Micro-cost analysis of reusable compared to affordable single-use flexible ureteroscopes

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KEY MESSAGES

- Investing in a reusable infrastructure may be advantageous for centers performing more than 130 flexible ureteroscopy procedures annually.
- A procedure involving a flexible reusable ureteroscope (fURS) costs $245 CAD based on a yearly volume of 418 annual procedures.
- New, affordable, single-use fURS are entering practice and may require further investigation to assess their clinical and environmental impact.
- Single-use fURS may play a role in preventing reusable ureteroscopes breakages during complex surgical procedures.

ABSTRACT

Introduction: Flexible ureteroscopy is increasingly used for managing upper urinary tract pathologies, particularly kidney stones. With the emergence of affordable, single-use flexible ureteroscopes (fURS) as an alternative to reusable systems, the contemporary economic impact of each device is unclear. We performed a micro-cost evaluation comparing reusable fURS with two single-use models in a single-payer Canadian healthcare system.
Methods: The costs of reusable fURS were divided into acquisition, repair, and reprocessing expenses. Per-procedure costs for reusable fURS were calculated by dividing the total annual costs by the average annual number of procedures, whereas single-use costs were based solely on device prices. The total number of repairs and specific reasons for repairs were also collected for the entire reusable fURS fleet from 2022–2024.
Results: At our center, an average of 418 procedures were performed annually using reusable fURS, with total annual costs of $102 420.60, equating to $245.03 per procedure. Reusable fURS become more cost-effective at volumes exceeding 130 cases compared to EU-Scope™ US 31E-12 and 83 cases compared to the Standard LithoVue™. Additionally, 65 repair events were

recorded from 2022−2024, mainly due to distal tip leakage (77%). One repair was required for roughly 20 procedures (20.22:1).
Conclusions: Our analysis indicates that reusable systems are more cost-efficient in high-volume settings, while single-use devices, especially the EU-Scope™, may be advantageous in lower-volume centers. In tertiary centers, the use of single-use fURS represents an excellent opportunity to preserve the durability of reusable fURS, particularly during complex procedures with a high risk of ureteroscope damage.

INTRODUCTION

Flexible ureteroscopy is an essential tool in the diagnosis and treatment of upper urinary tract pathologies, especially kidney stones, and its use has dramatically increased for both simple and complex cases.[1-3] Single-use, disposable flexible ureteroscopes (su-fURS) were introduced in 2011 as an alternative to traditional reusable systems, which created ongoing debate surrounding their clinical, environmental and economic impacts.[4, 5] Adoption of su-fURS reduces the risk of patient cross-contamination, reduces post-operative infections and eliminates scope reprocessing delays.[6] However, their outcomes on clinical practice and healthcare spending need additional assessment, especially in a Canadian context.[4]

Since su-fURS arrival, multiple devices have entered the market, with products such as LithoVue™ from Boston Scientific being extensively studied.[7-9] Competition amongst manufacturers has fueled innovation all while reducing device costs. However, su-fURS is variably adopted by hospitals: the cost dynamics of high-volume referral centers with developed endoscope infrastructures differ from those of community hospitals with lower procedure volumes.[10]

In light of these considerations, our study expands upon previous work on su-fURS through a micro-cost analysis of reusable fURS (re-fURS) and two affordable su-fURS models at a Canadian tertiary academic center. Our study provides a comprehensive comparison that not only explores cost differences between different fURS modalities but also enables hospitals to make evidence-based decisions about device selection based on their existing endoscopic cases volume for effective resource allocation.

METHODS

Cost components were categorized into acquisition, repair, and reprocessing costs, as per the methodology outlined by Mager et al. (2018).[9] Operating room costs were excluded from the analysis, as these were assumed to be equivalent for both re-fURS and su-fURS.[11, 12]

Acquisition costs

The acquisition costs for re-fURS were determined based on the capital expenses incurred to purchase nine ureteroscopes (eight URF-V2 and one URF-V3; Olympus, Tokyo, Japan), used in a single center from 2022 to 2024. These costs were amortized over three years, reflecting the average lifespan of a fURS.[7] The capital cost of the endoscope sterilization machine (V-Pro Max; Steris, Dublin, Ireland) was also included in the analysis and amortized over 10 years, reflecting its approximate lifespan (Regional director, STERIS Canada Sales, personal communication).

Repair costs
Our institution holds a repair contract with the re-fURS manufacturer (Olympus, Tokyo, Japan) covering various endoscopic equipment, including flexible fiber-optic and video cystoscopes (CYF models), nasopharyngoscopes (ENF models), and ureteroscopes (URF models). Under this contract, unlimited repairs are provided for a fixed fee of $50.29 per procedure, uniformly applied across all covered devices.

Reprocessing costs
Reprocessing costs were calculated for reprocessing-related labor costs (average reprocessing time of 30 minutes per fURS), manual cleaning, automated sterilization, reassembly and packaging. This information was retrieved from our local medical device reprocessing unit (MDRU).

Procedure volume
Average annual re-fURS procedure volume was estimated by using the frequency of sterilization cycles as a proxy, since each re-fURS is sterilized after every use. Records that were suspected to be entered twice by mistake (i.e. two sterilization cycles for the same scope within 2 hours) were screened and removed. Records were available for April 1st, 2023 through December 31st, 2024, from which average annual re-fURS procedure volumes were extrapolated.

Per-procedure costs
The per-procedure cost for re-fURS were calculated by dividing the amortized scope and the sterilization machine acquisition costs by the average annual procedure volumes added to per-procedure repair and reprocessing costs. For su-fURS, the per-procedure costs were simply the price of individual devices, i.e. $850 and $575 for the Standard LithoVue™ (Boston Scientific; MA, USA) and the EU-Scope™ US 31E-12 (Innovex AnQing Medical; Shanghai, China), respectively (Regional sales manager, personal communication). All costs and calculations were performed using 2025 Canadian dollars ($ CAD).

Repair frequency and causes
Data on the total number of repairs and the reasons behind repairs were collected for the 9 re-fURS fleet between January 1, 2022, and December 31, 2024.

RESULTS
On average, 418 procedures involving re-fURS are performed annually. The amortized acquisition costs totaled $62,000.00 per year. Repair costs totaled $21,021.22 per year. Reprocessing expenses, including manual cleaning, automated washing, assembly and MDRU labor, yielded a total cost of $19,399.38 per year. Taken together, re-fURS incurred $102,420.60 in costs annually, i.e. $245.03 per procedure. Full re-fURS cost breakdown is presented in Table 1.

Per-procedure su-fURS costs are directly proportional to annual procedure volumes (Table 2). Conversely, re-fURS per-procedure costs are inversely proportional to annual procedure volumes with cost-advantage above 130 and 83 procedures annually compared to the EU-Scope™ US 31E-12 (Innovex AnQing Medical; Shanghai, China) and the Standard Lithovue™ (Boston Scientific; MA, USA), respectively (Figure 1). Assuming acquisition, repair and reprocessing costs similar to those in our institution, su-fURS may offer a more economical option below these volumes, whereas above them, re-fURS prove to be more cost-efficient (Figure 1).

The nine re-fURS fleet required an average of 21.67 repairs per year (65 repairs in total from 2021 to 2024). A repair occurrence increase has been noted in 2024, with 37 repairs recorded, compared to 15 and 13 repairs in 2022 and 2023, respectively. Distal tip leakage was the most common issue, accounting for 77% of repairs (n=50), followed by distal tip breakage (6% of repairs, n=4) and unstable distal tip (also 6% of repairs). Optic end damage (n=2), light dysfunction (n=1), laser obstruction (n=1), controller malfunction (n=1), off-center visualization (n=1), and unspecified breakages were also observed. On average, one repair was required for every 20 procedures (procedure:repair ratio = 20.22:1). See Table 3 for details.

DISCUSSION

Here, we provide a comprehensive analysis of acquisition, repair, and reprocessing costs for re-fURS at a Canadian tertiary referral center in comparison to two available su-fURS devices. We found that re-fURS becomes more cost-effective with higher case volumes, with inflection points varying between disposable scopes. Our findings may offer practical guidance for other institutions. For instance, low-volume centers may benefit economically from investing in su-fURS rather than a re-fURS fleet, whereas high-volume centers could benefit by using re-fURS with su-fURS devices on reserve for cases with a high risk of device breakage.

At our institution, the purchase price for the EU-Scope™ and Standard LithoVue™ were $565 and $850 CAD, respectively. These costs are markedly lower than those published by others, ranging from $1,300 to $3,180 USD.[7, 9] Moreover, a recent Canadian study reported purchase cost of $1,500 CAD and $800 CAD for two su-fURS analyzed.[13] One possible explanation for progressively lower purchase costs is increased competition within the device market as new manufacturers are receiving regulatory approval.[14, 15] Cost-reductions from su-fURS have the potential to reduce overall healthcare costs while expanding access to endoscopic urologic care.

Multiple studies have found comparable efficacy of su-fURS and re-fURS, with one recent meta-analysis of 12 studies finding no significant differences in stone-free rate, operative time, nor post-operative complications.[11] However, as the diversity of su-fURS technologies grows, future research should focus on comparing emerging su-fURS devices directly against each other and against reusable systems to guide evidence-based device selection and ensure that cost savings do not come at the expense of image quality, maneuverability, or patient outcomes.

Consistent with the existing literature, re-fURS costs comprised three main components: acquisition, reprocessing, and repair. In our center, the average cost per case was $245.03 CAD based on an annual volume of 418 procedures. This figure is considerably lower than previously reported values from American ($1180 to $1,743 USD per procedure) or European studies (€480 to €503 per procedure),[7, 9, 16, 17] but is comparable with a recent Canadian analysis, which reported a re-fURS cost of $353 CAD per procedure.[13]

Our slightly deferring results could be partially explained by our analysis including the capital cost of the sterilization machine (V-Pro Max, Steris; Dublin, Ireland), whereas others did not. One main consideration is that this machine is not exclusively used for re-fURS, in fact, it is used for sterilizing many other endoscopic instruments. Therefore, attributing its entire amortized cost to flexible ureteroscopy cases likely overestimates per-procedure expenses. Conversely, this could represent a net cost-reduction for larger centers, as investments in sterilization infrastructure can be distributed across multiple endoscopic instruments, making them more inclined to invest in a re-fURS fleet. For lower-volume centers, su-fURS offer an economic alternative to this important overhead.

Another potential explanation for our differing costs is our amortization scheme. In the present study, we assigned an estimated three year lifespan for re-fURS devices, in accordance with another study.[7] In fact, we were unable to find a consensus on lifespan and amortization time, with some studies amortizing costs across the cases included in their study cohorts,[8-10] or over an empiric six years.[13] This is important to consider as studies amortizing the capital costs of their re-fURS fleet only over the number of cases of their study will artificially inflate per-procedural costs and mislead decision-making. Instead, we favored life expectancy-based amortization with an understanding that actual lifespan depends on a center's procedural volume, fleet size and repair frequency. Having less devices available exposes each re-fURS to more procedures and wear, thereby shortening lifespan. At our center, approximately 418 cases are performed with a fleet of nine re-fURS devices, none of which have been irreparable over the three years for which we have data. Therefore, more data is needed on the lifespan of specific devices.

Repair expenses represent a critical component of re-fURS economics, in fact, studies suggest that they might account for more than half of the per-procedural costs of re-fURS.[7, 8, 10, 13, 16] At our center, a repair contract provides unlimited repairs for multiple endoscopes (i.e. cystoscopes, nasopharyngoscopes, and ureteroscopes) for a fixed fee of $50.29 CAD per procedure, regardless of which device is used. While this model aids in predictable budgeting, it makes the true cost of repair impossible to assess and likely underestimates the real re-fURS per-procedural repair cost. For instance, a recent meta-analysis of 18 studies has revealed an average repair cost of $6,808 USD per event and approximately $441 USD when calculated on a per procedure basis, far exceeding our per-procedural contract value.[18] However, scopes from specific manufacturers may involve lower or higher prices. In fact, one study reported repair costs of $292 CAD per procedure when analyzing their entire fleet, with this falling to $96 CAD per procedure when analyzing Olympus devices' repair costs specifically, a figure much closer to our contract and significantly lower than previously reported data.[13] Future studies should report device-specific repair data to improve comparability. Once again, it is interesting to highlight the fact that centers with developed endoscopic infrastructure are often able to negotiate economically favorable service agreements and would therefore be encouraged to adopt re-fURS.

Perhaps a promising strategy to maximize cost savings without sacrificing performance is to selectively allocate su-fURS for procedures that carry a higher risk of re-fURS damage. Ventimiglia et al. (2022) reported that re-fURS lifespan increased by 40% when integrating su-fURS for complex procedures, delaying the need for repair from 35 to every 49th procedure.[19] At our institution, we observed an average inter-repair interval of 20 procedures. However, our findings are nonetheless longer than the 15-procedure interval reported by one meta-analysis.[18] Moreover, we have anecdotally (i.e. not in a formal study context) noted that breakages were frequent when tip-bendable suction sheaths are employed. This likely reflects the wear caused by the fact that the scope is used to direct the sheath in the desired location within the kidney, therefore adding a counter-deflection stress to the scope's tip, especially when treating stones in the lower pole. This is a very interesting aspect to consider, and future studies should aim to identify procedure types and characteristics (e.g. stone burden, stone location, and use of suction sheaths) that are most associated with breakages and assess how deploying su-fURS for those cases affects the longevity of a re-fURS fleet and its overall costs.

Beyond costs, the environmental footprint of endourologic instruments requires further consideration. Only two studies were found comparing the environmental impact of re-fURS to su-fURS. One found a slightly higher carbon footprint for re-fURS devices (4.47 kg CO_2 equivalents [CO_{2eq}] compared to 4.43 kg CO_{2eq}).[20] Conversely, the other found emissions of 1.2 kg CO_{2eq} and 4.9 kg CO_{2eq} for re-fURS and su-fURS, respectively.[21] Emissions were mainly driven by device reprocessing for re-fURS and production for su-fURS. Given the limited number of environmental studies on ureteroscopes, it would be helpful to examine literature on other endoscopes for relevant insights. One study found that su-cystoscopes emitted 1.42 kg CO2eq per case compared to 2.22 kg CO2eq for reusable devices.[22] Another found that su-cystoscopes emitted 2.40 kg CO_{2eq} per case, compared to 0.53 kg CO_2 for reusable devices.[23] Yet another found that each case emitted 2.06 kg CO_{2eq} compared to 3.08 kg CO_{2eq} for reusable devices.[24] A fourth study found values of 2.41 kg CO_{2eq} and 4.23 kg CO_{2eq} for single-use and reusable cystoscopes, respectively.[25] However, the latter findings were subject to criticism, with Rizan et al. (2022) recalculating 3.09 kg CO_{2eq} and 1.35 kg CO_{2eq} for the single-use and reusable cystoscopes used by Hogan et al. (2022), highlighting the difficulty of calculating CO_{2eq}, with computational assumptions sometimes resulting in drastically different conclusions.[26] Similarly, when accounting for waste associated with cystoscope reprocessing, Bertolo et al. (2024) calculated that 3kg of waste was saved per case employing su-cystoscopes (i.e. 15 CO_{2eq}). Given the relative size increase of ureteroscopes (i.e. length), this figure may be even greater for re-fURS. Moreover, device reprocessing often requires ecotoxic chemicals which may be harmful to aquatic organisms, as well as significant energy and personal protective equipment.[27] Interestingly, in a systematic review of environmental impact studies across specialties using standardized criteria, multiple studies favored single-use endoscopes, with the aforementioned studies by Davis et al. (2018), and Hogan et al. (2022) being poor in quality.[28] Whether utilizing disposable or reusable devices, medical waste is a significant concern. However, waste can be incinerated to generate energy, or at times be recycled to reduce the need for primary materials, although little operating room plastic is actually recycled.[29] Some companies, for instance Ambu (Denmark) and Stryker (USA), have programs to recuperate and/or reprocess devices, thereby mitigating waste generation from an institutional perspective. Moreover, certain devices incorporate the partial use of bioplastics derived from food waste (e.g. used cooking oil reducing CO_{2eq} by 70%) (Ambu A/S, Denmark). Further robust studies decorticating the lifecycle emissions of endoscopes, as well as surgical plastic and its lifecycle will be helpful in determining the environmental impact of these devices.

Our study offers an up-to-date micro-cost analysis of reusable and two newly affordable su-fURS models, providing valuable benchmarks for institutions considering reusable endoscopic investments. However, some limitations should be acknowledged. As a single-center assessment, the findings reflect our local practice patterns, such as the repair contract potentially underestimating true repair expenses. In contrast, attributing the full cost of a shared sterilization system to ureteroscopy may overestimate the resulting costs. Moreover, our study does not account for clinical outcomes. Future studies should therefore compare the efficacy of those emerging, lower-cost su-fURS in both laboratory (in vitro) and clinical (in vivo) settings to assess their technical performance and patient outcomes, such as stone-free rates and complications. Finally, a long-term assessment of the adoption of hybrid fURS strategy could provide insight into the potential cost savings and clinical outcomes of using su-fURS selectively for complex cases.

CONCLUSIONS

Our micro-cost analysis illustrates a new affordable su-fURS and found that re-fURS become more economical after 83 LithoVue™ cases and 130 EU-Scope™ cases. While reusable systems offer greatest savings in high-volume centers, single-use devices, particularly the lower-cost EU-Scope™, might be an attractive option for lower-volume centers. In tertiary centers, selectively deploying su-fURS for complex, high-risk cases may help protect reusable scopes from damage, further extending their service life and optimizing overall cost-effectiveness.

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FIGURES AND TABLES

Figure 1. Cost per case for reusable and single-use flexible ureteroscopes based on number of cases.

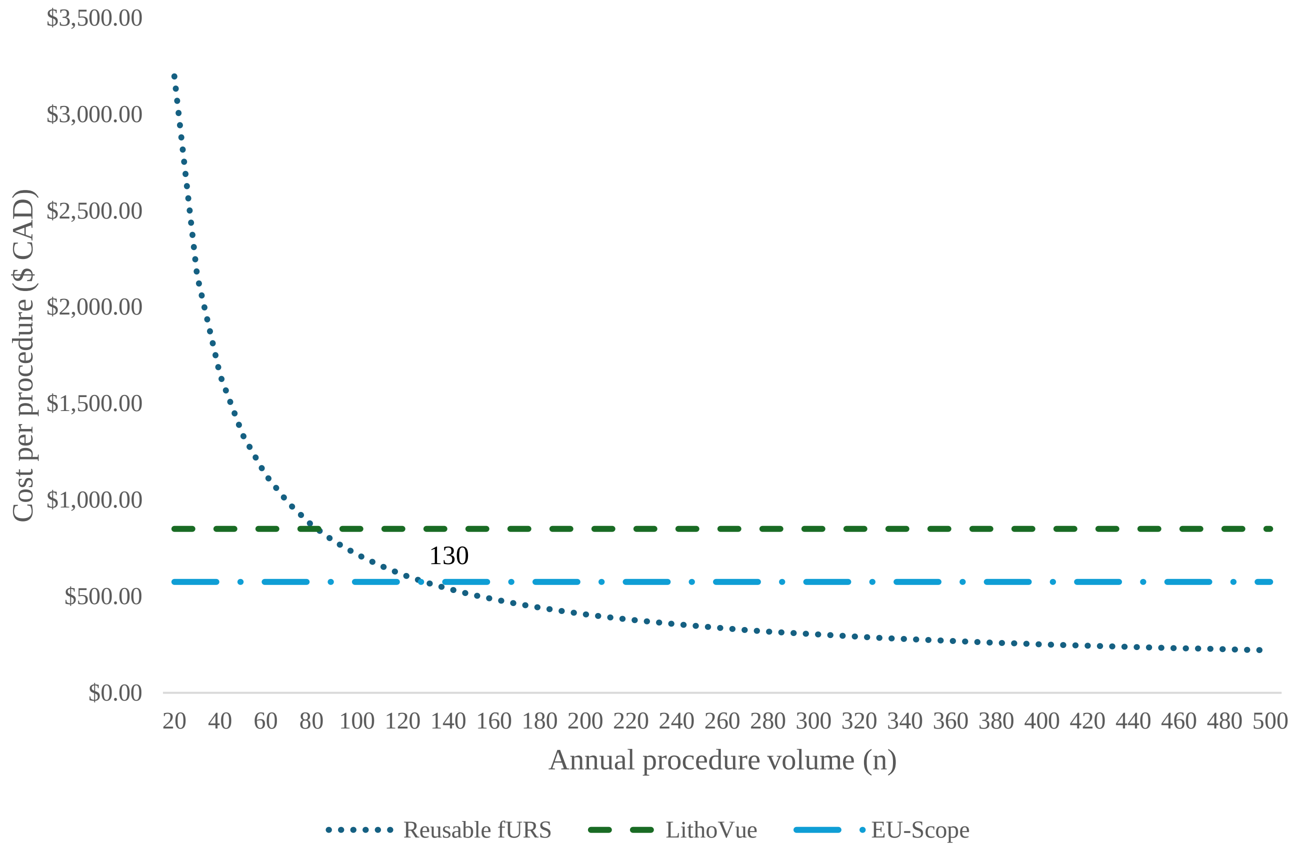

Table 1. Estimated annual costs for reusable flexible ureteroscopes					
	Quantity (n)	**Cost per unit ($CAD)**	**Total cost ($CAD)**	**Amortization (years)**	**Annual cost ($CAD)**
Acquisition					
Ureteroscopes	9	16 000.00	144 000.00	3	48 000.00
Sterilization machine	1	140 000.00	140 000.00	10	14 000.00
Total acquisition					62 000.00
Repair					
Ureteroscopes repairs	418	50.29	21 021.02	1	21 021.22
Total repair					21 021.22
Reprocessing					

Manual cleaning	418	14.04	5868.72	1	5868.72
Automated washing	418	2.43	1015.74	1	1015.74
Assembly and sterilization	418	14.94	6244.92	1	6244.92
Labor	418	15	6270.00	1	6270.00
Total reprocessing					19 399.38
Total annual cost					102 420.60
Total cost per procedure					245.03

Table 2. Estimated annual costs for reusable and single-use flexible ureteroscopes

Model	**Cost per procedure ($CAD)**	**Estimated annual volume**	**Annual cost ($CAD)**
Standard LithoVue^{TM}	850.00	418	355 300.00
EU-Scope^{TM}, US 31E-12	575.00	418	240 350.00
Reusable fleet of 9 re-fURS	245.03	418	102 420.60

fURS: flexible ureteroscopes.

Table 3. Repair frequency and causes for the fURS fleet from 2022 to 2024

Repair reasons	**Occurrence in 2022**	**Occurrence in 2023**	**Occurrence in 2024**	**Total**	**Mean yearly occurrence**
Distal tip leakage	11	11	28	50	16.67
Unstable distal end			4	4	1.33
Distal tip breakage	1	1	2	4	1.33
Optic end damage	1		1	2	0.67
No light output	1			1	0.33
Laser obstruction		1		1	0.33
Remote control malfunction	1			1	0.33
Off-center visualization			1	1	0.33
Unspecified breakages			1	1	0.33

Total	15	13	37	65	21.67
Procedure to repair ratio					20.22:1