Lack of Diversity in Minimally Invasive Bladder Outlet Surgery Among Urologists in the United States

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ABSTRACT

INTRODUCTION: New bladder outlet procedures have been introduced in the last decade, but there has been limited research into procedural uptake and diversification at provider and regional levels. In this study, we investigated trends in these procedures within Medicare over a six-year period. We hypothesized that provider age and rurality would be associated with procedural diversity.

METHODS: We conducted a retrospective analysis of bladder outlet procedures in Medicare data from 2014 to 2019, including transurethral resection of prostate (TURP), Greenlight laser vaporization (GL), UroLift (UL), Rezum (RZ), and laser enucleation (LEP). Data were analyzed by provider and U.S. census region. Vector autoregressive modeling was used to test the hypothesis that greater procedural diversity would be found in more urban regions with younger providers.

RESULTS: In 2019, a sample of 2747 Medicare providers performed bladder outlet surgery nationwide. 81% performed one type of procedure, whereas only one performed more than three types. TURP was favored across all regions. TURP and GL volume decreased while UL increased over the study period; RZ and LEP were less common. Two regions, the Northeast and West, demonstrated significantly greater procedural diversity, but differences could not be attributed to provider age or rurality at the national level. In the regional analysis, however, rural areas with less variation in provider age had slower uptake of newer procedures ($p = 0.022$), and urban areas with more variation in provider age demonstrated more rapid uptake ($p = 0.008$).

CONCLUSIONS: While TURP continues to be the most common bladder outlet procedure, there is steady adoption of new technologies with complex patterns of uptake based on provider age and rurality. Understanding the dissemination of new procedures and the appropriate role of procedural diversification may help to improve both access to and quality of care.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition characterized by the proliferation of normal prostate tissue which affects nearly all men beyond the age of 80 years.[1] This often leads to the clinical presentation of benign prostatic enlargement (BPE), which, if refractory to behavioral and medical therapies, can require surgery. The historical gold standard procedure for BPE-related symptoms is transurethral resection of the prostate (TURP), removing prostatic tissue using monopolar or bipolar electrocautery.[2] Alternative transurethral approaches involve Greenlight vaporization (GL) and Holmium or Thulium laser enucleation (LEP).[3] Newer minimally invasive technologies, including Rezum water vapor therapy (RZ) and prostatic urethral lift, or Urolift (UL), have also been introduced in the last decade.[4] These procedures have been shown to be safe and efficacious, but there is sparse comparative evidence between therapies.[3] Certain technologies appear to have better efficacy for larger glands or lower risk of retrograde ejaculation, which can be advantageous for certain patients.[5,6] Side effect profile can be the dominant consideration for patients when considering options.[7,8]

Despite the significant array of bladder outlet procedures, there has been little research into procedural uptake and diversification. Early studies focused on trends of TURP volume with the advent of laser enucleation, showing that while TURP remained the most common, its rate of use declined with increased enucleation.[9,10] Other analyses have assessed a wider variety of surgeries but relied on self-reported data, such as case logs and surveys.[11,12] The effect of practice characteristics like provider age and rural versus urban setting on the types of available procedures also remains unclear. This may be important because prior research has shown that rural communities have limited access to specialty urologic care.[13,14] One study found that only 2.4% of U.S. urologists practiced in a rural setting, and 48% of them were older than 65 years of age. In this study, we sought to investigate the national and regional diversification of procedures for BPE-related LUTS over a recent six-year period. We hypothesized that younger providers practicing in urban areas would have greater procedural diversity, based on more recent training and potentially greater demand for different procedures in their practice environments. Evaluating this hypothesis might provide useful information on barriers to access to diverse procedures, and potentially how to anticipate trends with the advent of newer technologies.

MATERIAL & METHODS

We conducted a retrospective analysis of bladder outlet procedures in publicly available Medicare data from 2014 to 2019. Procedures were identified by CPT code and included TURP (52601), GL (52648), UL (52441), RZ (53854), and LEP (52649). Rural composition, obtained from the U.S. census, and provider age were compared to uptake of newer procedures over time, defined as increasing rates of UL RZ, and LEP compared to the older TURP and GL. We performed a two-step analysis, first examining national trends, then focusing on our practice region, New England.

At the national level, we sought to understand how differences in provider characteristics influence procedural diversity. Data were analyzed by four U.S. census regions, South, Midwest, West, and Northeast. We directly incorporated provider age and rural composition into the New England analysis. Provider age was characterized by mean and kurtosis, the first and fourth centralized moment of the distribution. Kurtosis represents the heaviness of tails of a distribution and, in this context, helps to differentiate workforce profiles. Positive kurtosis was expected for either a very low or very high mean provider age. For a mean provider age that was not particularly high or low, positive kurtosis suggested that most providers were mid-career, whereas negative kurtosis indicated that the provider population was actively turning over, with older providers retiring and younger providers entering practice.

We hypothesized that more rural regions have older providers and a lower rate of newer procedures. To test this, we used vector autoregressive modeling. A quadratic function representing the average change over time for procedure nested within each state was utilized. For example, there was a quadratic function estimated for the change in TURP over time in Rhode Island, a quadratic function for REZUM over time in Rhode Island, a quadratic function for UROLIFT over time in Rhode Island, etc. Then there was a quadratic function for TURP over time in Connecticut, and a quadratic function for REZUM over time in Connecticut, and so on again. This method covered each procedure in each state within the region. This methodology jointly modeled average level and increase or decrease over time, as well as common associations at specific time points across the dataset. Estimation was accomplished using the SAS procedure PROC GLIMMIX. Random effects were included to account for unique changes in procedure and state. Additionally, an autoregressive component was estimated for each procedure to avoid violating the assumption of independence. Reported results were based on the data-centered and standardized Z scores by year and state. This permitted direct comparison of the estimates as relatively high or low, accounting for the overall average level and scaled to variation in procedure usage. Additionally, this allowed for differences between averages to be represented as the standardized effect size Cohen's d.

RESULTS

National

In 2019, a total of 2747 Medicare providers performed bladder outlet surgeries. The mean age of providers was significantly lower in the Midwest ($Z = 2.20$, $p = 0.033$, see **Figure 1**). No meaningful differences in rural populations were identified by region ($p > 0.05$).

81% of providers performed one type of procedure, 18% performed two procedures, and 1% performed three procedures. One provider performed four procedures, and none performed all five procedures. In every U.S. region, most providers favored TURP [**Table 1**]. The two least popular procedures were consistently LEP and RZ.

Temporal trends in the average number of procedures per state between 2014 and 2019 are shown in **Figure 1**. TURP accounted for the most procedures every year, but its prevalence and that of GL decreased over the six-year study period. There was a consistent increase in UL cases. LEP and RZ were steadily less common.

Figure 2 summarizes the uptake of newer procedures, defined as increasing rates of UL, RZ, and LEP compared to

Figure 1. Mean and skew of provider age densities by U.S. census region. Kurtosis is inferred from the visual representation of the distribution.

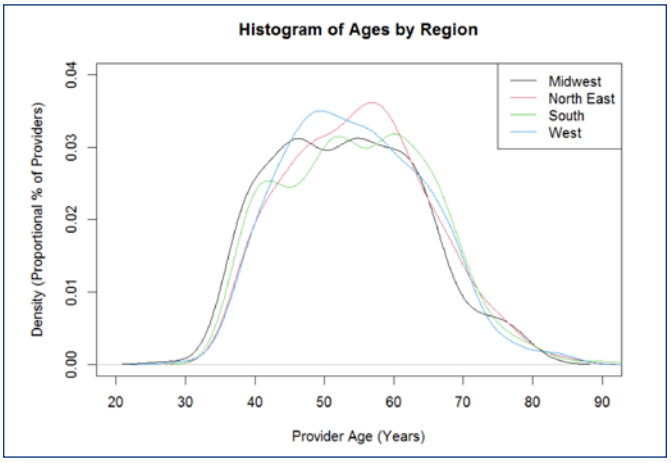

Table 1. Types of procedures favored by urologists by region in 2019.

Region	TURP	Greenlight	UroLift	Rezum	HoLEP
Pacific	145	40	77	26	14
East South Central	86	13	46	3	8
West South Central	159	61	46	16	14
Mountain	97	40	66	25	6
New England	45	28	12	0	8
South Atlantic	278	99	167	20	17
West North Central	81	27	58	9	7
East North Central	128	96	75	21	21
Mid-Atlantic	94	48	92	22	13

Figure 2. Change in average number of procedures per state between 2014 and 2019.

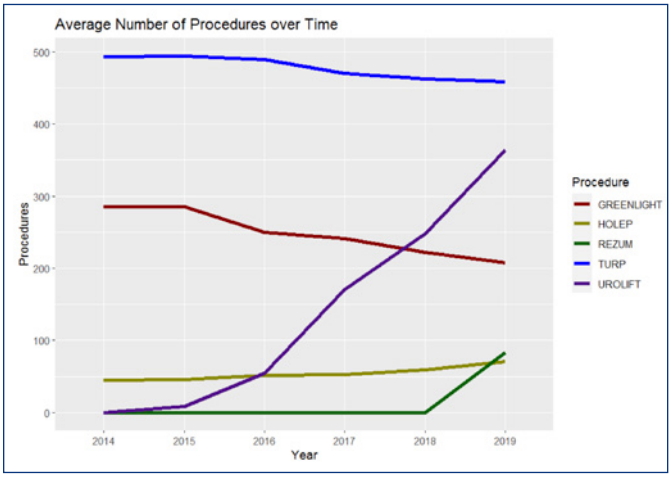

Figure 3. Average difference in established versus newer procedures by U.S. region.

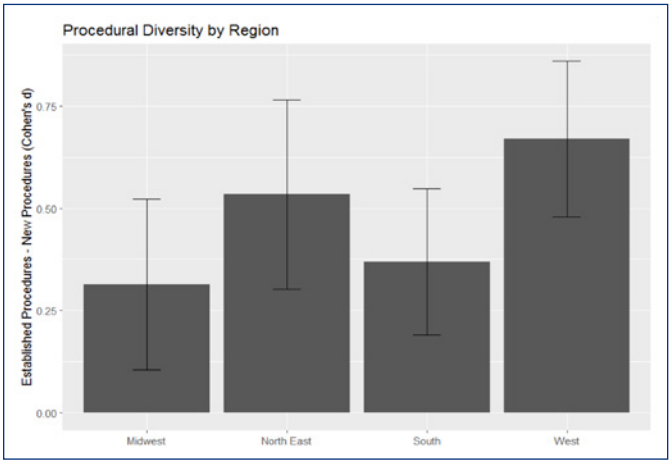

Table 2. Multivariate time series analysis of procedure rates (linear change in number of procedures performed over time) and utilization among providers in New England from 2014 to 2019.

	Procedures					Providers				
	Estimate	Error	df	t	p	Estimate	Error	df	t	p
TURP	0.46	0.07	145	6.58	<0.0001	0.04	0.08	145	–0.54	0.5917
Greenlight	0.00	0.11	145	0.00	>0.9999	0.00	0.11	145	0.00	>0.9999
UroLift	0.98	0.11	145	8.69	<0.0001	0.51	0.06	145	7.91	<0.0001
Rezum	0.50	0.08	145	6.63	<0.0001	0.08	0.05	145	1.60	0.1115
HoLEP	0.32	0.07	145	4.59	<0.0001	-0.02	0.05	145	–0.29	0.7685

TURP and GL, in four U.S. regions. All regions had a significant increase in procedural diversity, but the Northeast and West demonstrated faster rates of adoption (Z = 2.11, $p = 0.035$).

Table 3. Combined effects model of provider age and rural composition on procedural diversity in New England.

Comparison	Cohen's d	Z	p
Procedures (Less Common–More Common)			
Rural area, less spread in provider age	–0.65	–2.29	0.022
Rural area, more spread in provider age	0.77	1.35	0.1766
Urban area, less spread in provider age	–0.06	–0.19	0.8481
Urban area, more spread in provider age	1.36	2.67	0.0076
Providers (Less Common–More Common)			
Rural area, less spread in provider age	–0.74	–2.28	0.0223
Rural area, more spread in provider age	0.52	0.8	0.4243
Urban area, less spread in provider age	0.11	0.3	0.7653
Urban area, more spread in provider age	1.38	2.36	0.0181

Regional

Of the 93 Medicare providers in New England who performed bladder outlet surgeries in 2019, 90% performed only one procedure; 10% of providers performed two different procedures, and none performed more than two procedures.

While procedure and provider counts for TURP and GL declined over the five years, there were simultaneous increases in the UL and LEP data [**Figure 3**]. Longitudinal analysis of data spanning 2014 to 2019 revealed highly significant associations between four procedures [**Table 2**]. Estimates for TURP, LEP, UL, and RZ were positive, indicating that their uptake contributed to diversification in areas with a high case volume. The exception was GL, which showed no association with other procedures. At the provider level, there was no relationship between different procedures.

Table 3 represents the comparison of four groups defined by rural versus urban composition and distribution of provider age. Rural areas with less variation in provider age demonstrated slower uptake of newer procedures (Cohen's d = –0.65, Z = –2.29, p = 0.0220), whereas urban areas with more variation in provider age demonstrated more rapid uptake of newer procedures (Cohen's d = 1.36, Z = 2.67, p = 0.008).

DISCUSSION

A key aim of this study was to determine whether the introduction of new technologies contributed to diversity in the surgical management of BPE-related LUTS. This did not appear to be true, as most urologists focused on one procedure through 2019. In both national and regional Medicare data, TURP was the most common

procedure. This is consistent with data from Canada, in which TURP represented 91.5% of bladder outlet surgeries.[15]

Providers who elected to incorporate new technologies into their practice seemed to perform fewer well-established procedures. For example, the absolute frequency of GL cases decreased over the study period, while UL demonstrated a significant uptake in both the number of procedures and the number of providers utilizing the technique, particularly after 2016. Specifically in the New England data, there was greater uptake of newer procedures in areas with a higher procedure total, suggesting that diversification might be occurring, but this is not definitive.

Observed trends in procedure utilization are expected and mirror recent studies.[12] Procedures with a lower side effect profile and similar short-term outcomes have had increased popularity.[16-18] AUA guidelines suggest assessment of prostate size and anatomy, as well as clinical factors and patient preferences, in discussions of bladder outlet procedures.[19] The diversity of procedures that are available and limited comparative evidence, however, present an opportunity to study how new technologies disseminate and how providers adopt new techniques, as non-medical factors may influence these trends.

We show that, in general, there is a lack of diversification in bladder outlet procedures at the provider level. This may reflect comfort among providers with procedures with which they have the most experience and that have the most robust long-term evidence. Notably, except for laser enucleation, these techniques can be completed quickly in an ambulatory setting and are easy to learn.[20] It may be that the use of fewer techniques reflects a skepticism of longer-term efficacy of newer procedures, though there may be specific potential benefits, e.g., avoiding ejaculatory disturbances. It may also be that consumer demand for novel therapies is limited in certain communities. Further research is needed to determine the extent to which uptake of new procedures is driven by patients, providers, industry, or some combination.

There are several other potential reasons for a lack of procedural diversification. With larger practices, providers may focus on a particular procedure to develop and maintain expertise, with their colleagues performing alternative procedures when needed or requested. Rural providers tend to be in smaller practices and are older, which may affect interest in learning and performing newer procedures.[13,21] Finally, access to newer technologies may differ between rural and urban settings. Smaller community hospitals may not be able to financially support the resources required to offer new procedures, which require a capital investment.[22]

We investigated how workforce characteristics, specifically provider age and population density, related to changes in surgical practice patterns. At the national level, although the Northeast and West had significantly greater procedural diversity than the Midwest and South, this did not appear to be related to provider age or rurality, contrary to our expectations. However, focusing on data from New England, where the authors practice, we found a regionally specific dynamic. Patients needing bladder outlet surgery who lived in rural areas of New England with less variation in provider age had fewer surgical treatment options. Thus, such patients may face a travel burden to access newer or preferred procedures. These findings support the hypothesis that, at least in certain regions, there are multifactorial risk factors for less procedural diversity that may be accounted for as new techniques become available.

While our results provide important information about temporal and regional trends in the use of procedures for BPH, there are limitations to this research. First, our database only included Medicare providers. Patients with private insurance may have different options available to them, and even Medicare coverage is variable based on location.[9] Second, the procedure code for RZ was not introduced until 2018. Thus, our data demonstrated artificially low utilization of RZ until the last year, and we cannot make claims about the uptake of this newer procedure over time. Finally, we studied only five procedures, but there are others, such as Aquablation, that deserve consideration. Similarly, we did not evaluate utilization of simple prostatectomy, the traditional definitive treatment for prostates larger than 100 mL. Additional research might consider the influence of specific anatomic characteristics, including size, on the uptake of newer procedures for BPH.

Finally, it is an open question whether procedural diversity by a provider versus specialization is uniformly "best". It may be that some providers focusing on BPH care will and should have more quality options to offer patients, while others may focus on a single treatment modality with which they are most comfortable. Thus, analysis at the provider and regional level is important when trying to understand access and equity in this area. Further work to understand procedural uptake and diversification will be important, particularly for conditions where there are multiple viable treatment options, and a heterogeneous disease like BPE/LUTS, to ensure patients can consider the panoply of options that are available to them.

CONCLUSIONS

While TURP continues to be the most common bladder outlet procedure, there is steady adoption of new technologies with complex patterns of uptake based on regional factors. Further work in this area is needed to ensure fair access to diverse bladder outlet surgeries with different advantages and disadvantages. Also, further discussion at the urological societal level will be helpful to explore whether individual urologists should focus on or expand their surgical approach to the management of BPE-related LUTS and how this might affect clinical outcomes.

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Acknowledgments

This work would not have been possible without research program coordinator Taylor Braunagel, MS, and program manager Christopher Tucci, MS, from the Minimally Invasive Urology Institute at the Miriam Hospital. The authors would also like to thank Rebecca Wales, BA, for her assistance with background research, Crow Kopsack for their data compilation, and Dr. Faizanahmed Munshi for his contributions to early abstracts.

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The views expressed herein are those of the authors and do not necessarily reflect the views of the Warren Alpert Medical School of Brown University or the Minimally Invasive Urology Institute.

Disclosures

The authors have no conflicts of interest to disclose. This work was supported by the Minimally Invasive Urology Institute at The Miriam Hospital

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