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ORIGINAL RESEARCH

Laryngoscope Investigative Otolaryngology

Single-use versus reusable rhinolaryngoscopes for inpatient otorhinolaryngology consults: Resident and patient experience

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Abstract

Objectives: Single-use rhinolaryngoscopes were brought to market in 2019 as an alternative to traditional reusable scopes and have garnered interest across settings given portability and potential cost advantages. While single-use was previously evaluated compared to traditional devices, the overall impact to the consult experience for both users and patients has not been captured.

Methods: Eighteen residents performed consults with both single-use and reusable rhinolaryngoscope systems on alternating weeks. A five-question cumulative survey administered across three assessment points over a 12-week period using a five-point rating system to rate favorability. Residents and patients also completed four-point scale surveys following procedure(s) to capture the consult experience. Statistical analyses were performed to measure significance differences between survey responses between the two systems.

Results: Single-use rhinolaryngoscopes received higher overall ratings compared with reusables across each metric captured including overall consult time (4.3 vs. 2.2, $p < .001$), multiscope consults (4.4 vs. 3.1, $p < .001$), patient communication (4.6 vs. 2.1, $p < .001$), teaching opportunities (4.6 vs. 2.1, $p < .001$), and overall ease of use (4.7 vs. 2.6, $p < .001$). Residents rated single-use higher than reusable after each procedure in terms of ease of use (1.07 vs. 2.68, $p < .001$) and visual clarity (1.27 vs. 1.89, $p = .003$), while patients rated single-use higher for understanding of illness (3.9 vs. 3.1, $p < .001$) and understanding of treatment rationale (3.9 vs. 3.1, $p < .001$).

Conclusion: Resident and patient experience feedback favored single-use rhinolaryngoscopes compared to reusable scope technology across multiple surveyed measurables. Single-use rhinolaryngoscopes provide a viable tool for otorhinolaryngologist and other clinicians to perform rhinolaryngoscopy consults.

Level of Evidence: 4.

KEYWORDS
endoscopy, nasopharyngoscopy, rhinolaryngoscopy, single-use

1 | INTRODUCTION

Flexible rhinolaryngoscopes used for otolaryngologic evaluation of the upper airway are handheld devices comprised of a thin, flexible insertion cord and an eyepiece viewing port, or digital chip with an integrated camera, enabling the operator to visually inspect the upper airway. In both inpatient and office clinic settings, flexible rhinolaryngoscopy with reusable (RU) scopes requires multiple pieces of equipment including a light source, light lead, and display monitor.[1] In particular to the inpatient setting where the site of the laryngoscopic examination varies, mobility of this equipment is essential. This is particularly relevant where this equipment can be needed on short notice, such as in the emergency department to rule out urgent airway pathology.[2] Complicating this need for expedient delivery is that flexible laryngoscopes are considered semicritical instruments given their contact with mucous membranes and potentially nonintact skin. High level disinfection (HLD) for the eradication of bacterial, fungal, and viral pathogens is therefore required.[3] While HLD demonstrates near 0% transmission of bacterial and viruses with flexible laryngoscopes,[4,5] HLD can require up to 100 or more steps and nearly an hour to complete one cycle,[6] which can ultimately delay equipment availability.

In 2019, a single-use (SU) flexible rhinolaryngoscope system was brought to market as an alternative to conventional RU rhinolaryngoscopes. SU endoscopes do not require reprocessing as they are sterile out of the package and are disposed of after one use, which may allow for speech language pathologists (SLP) and ENT physicians to perform diagnostic rhinolaryngoscopies and ENT exams more freely without concern of procedural delays due to scope turnaround. In addition, this SU rhinolaryngoscope system includes a portable monitor to display the image from the procedure and does not require the number of individual components for image display as RU endoscope systems, enabling the scope and monitor to be used across departments as needed.

While previous investigations compared the costs of utilizing RU rhinolaryngoscopes versus SU and the overall performance of each endoscope type,[7] analysis of scope type on workflow, user, and patient preferences is limited. This study aimed to compile resident and patient feedback of a new SU rhinolaryngoscope system compared with RU rhinolaryngoscopes during use for inpatient bedside consults.

2 | MATERIALS AND METHODS

This investigation was performed at one major tertiary care center following confirmation from the Mayo Clinic Institutional Review Board (IRB) that no formal IRB was necessary. The study consisted of a 12-week period from 08/2020 to 12/2020 performed by the otorhinolaryngology inpatient consult service that covers consultation requests amongst two hospitals that in total service 2059 patient beds.

2.1 | RU flexible laryngoscopic system

The inpatient consultation service employed 21 flexible fiberoptic laryngoscopes scopes consisting of six different designs employed from three separate brands (Olympus, Pentax, and Vision Science). Scopes were transported from the otorhinolaryngology treatment room located to a patient's room by the inpatient service (Figure 1). Visualization is through the scope eyepiece, with no recording capability. Once used, rhinolaryngoscopes were manually transported back for reprocessing and passed through an EVOTECH® endoscope cleaner and reprocessor (ECR) for disinfection, prior to reuse.

2.2 | Ambu aScope 4 RhinoLaryngo SU system

During the investigation, the inpatient service employed the use of aScope 4 RhinoLaryngo Slim endoscope for flexible laryngoscopic examinations and the aScope 4 RhinoLaryngo Intervention endoscope for tracheoscopies and bronchoscopies. The Slim endoscope has an outer diameter of 3.0 mm making it amenable for use in adult and pediatric patients whereas the Intervention endoscope contains a 2.2 mm working channel allowing for suctioning and application of medicine. Both scopes utilized an external video monitor with recording capability and temporary storage space of recorded exams in place of a built-in eye piece. A modified IV pole was used to transport both the video monitor and scopes (Figure 2). Following completion of the

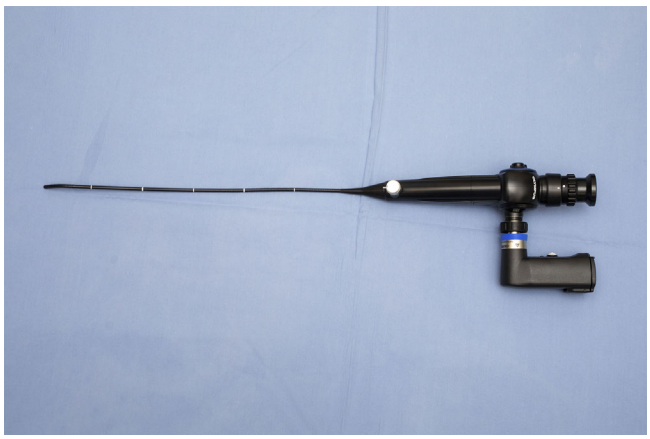

FIGURE 1 A reprocessed reusable flexible laryngoscope that is transported in partially padded containers by the residents for completion of an airway evaluation.

laryngoscopic examination, the scopes were transported back to the treatment room for placement in an Ambu provided recycling bin. The recorded exams were eventually uploaded from the Ambu monitor to a patient electronic medical record.

FIGURE 2 The single use flexible laryngoscopic system set up. An IV pole is modified to transport the Ambu® aView monitor in which the flexible laryngoscopic exam is both visualized and recorded on with a playback feature. The Ambu® aScope 4 RhinoLaryngo Slim endoscope is also conveniently transported on the modified IV pole as well.

2.3 | Study period

During the 12-week study period, the inpatient service alternated between the RU flexible laryngoscopic system and the Ambu aScope SU scope system. Residents on the inpatient service alternated between the two systems on a weekly basis so that only one system (RU or SU) was under focus.

2.4 | Resident cumulative experience survey

A survey designed to assess residents' overall perception and experience with a given scope system was administered to residents who participated in the inpatient service during the trial period. This survey consisted of five questions using a five-point modified Likert scale for responses ranging from 1 (in negative favor of the system) to 5 (in positive favor of the scope system) (Figure 3). Residents were provided these surveys at the start of the study period (baseline) to assess the current RU system. Residents did not complete a baseline survey for the SU system given no prior experience employing it. The survey was completed for both systems at trial midpoint (6 weeks) and endpoint (12 weeks).

2.5 | Resident per use survey

Aside from the cumulative experience surveys, residents on the otorhinolaryngology inpatient system were also asked to complete surveys following each individual use of the SU or RU scope system following each laryngoscopic exam. The survey consisted of four questions that aimed to assess the ease of use and visual clarity during the examination, along with whether a second scope examination was ultimately required due to device failure or if the scope system caused a delay in care (Figure 4).

Resident Cumulative Experience Survey

Resident Year (select one): PGY1/PGY2/PGY3/PGY4/Chief Resident

	Very Slow	Slow	As expected	Fast	Very Fast
How is the overall time to completion of a consult like?	1	2	3	4	5
	Every time	Most of the time	Occasional	Rarely	Never
How often are multiple scope examinations required for a single consult?	1	2	3	4	5
	Very Difficult	Difficult	Satisfactory	Easy	Very Easy
How is the ease of communicating scope exam findings and treatment rational to patients?	1	2	3	4	5
	None	Few	Occasional	Multiple	Many
How are teaching opportunities with the scope system like?	1	2	3	4	5
	Challenging	Difficult	Tolerable	Easy	Very Easy
Please rate the overall ease of use of the scope system	1	2	3	4	5

FIGURE 3 The resident cumulative experience survey consisting of five questions using a five-point modified Likert scale assessing resident's overall perception and experience with either the single use or reusable scope systems.

Resident Per Use Survey	
Year in Residency (circle)	PGY1/PGY2
Scope System Used (circle)	Olympus/Ambu aScope
Time when scope was taken for use	
Time when scope was sent off for cleaning	
Ease of use of the scope	Easy/Mild/Moderate/Challenging
Visual Clarity	Clear/Partially obscured/Moderately obscured/ No clarity
If using an Ambu aScope, was a reusable scope required at any point?	Yes / No
Was there a delay in patient care during the consult secondary to the scope system	Yes / No
Ambu aScope serial number (if used)	
Patient Insurance (Commercial or Medicare)	

FIGURE 4 The resident per use survey, consisting of questions aimed to assess the resident experience with either the single use or reusable scope systems following each subsequent use of a given scope system.

Patient/Patient Family Experience Surveys				
Question	Strongly disagree	Disagree	Agree	Strongly Agree
The scope exam was painful and uncomfortable (patient only).	1	2	3	4
The scope exam performed by the physician helped improve your understanding of your (or your loved one's) illness.	1	2	3	4
The scope exam helped you understand the reasoning behind treatment recommendations.	1	2	3	4

FIGURE 5 The patient/patient family experience survey that was offered to patients and their family members when a scope exam was performed.

2.6 | Patient/patient family experience surveys

Patients and their families were also provided with the opportunity to rate the scope system that was employed during an exam (RU = 11, SU = 32). This was offered throughout the entire trial period when either the SU or RU scope system was currently being employed. The survey measured responses on a four-point Likert scale (Figure 5). If a family member was completing the survey, they were asked not to respond to the first question.

2.7 | Analysis

The mean for each question response for the resident cumulative experience survey was calculated for the baseline, midpoint, and endpoint periods of the study period. Mean responses between the RU scope system and the SU scope system were compared with each other at the midpoint and endpoint periods using the Wilcoxon rank sum test with statistical significance set at a p-value of less than .05. The mean responses for the first two questions of the resident per use survey were calculated and compared between the two scope systems using Wilcoxon rank sum tests. The number of times a new scope was needed during completion of a consultation was recorded along with the percentage of times a patient's care was delayed secondary to difficulties with equipment from the resident per use survey responses. Finally, the mean for each question's response for the resident cumulative experience survey was calculated between the RU scope and SU scope system and compared using Wilcoxon rank sum tests.

3 | RESULTS

Results of the cumulative resident experience with RU and SU scopes over the study period are detailed in Table 1 with additional information in Appendix S1. Given the differences noted above, analyses were run to determine whether or not the overall differences between RU and SU scopes were significant. The findings indicated that SU scopes were generally rated as "fast" or "very fast" to complete a consult by 72% of residents at 6 weeks and later by 83% of residents at 12 weeks whereas RU was rated as "fast" by only two residents at 6 weeks and was not considered "fast" by any resident at 12 weeks. This difference in survey responses was significant across both time points (6-week, RU: 2.7 SU:4.1 $p < .001$; 12-week RU:2.2 SU:4.3 $p < .001$). SU also demonstrated significantly favorable survey responses in regards to the need for multiple scopes to complete an exam across both time points compared with RU (6-week, RU: 2.9 SU:4.3 $p < .001$; 12-week RU:3.1 SU:4.4 $p < .001$) as well as with ease of use (6-week, RU: 2.6 SU:4.5 $p < .001$; 12-week RU:2.6 SU:4.7

TABLE 1 Resident cumulative experience survey results.

Study timeline	Consult completion time (1 = very slow, 2 = slow, 3 = as expected, 4 = fast, 5 = very fast)		p-value	Multiple scopes utilized (1 = every time, 2 = most of time, 3 = occasional, 4 = rarely, 5 = never)		p-value	Patient communication of findings (1 = very difficult, 2 = difficult, 3 = satisfactory, 4 = easy, 5 = very easy)		p-value	Teaching opportunities (1 = none, 2 = few, 3 = occasional, 4 = multiple, 5 = many)		p-value	Ease of use (1 = challenging, 2 = difficult, 3 = tolerable, 4 = easy, 5 = very easy)		p-value
	RU	SU		RU	SU		RU	SU		RU	SU		RU	SU	
Baseline	2.7	NA		3.1	NA		2.1	NA		2.1	NA		2.5	NA	
6-weeks	2.7	4.1	<.001	2.9	4.3	<.001	2.2	4.5	<.001	2.1	4.3	<.001	2.6	4.5	.001
12-weeks	2.2	4.3	<.001	3.1	4.4	<.001	2.1	4.6	<.001	1.9	4.5	<.001	2.6	4.7	<.001

Abbreviations: RU, reusable; SU, single use.

$p < .001$). A major significant difference between SU and RU scopes survey responses was seen with the ease of communicating findings to patients, in which 90% of residents found SU to make communicating findings to patients "easy" or "very easy" at both 6 and 12 weeks whereas the RU was only rated as making communication with patients "easy" by one resident across the entire study period (6-week, RU: 2.2 SU:4.5 $p < .001$; 12-week RU:2.1 SU:4.6 $p < .001$). The greatest significant difference between survey responses was in regards to teaching opportunities, in which 83% and 90% of residents found SU to provide "multiple" or "many" teaching opportunities at 6 and 12 weeks respectively, whereas the RU was rated as providing "none" or "few" teaching opportunities by 83% of residents at 6 weeks and 90% of residents at 12 weeks (6-week, RU: 2.1 SU:4.3 $p < .001$; 12-week RU:1.9 SU:4.5 $p < .001$).

Resident ratings for each scope were captured after a procedure (RU = 19, SU = 41) (Table 2). When considering differences of scopes after each case, SU rated significantly better than RU (1.07 vs. 2.68 $p < .001$) where 1 indicates easy and 3 indicates moderate. When reviewing visual clarity where 1 indicates clear, SU also rated significantly better than RU (1.27 vs. 1.89 $p = .003$). When considering cases requiring a second scope for the exam, no SU cases required a secondary scope while 5% of RU cases needed an additional scope to complete the exam. Lastly, 32% of RU cases saw a delay in patient care, which was secondary to the scope system, compared with only 2% of SU cases.

Patient feedback and experience with the scopes were collected following a procedure (Table 3) (additional detail can be found in Appendix S2). Overall, patients did not find their procedures to be painful with either scope type (1.6 vs. 1.8, $p = .83$). Patients also found that the exam helped to improve their understanding of their illness with SU rating higher (3.9 vs. 3.1, $p < .001$). Similarly, patients noted that the exam helped them understand the reasoning behind treatment recommendations with SU rating higher (3.9 vs. 3.1 $p = .005$).

4 | DISCUSSION

This investigation measured and compared user experiences of RU and SU rhinolaryngoscopes at both the summary and procedural level, while also evaluating the patient experience, which revealed interesting findings across the entirety of the study, and also at the individual level. The application of SU technology amongst otolaryngology resident physicians was previously evaluated through a nationwide survey sent out to all otorhinolaryngology residency programs employing SU scopes for rhinolaryngoscopy. A cost analysis was concurrently performed at SUNY Upstate University.[7] Residents who completed the survey responded favorably to using SU while the cost analysis demonstrated that SU was comparable to the RU system. More recently, SU was evaluated during fiberoptic endoscopic evaluation of swallowing procedures, which found that SU rhinolaryngoscopes were highly rated amongst SLP during these procedures.[8]

While SU scope experience was previously surveyed amongst otorhinolaryngology residents, this is the first investigation to

TABLE 2 Resident per use survey results.

Rhinolaryngoscope type	Ease of scope use (1 = easy, 2 = mild, 3 = moderate, 4 = challenging)	Visual clarity (1 = clear, 2 = partially obscured, 3 = moderately obscured, 4 = no clarity)	Percent of cases requiring second scope exam	Delay in patient care (secondary to scope)
RU ($n = 19$)	2.68	1.89	5%	32%
SU ($n = 41$)	1.07	1.27	0%	2%
p-value	<.001	.003	.3	.005

Abbreviations: RU, reusable; SU, single use.

TABLE 3 Patient/patient family experience survey results.

Rhinolaryngoscope type	Scope exam pain (patient only)	Improved understanding of illness	Improved understanding of treatment
RU ($n = 11$)	1.8	3.1	3.1
SU ($n = 32$)	1.6	3.9	3.9
p-value	.83	<.001	.005

evaluate the experience with SU amongst a group of residents during the adoption of an SU system, with no previous experience with its utilization. This setting allowed for the simultaneous comparison of the SU scopes with the previously employed RU system, which to our knowledge has not been previously completed before. RU scopes rated moderate to low on a five-point scale with the highest rating equaling 3.1. When looking at the assessment from baFalseline to 12-weeks, little improvement was seen, which could be attributed to previous experience with these scopes, but overall ratings only increased by 0.1 and typically decreased by up to 0.5 at each assessment. See Appendix S1 for findings drawn from the independent ratings by clinicians. Although no resident rated the RU system "very slow" at baseline, by the end of the trial period, 17% found the RU scope to be "very slow" related to consult time and 61% rated the scope "slow" or "very slow" by the end of the study, whereas no one rated the system "fast" or "very fast". As it relates to communicating with patients at the baseline assessment, 78% found communicating treatment rationale to be "difficult" or "very difficult." While this decreased, not one respondent at baseline or study completion (12 weeks) found the use of RU for communicating with patients to be "easy" or "very easy." Lastly, no one reported there to be multiple teaching opportunities with RU scopes at baseline or study completion and no one found the RU scope overall, to be easy to use, which differs from what was seen with SU scopes.

SU scopes were rated highly in each category at 6-weeks and 12-weeks, with 4.7 and 4.1 as the highest and lowest ratings, respectively. Resident ratings did not vary significantly between the 6-week and 12-weeks assessments for SU scopes, with most metrics increasing by 0.2 or remaining constant. Similar to responses regarding the RU rhinolaryngoscope system, reviewing the individual physician ratings at each assessment revealed how perceptions changed as they gained more experience with SU. At the 6-week assessment, 72% found consult time with the SU scope to be "fast" or "very fast" and increased to 83% at 12-weeks, whereas no resident felt the SU scope was "slow" or "very slow" at any assessment point. When relaying diagnosis and treatment rationale to patients, as well as providing learning opportunities for staff, 67% found communicating the treatment and findings to be "very easy" with the SU scope, whereas 90% felt the system provided "multiple" or "many" teaching opportunities for residents at 12-weeks. The SU rhinolaryngoscope system is compact and portable with the ability to store images, which may have eased communication and translation between the physician and patient and allowed for other staff and residents to learn about specific conditions or diagnosis by revisiting stored images after the procedure with the lead physician. At both assessments for SU rhinolaryngoscopes, 100% of residents felt the system was "easy" or "very easy" to use, with no resident rating the system lower than "easy" at any point.

When comparing the ratings of each scope system across each assessment point, baseline assessment revealed that 67% of residents noted consult time was "as expected" with RU scopes, but this fell to 39% at 12-weeks with no residents rating the system as "very fast." Conversely, the SU system never received a rating of "slow" or "very slow" at either assessment, with 72% and 83% of residents selecting "fast" or "very fast" consult time at 6 and 12-weeks, respectively. With teaching opportunities, by the end of the study, 22% of residents felt there were no teaching opportunities with the RU system, whereas 90% noted "multiple" or "many" teaching opportunities with the SU scope, and nearly all residents indicated "easy" or "very easy" patient communication with the SU system. Improvement in patient communication and staff education may be due to the digital video and image capability of the SU scope not available with the RU system allowing for senior residents and staff to explain physical exam findings with visual aid of the recorded video.

After procedures using either the SU or RU system, residents completed surveys evaluating the ease of scope use, image clarity of the scope, while patients completed surveys around the knowledge of illness and treatment rationale. Overall, residents and patients rated SU rhinolaryngoscopes higher than the RU system across each metric captured, aligning with the findings from the resident survey. All

patients agreed or strongly agreed that their understanding of the illness and treatment rationale improved following a procedure with a SU rhinolaryngoscope, whereas 18% and 27% of patients disagreed with this assessment following exams with a RU rhinolaryngoscope. This again is likely due to the display capability of the SU system and ability to view visual references of the exam. Given how well received the SU system was during this investigation, it is now the current system employed by the inpatient otorhinolaryngology service.

This study evaluated the user and patient experiences when utilizing RU fiberoptic and SU digital rhinolaryngoscopes and is not without limitations. First, residents who participated in this study had previous experience with the RU rhinolaryngoscope system prior to initiating the study. This may have prevented adaption and significant change in their experience over time as seen with the SU scope system. There was also a threefold difference in the number of patient/family experience surveys collected between RU ($n = 11$) versus SU ($n = 32$) and a twofold difference in the number of SU resident per use surveys completed compared with RU (RU = 19, SU = 41). This is likely secondary to the unblinded nature of this work in which the on-call residents were aware that the SU laryngoscope was under review were therefore more likely to complete the resident per use survey and request feedback from patients and patient's families during a consultation. This difference in survey numbers may have introduced bias to the study results the resident experience and regarding the patients and family member experience. In addition, RU digital rhinolaryngoscopes were not included in the following investigation but could represent a more appropriate comparator as these systems have similar image display capabilities as the SU system. Lastly, participants in this study were from a single tertiary care center solely in the inpatient setting, with no outpatient experience with the scopes. Future studies may consider expanding their study sites and number of participating residents and patients across each scope type.

5 | CONCLUSION

Previously, the Ambu aScope 4 RhinoLaryngo SU rhinolaryngoscope system demonstrated comparable clinical metrics in performance and capability versus RU rhinolaryngoscopes.[7,9,10] The findings from this study show resident and patient experience feedback favored the SU rhinolaryngoscope versus the RU comparator specifically related to ease of use, efficiencies, and the promotion of the patients understanding of their treatment and care. Implementing SU rhinolaryngoscopes could reduce overall procedure time through the reduction or elimination of multiscope consults, while providing more teaching opportunities for residents and improving patient communication through the portable monitor system.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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