Adherence to Long-Term Follow-up in Patients With Sporadic Vestibular Schwannomas Managed With Serial Observation

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Abstract

Objectives. To examine the long-term adherence to serial imaging of patients with sporadic vestibular schwannoma and analyze factors associated with being lost to follow-up.

Study Design. Retrospective chart review with telephone interview.

Setting. Single tertiary care center.

Methods. Patients with a sporadic vestibular schwannoma and started on observational surveillance management between January 2005 and December 2010 were included. Demographic data, tumor size, hearing and vestibular changes, and follow-up length were recorded. Patient factors were analyzed for association with being lost to follow-up.

Results. In total, 122 patients were included with a median length of follow-up of 5 months (range, 0-146). After initial surveillance, 22.1% (n = 27) of patients had a change in management to either microsurgery or radiosurgery. Of the remaining 77.9% (n = 95), nearly half (44.2%, n = 42) never returned for a second visit, and all but 3 were eventually lost to follow-up. There was no association between sex, race, age at diagnosis, initial tumor size, insurance status, household income, or driving distance to hospital and being lost to follow-up. Of 26 interviewed patients initially lost to follow-up, 11 (42.3%) sought care at another institution, 5 (19.2%) chose to no longer receive care, 1 (3.8%) had transportation difficulties, and 9 (36.4%) had poor understanding of their diagnosis or instructions.

Conclusions. The length of follow-up for patients undergoing surveillance of sporadic vestibular schwannoma varies widely, and patients are commonly lost to follow-up. Further efforts should be made to identify at-risk patients and provide adequate education to improve long-term surveillance.

Keywords

sporadic vestibular schwannoma, observational surveillance, follow-up, adherence

Observation of sporadic vestibular schwannoma (SVS) has become a well-accepted route of management for many patients because of low upfront risk, the ability to understand the tumor's behavior, and the option of acting on the tumor if it demonstrates growth.[1-7] While untreated SVS may grow minimally and slowly, a considerable portion of initially small tumors do not grow at all and never require intervention.[4,8-12] However, unpredictable tumor growth may occur, resulting in hearing loss, facial nerve paralysis, or brainstem compression.

Successful observation thus relies on a patient's ability to follow up at regularly scheduled intervals and obtain imaging to track tumor growth. Earlier retrospective studies on observation of patients with SVS report rates of inadequate follow-up between 16% and 43% but with differing definitions of follow-up failure.[13-15] A variety of dynamic patient-centered factors can contribute to failure to follow-up, including prioritizing comorbidities, a lack of understanding of the importance of follow-up, and a desire to avoid intervention, but a number of relatively fixed demographic or systems factors such as age, sex, race, socioeconomic status, hospital accessibility, and insurance ownership could play a role.[13] Despite the rise of serial observation as a management strategy for SVS, there is a paucity of literature devoted to predictors of successful serial observation; therefore, we sought to examine

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the adherence to surveillance over time in patients undergoing serial observation for SVS and to identify predictive patient factors for failure to follow up. Second, we sought to report the natural history of tumor growth, hearing loss, and vestibular dysfunction of these patients over the surveillance period.

Materials and Methods

A retrospective chart review was performed for 122 patients who were found to have SVS between January 2005 and December 2010 at a tertiary care center. Patients with neurofibromatosis type II, whose initial treatment plan included radiosurgery or microsurgery, or who presented after initial intervention were excluded from the study (**Figure 1**). Demographic data, including age at diagnosis, sex, race, insurance status, and home ZIP code, were recorded.

The patient's home ZIP code was used to estimate the travel distance to their surveillance visit. This was based on the average distance between the patient's home ZIP code and the ZIP code of the facility where they received care. ZIP codes were also used to estimate household income based on US census reporting data from the American Community Survey, a 5-year estimate, taken from 2006 to 2010.[16]

The date of the initial clinic visit was used as the first point of contact from which follow-up lengths were calculated. At our institution, the serial observation protocol generally calls for a visit and magnetic resonance imaging (MRI) 6 months after the initial diagnosis, followed by yearly visits with MRIs should there be no significant tumor growth. Occasionally, the length of time between appointments is increased to 2 years for tumors demonstrating little to no previous growth. The process to arrange for follow-up is initiated by a scheduler, who calls the patient after the visit to set up a second visit with a same-day MRI. Since 2010, an appointment reminder system has been in place, through which patients receive reminders via phone call or text. There is no system in place to reautomate reminders if patients do not return for the scheduled visit.

The dates of all surveillance visits for each patient were recorded as well as any plans to discontinue surveillance or increase the length of time between visits. The date of the last observational follow-up visit for all patients was recorded. This date signified either a change in management to radiation or surgery or the date after which a patient was ultimately lost to follow-up (LTFU). The length of follow-up was then calculated from the difference in time between the last recorded date and the date of the initial visit.

Patients were also classified as being partially LTFU or completely LTFU. Patients were considered partially LTFU if they underwent a period of surveillance as recommended and then discontinued this surveillance. Patients were considered completely LTFU if they never returned for surveillance after their initial visit. For the purposes of analysis, patients with both partial and complete LTFU were combined, as these patients are all at risk of missed management opportunities should their tumors grow or they become symptomatic. This stratification was chosen because, independent of time, the outcome of being lost to follow-up constitutes a failure of
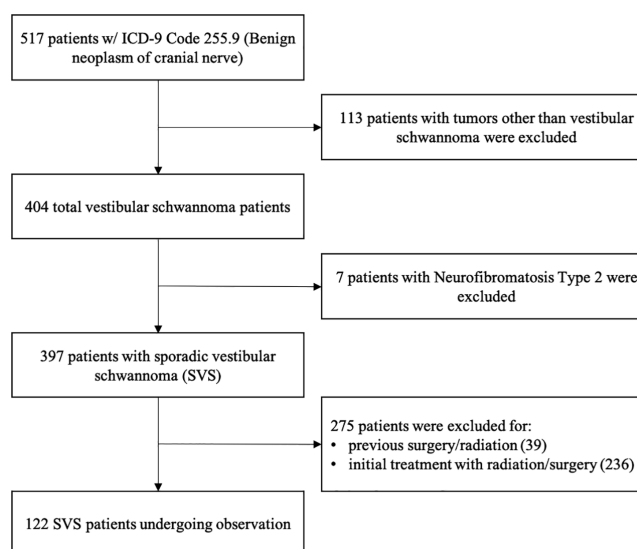

Figure 1. Flowchart demonstrating narrowing of patient population fitting inclusion criteria for this study.

serial observation. The end of the follow-up period was determined to be the time at which this study was conducted, in September 2019. Any patient who failed to appear after a recommended annual visit and subsequently never returned was defined as being lost to follow-up. Patients undergoing surveillance at the time of data collection, who completed surveillance or who underwent treatment crossover, were considered adherent with follow-up.

The date of initial imaging was recorded as the first MRI performed during a planned serial observation, regardless of the location of diagnosis or MRI. The date of each subsequent MRI was recorded. Often, only the MRI report was available, so it was used for documenting tumor size. Because of variability in measurement reporting, tumor dimensions were not analyzed.

Audiometric data were collected from each patient's initial evaluation and consecutive follow-up appointments. The pure-tone average (PTA) was calculated for each patient (from thresholds at frequencies of 500 Hz, 1 kHz, and 2 kHz) at the initial evaluation and monitored for a change over the course of the observational period. Similar methodology was used to evaluate speech discrimination (SD) scores. A significant change was defined as a 10-dB HL increase in PTA or a 15% decrease in SD. This 15% decrease in SD cutoff has been used in previous studies addressing hearing loss. For patients who exhibited a significant change in either variable, time in months from initial audiogram to audiogram that exhibited the drop was recorded.

The severity of subjective vestibular symptoms was recorded at the initial visit and each subsequent visit and categorized as asymptomatic, mild, moderate, or severe. Mild vestibular symptoms were defined by documentation of intermittent disequilibrium, moderate by persistent disequilibrium with multiple episodes, and severe by symptoms prompting presentation to an emergency department or requiring admission. A decrease in vestibular function was defined by a

worsening degree of symptoms based on the above definitions. The time from initial visit to a worsening in vestibular function was calculated.

The researchers attempted to contact all patients who were LTFU by calling 5 times over the course of 2 months. During the interview, patients were asked to recount the instructions they received regarding their diagnosis and treatment and if and how they continued surveillance. Public death records and obituaries were searched for patients who could not be contacted.

The Emory Institutional Review Board approved both the retrospective review and patient telephone interviews for the purpose of this study.

Fisher exact tests, χ^2 tests, independent *t* tests, and Pearson correlation tests were used to analyze association and correlation between patient factors and being LTFU. Kaplan-Meier analysis was used to demonstrate significant changes of PTA, SD, and vestibular symptoms over time, as well as total length of surveillance before being LTFU. Statistical calculations were performed in SPSS version 26 (SPSS, Inc).

Results

Demographics

We identified 517 patients from January 2005 to December 2010 with the *International Classification of Diseases, Ninth Revision* code 225.1, of whom 122 met our inclusion criteria. This data collection span allowed us to capture 9 to 14 years of follow-up. Nearly half of the patients identified as males (47.5%, n = 58) and being white (48%, n = 59). The median (MD) age at the time of diagnosis was 62 years (range, 23-86). Private insurance was held by 43.4% (n = 53), while 34.4% (n = 42) were insured by Medicaid/Medicare. Only 3.3% (n = 4) were uninsured, and the insurance status of the remaining is unknown. The estimated mean household income and driving distance to the facility were $74,36078.6 ± $29,076 and 78.6 ± 110 miles, respectively.

Surveillance Length

The mean and median length of follow-up were 19.4 ± 30 months and 5 months (range, 0-146), respectively, over which time patients underwent on average 2.3 ± 1.4 MRIs and completed 2.9 ± 2 office visits. The plan of observation was discontinued for 22.1% (n = 27) of the main cohort, of whom 59.2% (n = 16) underwent eventual radiation and 40.8% (n = 11) microsurgery. Reasons for treatment cross over included tumor growth alone (52%, n = 14), worsening severity of dizziness (4%, n = 1), facial weakness (7%, n = 2), or tumor growth accompanied by another symptom (37%, n = 10). The median observational length prior to a change in plan was 8 months (range, 1-117), while the median observational length for those with continued observation was 3 months (range, 0-146) (**Figure 2**). Of the remaining 79.9% (n = 95) with plans for continued observation, 42 (44.2%) were completely LTFU, 50 (52.6%) were partially LTFU, and only 3 (3.2%) were not LTFU. These 3 patients either continue their observation or have documentation that further observation is no longer warranted.
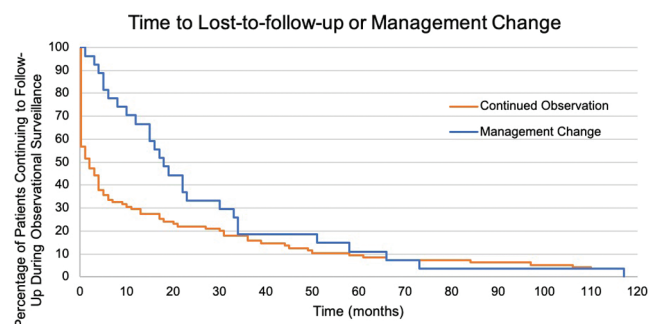

Figure 2. Kaplan-Meier plot comparing the percentage of patients continuing to follow up vs those who had a change in management over the course of 10 years.

Among patients who were eventually LTFU (n = 92), there was a slight negative correlation between length of follow-up and age at diagnosis ($r = -0.31$), initial tumor size ($r = -0.18$), and driving distance to the facility ($r = -0.11$) and a positive correlation with income ($r = 0.11$); however, these were not statistically significant. In addition, there was no significant association between sex, race, age at diagnosis, initial tumor size, insurance status, estimated household income, or driving distance to hospital and eventually being lost to follow-up; however, whites had a lower rate of being LTFU than patients of racial minorities (57.6% vs 84.6%, $P = .112$) (**Table 1**). Within the group of patients who were LTFU in general, a subgroup analysis comparing patients with complete and partial LTFU was performed. Again, there was no significant difference in any of the study variables.

Symptoms

On initial presentation, 96 patients (78.7%) complained of hearing loss (HL) and 59 (48.4%) of dizziness. All but 4 presented with audiometric data, and most showed some objective degree of hearing loss: 22% (n = 26) normal, 23% (n = 27) mild HL, 21.1% (n = 25) moderate HL, 14.4% (n = 17) moderate to severe HL, 8.5% (n = 10) severe HL, and 11% (n = 13) profound HL. Only 47 (38.5%) patients underwent audiograms after their initial visit, of whom 51% (n = 24) demonstrated a significant drop in PTA (of 10 dB HL or greater) at a median of 31 months (range, 3-159). In addition, 53 (43.4%) had documented SD scores over time, of whom 56.6% (n = 23) demonstrated a drop of 10% or greater at a median of 24 months (range, 1-159). Finally, vestibular symptoms were documented over time for 79 (64.8%) patients, of whom 19% (n = 15) had worsening of symptoms at a median of 2 months (range, 1-143). **Figure 3** demonstrates the Kaplan-Meier curves for each of these measures over time as patients continued their observational surveillance.

Patient Interviews

Attempts to contact the 92 patients who were LTFU were made (**Table 2**), and ultimately, 26 patients were interviewed. In total, 42.3% (n = 11) continued their serial MRIs at another institution closer to home; 19.2% (n = 5) electively chose to no longer receive care for their vestibular schwannoma,

Table 1. Association Between Patient Characteristics and Becoming Lost to Follow-up (LTFU).[a]

Characteristic	LTFU	Not LTFU	*P* value
Total	92 (75.4)	30 (24.6)	
Sex			.759
Male	44 (75.9)	14 (24.1)	
Female	47 (73.4)	17 (26.6)	
Insurance status			.552
Medicaid/Medicare	31 (73.8)	11 (26.2)	
Private	39 (73.6)	14 (26.4)	
Uninsured	2 (50)	2 (50)	
Race			.112
White	34 (57.6)	25 (42.4)	
Racial minority	11 (84.6)	2 (15.4)	
Age at diagnosis, mean ± SD, y	62.2 ± 15.2	59.77 ± 9.9	.32
Initial tumor size, mean ± SD (n = 67), mm	7.4 ± 6.2	7 ± 4.1	.812
Household income, mean ± SD, $	73,829 ± 25,495	76,015 ± 28,172	.691
Driving distance to hospital, mean ± SD, miles	81.9 ± 109.3	68.3 ± 113.2	.557

[a]Values are presented as number (%) unless otherwise indicated.
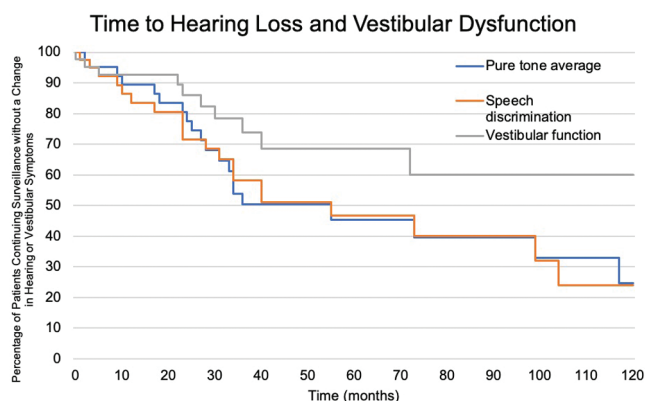

Figure 3. Kaplan-Meier plot of the percentage of patients continuing surveillance without a significant change in hearing or vestibular symptoms.

although they understood their diagnosis and the need for serial imaging; and 34.6% (n = 9) expressed either a poor understanding of their initial diagnosis or their need for follow-up. Three patients had no recollection of ever being told they had a tumor, and the remaining 6 patients recalled their diagnosis but did not recall the recommendation to receive serial scans, although it was well documented within the electronic medical record. Finally, 1 patient expressed issues with transportation. **Figure 4** displays the ultimate status of all patients undergoing observational surveillance as well as results of the phone interviews.

Discussion

In the past 2 decades, there has been a shift in the management of SVS toward conservation, reflecting patterns of increased

Table 2. Results of Patient Interviews (n = 122).

| Characteristic	No. (%)
Crossed over for treatment at same institution	27 (22.1)
Surgical excision	11 (9.0)
Stereotactic radiation	16 (13.1)
Still undergoing follow-up at same institution	3 (2.5)
Lost to follow-up after being seen at same institution	92 (75.4)
Followed up at different institution	11 (9.0)
Electively chose not to follow up	5 (4.1)
Transportation issues preventing follow-up	1 (0.8)
Poor understanding of diagnosis or requirement for serial scans	9 (7.3)
Declined to participate in study	11 (9.0)
Could not be contacted	33 (27.0)
Deceased	22 (18.0)
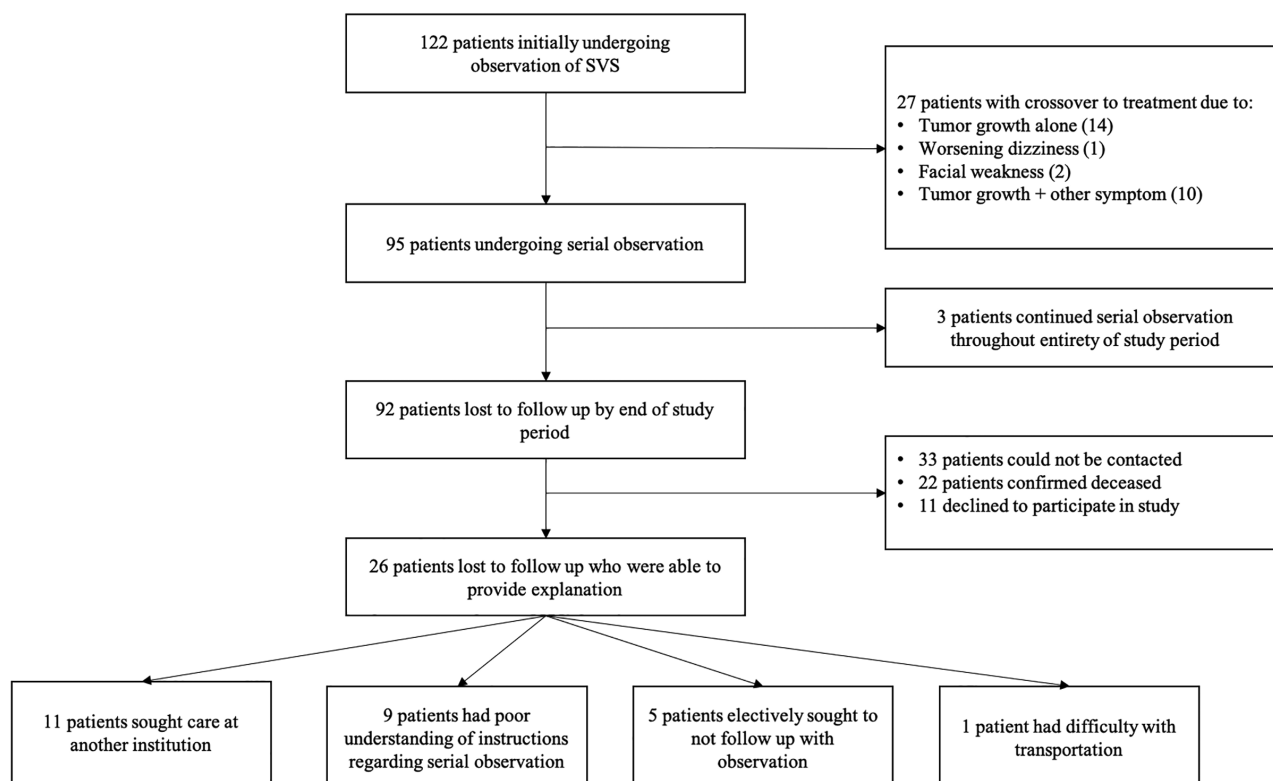
Figure 4. Flowchart demonstrating the final follow-up status of patients undergoing observational surveillance for sporadic vestibular schwannoma.

earlier detection, awareness of high rates of tumor growth stability, and value in both quality of life and facial nerve preservation.[17] It has been predicted that by 2026, half of all SVS cases will be initially managed with observation.[18] With the trend in observation set to continue to increase over the next decade, it is important to evaluate the success and consequence of this management practice. In this single institutional retrospective review of 122 patients diagnosed with SVS from 2005 to 2010 and initially managed with observation, we sought to record and analyze surveillance adherence. This study had the potential to follow patients for 9 to 14 years following their diagnosis of SVS, and an alarmingly low rate and short period of follow-up was discovered. After a single initial visit, nearly a third of the patients never returned, and only 3 patients remained adherent to the observation strategy in the end. This represents a large pool of unknown clinical courses during which a change in management may have been warranted.

Despite the trend toward increasing rates of observation and the suggestion that a period of initial observation is beneficial to most patients with small SVS in terms of quality of life and quality-adjusted life years,[19,20] reporting of adherence to early observation is scarce or biased. When compared to prospective studies, retrospective studies likely provide a better representation of the true rate of being LTFU. Reported rates of being LTFU range from 15% to 43% in 3 other retrospective studies on conservative management[13-15]; however, we have shown that follow-up rates are also a function of time

and that if followed long enough, many patients will eventually cease to return.

Explanations for a poor rate of follow-up include a lack of understanding of the disease process and importance of surveillance, death or other comorbidities of higher importance, or surveillance transferred to another facility. Hillman et al[13] found that while no patients in a group undergoing observation of SVS had any misconceptions regarding the instructions for follow-up, a significant portion did not understand their disease and its natural history. Similarly, a number of our interviewed patients had misconceptions regarding their diagnosis and follow-up, potentially due to poor health literacy or a lack of standardized education regarding the need for observation. Extrapolating from medication adherence literature, improving patient education by providing physical written materials and a direct contact for questions could improve rates of follow-up; however, most unbiased randomized controlled trials have used complex interventions and still have not been able to demonstrate robust benefits.[21] Therefore, improving education alone is not expected to greatly improve follow-up rates.

We also hypothesized that driving distance to the facility would affect a patient's follow-up, but this did not hold true. One explanation is the lack of direct correlation between living distance from the hospital and travel time—a drive from within the city could take as long as a highway drive from outside of the city. Therefore, we continue to hypothesize that traveling plays a role. Telehealth, emerging from the

COVID-19 pandemic as a reliable and safe method of monitoring patients, might offer a complementary means of observational surveillance when traveling is deemed inconvenient, unwanted, or unnecessary. Although there are no reports on the effectiveness of incorporation of telemedicine visits in the imaging surveillance of patients with SVS, it is predicted to play an increasing role in the management.[22] Prior to the pandemic, barriers to incorporation of telehealth included insurance reimbursement and privacy concerns and lack of institutional telehealth services; however, these have been largely overcome, and telehealth is being incorporated into neurotology care.[23,24] Telehealth visits are particularly well suited for imaging surveillance of SVS, where the physical exam plays a smaller role in decision making. Patients can locally undergo an MRI, which can be reviewed with the patient over the telehealth platform.[25] Still, long-term studies of changes in rates of follow-up and patient satisfaction are needed prior to making firm recommendations.

In addition to improving upfront education and minimizing need to travel, the strategy of telephone and text message reminders has been shown to improve follow-up rates for a number of chronic conditions.[26] Unfortunately, our call reminder system was put in place in 2010, so most patients in this cohort did not immediately benefit from it. Among the 18 patients who were diagnosed with SVS in 2010, the median length of follow-up was 6 months (range, 0-97 months), and 8 patients were LTFU after the initial visit. Although no interviewed patients reported unawareness of an appointment as a reason for lack of follow-up, given our inability to contact some patients, we assume that, especially as the length between follow-up visits increases, reminders are an important means to assist patients in returning. Automated reminders and rotating nurse reminders are not without pitfalls; automated reminders lack closed-loop communication, and nurses might differ in reliability.[27] These issues have been overcome at one of the author's home institutions by employing a skull base coordinator, whose role is to track and coordinate the care of all multidisciplinary skull base patients. Patient feedback has been unanimously positive, but data on effectiveness for ensuring adherence have not been collected.

There are several limitations to this study. The retrospective nature, single-institution design, and relatively small sample size all portend bias. Several important data points for audiometry, vestibular dysfunction, and tumor size were missing for a portion of the cohort, challenges inherent to a nonunified health care system. While we were able to perform Kaplan-Meier analysis for hearing loss and vestibular function, we excluded this analysis for tumor growth. Finally, no attempt at measuring quality of life was made.

Conclusion

The risk of early or complete LTFU in the surveillance of SVS is great, and no demographic factor predicts poor follow-up adherence. Patients who are LTFU are at risk of missing opportunities for a change in management based on tumor growth or symptom development. As observation of small- and medium-sized SVS becomes even more commonplace over the next decade, greater attention to follow-up adherence and optimization of surveillance protocols should be made. Initial suggestions for improving follow-up adherence include providing patients with upfront written educational material, offering telehealth visits, and employing a reliable, nonautomated system for contacting and tracking patients. Future investigation on follow-up adherence should focus prospectively on these quality improvement measures.

Author Contributions

Mallory Raymond, study design, data collection, data analysis manuscript writing, final approval; **Arian Ghanouni**, data collection, manuscript writing, final approval; **Kaitlyn Brooks**, data collection, data analysis, manuscript writing, final approval; **Sarah M. Clark**, data collection, manuscript writing, final approval; **Douglas E. Mattox**, study design, manuscript writing, final approval.

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