complex urologic inpatients and develop strategies to improve the care we provide to them.

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CORRESPONDENCE: Dr. Kaveh Masoumi-Ravandi, Department of Urology, Dalhousie University, Halifax, NS, Canada; kv260656@dal.ca