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# Use of a Novel Clinical Decision-Making Tool in Vestibular Schwannoma Treatment

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**Objective:** To determine the usefulness of a personalized tool and its effect on the decision-making process for those with vestibular schwannoma (VS).

**Study Design:** Prospective study.

**Setting:** Single institution, academic tertiary care lateral skull base surgery program.

**Patients:** Patients diagnosed with VS.

**Interventions:** A comprehensive clinical decision support (CDS) tool was constructed from a previously published retrospective patient-reported data obtained from members of the Acoustic Neuroma Association from January to March 2017. Demographic, tumor, and treatment modality data, including associated side effects, were collected for 775 patients and integrated in an interactive and personalized web-based tool.

**Main Outcome Measures:** Pre- and posttool questionnaires assessing the process of deciding treatment for VS using a decisional conflict scale (DCS) and satisfaction with decision (SWD) scale were compared.

**Results:** A pilot study of 33 patients evaluated at a single institution tertiary care center with mean  $\pm$  SD age of  $63.9 \pm 13.5$  years

and with average tumor size of  $7.11 \pm 4.75$  mm were surveyed. CDS implementation resulted in a mean  $\pm$  SD total DCS score decrease from  $43.6 \pm 15.5$  to  $37.6 \pm 16.4$  ( $p < 0.01$ ) and total SWD score increase from  $82.8 \pm 16.1$  to  $86.2 \pm 14.4$  ( $p = 0.04$ ), indicating a significant decrease in decisional conflict and increase in satisfaction.

**Conclusions:** Implementing a decision-making tool after diagnosis of VS reduced decisional conflict and improved satisfaction with decision. Patients considered the tool to be an aid to their medical knowledge, further improving their comfort and understanding of their treatment options. These findings provide a basis for developing predictive tools that will assist patients in making informed medical decisions in the future.

**Key Words:** Acoustic neuroma—Acoustic neuroma treatment—Clinical decision support tools—Quality of life—Shared decision-making—Vestibular schwannoma.

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## INTRODUCTION

Vestibular schwannomas (VSs) are benign in nature, typically slow growing, and occur in approximately 1 per 100,000 persons per year (1). Patients with these tumors can present with symptoms of unilateral sensorineural hearing loss, tinnitus, and vertigo. However, VS patients are frequently asymptomatic, and lesions are often detected by incidental imaging (2). Treatment of VS is heavily dependent on both tumor characteristics and the preferences of the patient. After diagnosis, VS patients are presented with

three possible treatment options: microsurgical resection, stereotactic radiation, or active observation (3).

With several options available and a multitude of risks and benefits to consider, VS patients are faced with difficult and nuanced decisions regarding their care. Thus, shared decision-making and partnership with the individual's healthcare team is imperative for managing VS patients, requiring assessment of both objective and subjective factors to determine treatment.

Clinical decision support (CDS) systems are software-based tools designed to directly aid in clinical decision-making (4). Computerized CDS systems match characteristics of an individual patient to a computerized clinical knowledge base to generate treatment recommendations that are patient specific. Results from a validated CDS system are presented to the clinician or the patient and have been shown to serve as a valuable guide in clinical decision-making (5,6). These tools are used in a variety of contexts, including diagnostics, disease management, and drug control (5). Studies evaluating the effect of these systems on patient care

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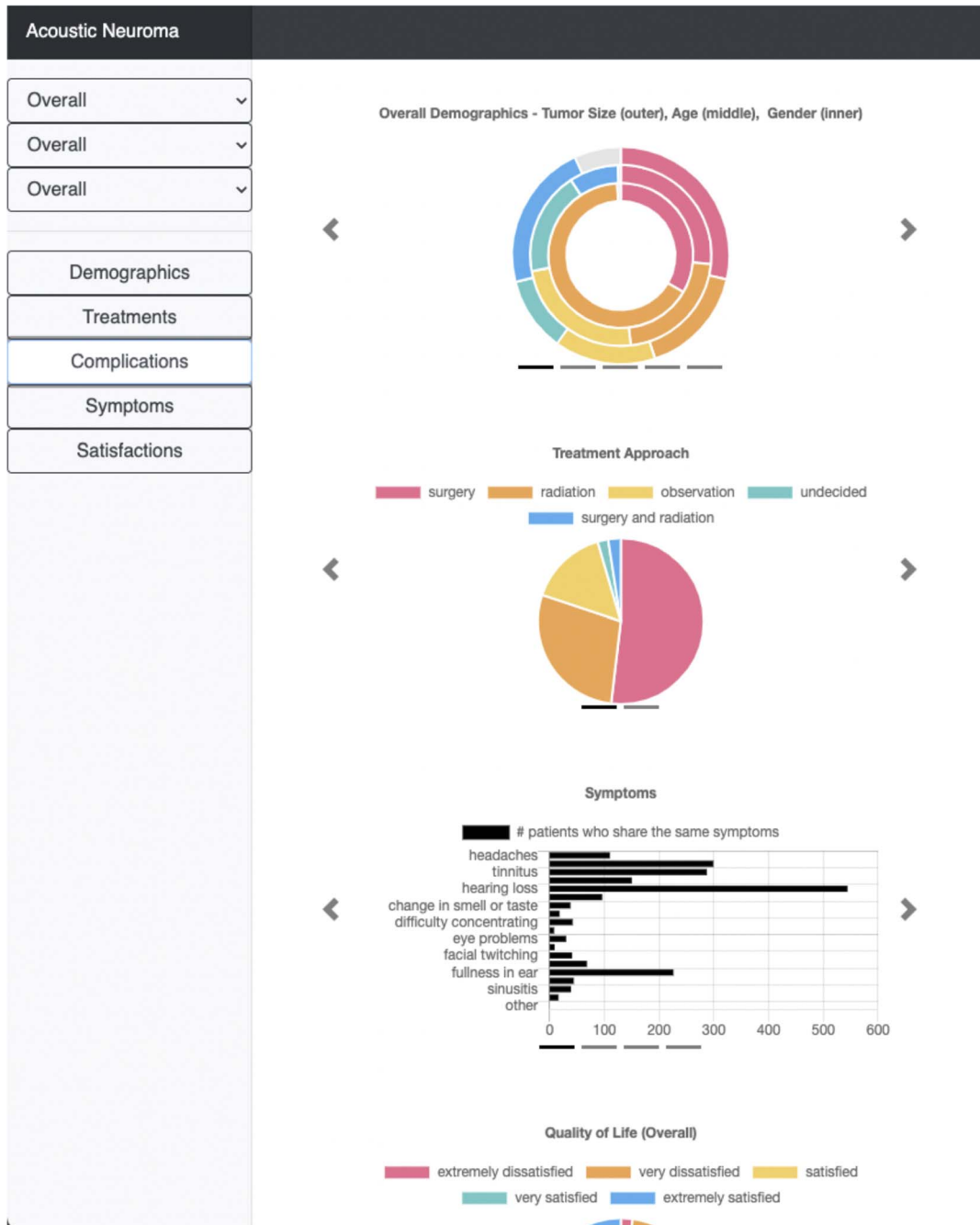
Supplemental digital content is available in the text.

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highlight their ability to improve practitioner performance while actively involving patients in treatment decision-making (7,8). Using evidence-based data from a range of patients in a tangible, collaborative manner can help guide both physicians and patients toward more effective treatment outcomes. Several studies have emphasized the importance of improved communication through shared decision-making in this population (9–11). In this pilot study, we investigated the use of an educational, personalized, patient-facing tool as an important adjunct to patient education and shared decision-making.

**METHODS**

A comprehensive CDS tool was developed from retrospective, previously published patient-reported data collected from VS patients within the Acoustic Neuroma Association from January to March 2017 (12). Data included demographic information, tumor characteristics, treatment modalities, and reported sequelae for 775 patients. This information was incorporated into an interactive and personalized mobile tool hosted on a web-based platform for software development (Fig. 1). For our pilot study, this tool was implemented prospectively on a group of VS patients evaluated at a



**FIG 1.** Image of decision support tool user interface.

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tertiary care center between 2017 and 2022. Inclusion criteria guiding chart review was having a diagnosis of VS and preliminary choice to undergo observation at their most recent clinic visit. Patients with neurofibromatosis type 2 or previous VS treatments were excluded.

After preliminary evaluation at a single institution tertiary care center, patients who planned for serial observation of their VS were eligible to participate in our study and were approached via e-mail or phone call after their initial visit. These patients were subsequently e-mailed a pretool survey, which included collection of demographic and clinical data as well as the research questionnaires described as follows. These questionnaires assessed the process of deciding treatment for VS using a validated decisional conflict scale (DCS) and satisfaction with decision (SWD) scale (13,14). Surveys were delivered using secure Redcap services (Nashville, TN) (15,16). Questions intended to assess the patient's understanding of the disease in terms of the complications of each treatment option discussed with them (surgery, radiation, or observation) by all healthcare practitioners with whom they interacted regarding their diagnosis. Upon completion of the pretool survey, patients were interviewed and guided through the decision-making tool with a member of the research team via video conferencing or phone call. After the use of the decision-making tool, the same series of pretool questionnaires were provided to evaluate the tool's effect on decision-making.

Descriptive statistics were used to analyze individual characteristics and opinion-based responses regarding decision-making tool usage for all participants. Total DCS and SWD scores were scaled to be out of a total of 100 per DCS scale manual. Pre- and posttool assessment using categorical variables, including treatment choice and individual DCS and SWD components, were compared using Pearson's chi-squared test. For the purposes of this pilot study, subjective opinions were included in the pre- and posttool questionnaires to qualitatively analyze the effect of our tool on the decision-making process. Pre- and posttool assessment using continuous variables including decision confidence, treatment likelihood, and total scaled DCS and SWD scores were compared using paired samples Student's *t*-test. When comparing pre- and posttool survey results, incomplete responses were excluded in the analysis for those questions. Analyses were performed using Stata/BE statistical software version 17.0 (StataCorp LLC, College Station, TX). All statistical analyses were two-tailed and used an alpha level of 0.05 to determine statistical significance.

## RESULTS

### Patient Demographics and Tumor Quality

Demographics and response rates for 33 individuals recruited for this pilot study are shown in Table 1. In total, 60 VS patients were contacted; of these, 33 patients agreed to take part in our study. Our study population had an average  $\pm$  SD age of  $63.9 \pm 13.5$  years, were diagnosed with VS between January 2020 and February 2022 (age at diagnosis  $61.2 \pm 13.2$  years), and had a mean  $\pm$  SD tumor size of  $7.11 \pm 4.75$  mm.

### Effect of Decision-Making Tool on Decisional Conflict and Satisfaction

The DCS and the SWD questionnaires were used to measure the change in decisional conflict and satisfaction with decision-making and were scaled to a total of 100 points.

**TABLE 1.** Characteristics of participants

	Total (N = 33)
Age at survey, mean $\pm$ SD, years	63.9 $\pm$ 13.5
Male sex, n (%)	17 (51.5)
Age at acoustic neuroma diagnosis, mean $\pm$ SD, years	61.2 $\pm$ 13.2
Maximum diameter of acoustic neuroma at diagnosis, mean $\pm$ SD, mm	7.11 $\pm$ 4.75

Demographic and clinical information collected from study participants. Data are presented as mean  $\pm$  SD for continuous measures and n (%) for categorical measures.

Importantly, decreasing DCS scores indicate decreased personal perceptions of uncertainty, whereas increased SWD scores indicate a higher level of satisfaction with decision in healthcare. The results of tool implementation were significant (shown in Table 2), as total DCS score decreased from  $43.6 \pm 15.5$  to  $37.6 \pm 16.4$  ( $p < 0.01$ ) and total SWD scale increased from  $82.8 \pm 16.1$  to  $86.2 \pm 14.4$  ( $p = 0.04$ ) for the pre- and postimplementation of the CDS tool, respectively. Reported confidence in decision did not change after use of the tool. Likelihood to elect for observation did not change significantly, and likelihood to elect for radiation therapy decreased from  $30.9 \pm 30.8$  to  $25.8 \pm 27.3$  ( $p = 0.09$ ). Interestingly, after use of the tool, the likelihood for patients to elect for surgery decreased significantly from  $41.9 \pm 31.3$  to  $29.8 \pm 31.8$  ( $p = 0.03$ ). Supplement Table 1 (<http://links.lww.com/MAO/B520>) reports expanded survey responses to the DCS and SWD questionnaires.

### Qualitative Analysis of Participant Responses and Changes in Decision-Making

On average, 76% of participants stated the tool provided them with important information, which assisted them with their decision-making processes (Table 3). The tool enabled 69% of participants to feel more comfortable with their decision. In total, 28% of respondents were neutral regarding the tool's ability to increase comfort levels. In total, 79% felt the tool would improve communication with their healthcare providers about their diagnosis.

As a result of using the CDS tool, 69% of participants strongly affirmed they knew which options were available to them compared with 50% pretool use ( $p = 0.05$ ). Although the significance threshold was not reached, we did observe a higher percentage of patients strongly agreed they were clear about the risks and side effects that matter most ( $p = 0.21$ ), they were clear about which was of greater importance to them ( $p = 0.19$ ), and they were able to make the decision easily ( $p = 0.12$ ) after use of the tool (Supplement Table 1, <http://links.lww.com/MAO/B520>). Underpowering of this pilot study and consequently type II error likely resulted in these questions not reaching the alpha level. Although our study focused primarily on changes in decisional conflict and satisfaction with decision, we did perform an analysis regarding the secondary effect of our informational tool on changing treatment decision.

**TABLE 2.** Posttool decision-making summary

	Pre (N = 32)	Post (N = 32)	<i>p</i>
Treatment choice			
Observation	24 (75)	27 (84)	0.22
Radiation	1 (3)	1 (3)	
Microsurgery	2 (6)	1 (3)	
Still undecided	4 (12)	0 (0)	
Missing	1 (3)	3 (9)	
How confident were you in your decision in general?	78.0 ± 21.9	77.6 ± 21.4	0.89
Likelihood to elect for observation with repeated MRI scans	90.8 ± 14.7	90.7 ± 14.4	0.97
Likelihood to elect for radiation therapy	30.9 ± 30.8	25.8 ± 27.3	0.09
Likelihood to elect for surgery*	41.9 ± 31.3	29.8 ± 31.8	0.03*
Total decisional conflict scale score, scaled*	43.6 ± 15.5	37.6 ± 16.4	<0.01*
Total satisfaction with decision scale score, scaled*	82.8 ± 16.1	86.2 ± 14.4	0.04*

Table presenting treatment choice selection and relative likelihood among patients pre- and posttool. Total decision scale score (higher score indicates increased conflict with decision) and satisfaction with decision score (higher score indicates increased satisfaction with decision) scaled out of a total of 100. Data are presented as mean ± SD for continuous measures and n (%) for categorical measures.

\**p* < 0.05.

In total, five patients (15.6%) indicated that they changed their final decision posttool usage, as indicated in Table 4.

## DISCUSSION

### Complexities of Decision-Making and Tool Effect on VS Patients

Treatment decisions are influenced by a multitude of factors related to symptoms, size of tumor, age, input from others, and relative patient expectations (17–20). The results of a recent study by Moshtaghi et al. (12) demonstrated that almost 80% of VS treatment decisions were made after consulting with more than one VS specialist (neurotologist, neurosurgeon, or radiation oncologist) and that 16% of VS patients reported feeling pressured into choosing a surgical intervention. Furthermore, one study reported that 78% of VS patients felt their doctors did not adequately respond to their specific life situation and individual conveniences when discussing treatment options (21). Studies evaluating patient opinion have highlighted quality of life as a critical consideration for VS patients when it comes to treatment decisions (22–24).

To measure the effect of patient-facing decisional support on the decision-making process, a multidimensional interactive tool was used to display demographic, symptomatic, and complication data of previous patients with VS. Patients who used our decision-making tool found it helpful in understanding diagnosis, treatment options, as well as possible symptoms and complications of individuals with similar clinical features to their own. Previous literature has emphasized ineffective patient-provider communication as a potential cause of pressure for the patient (20,21). As intended, patients indicated an improved ability to communicate with their healthcare providers after use of the tool, improving their decision-making ability in light of a complex and life-altering diagnosis such as VS. Studies have investigated patterns in VS decision-making and have shown a complex balance of risks and benefits through systematic (data retrieval and analysis) and heuristic (personal and

social influences) processing (21,25–29). Our customizable tool can fill the gap for both informational and personalized processing, ultimately improving shared decision-making among VS patients. Studies have reported that clinical features presented in our tool (age, tumor size, symptoms, and complications) significantly influence patient decision-making. With the increasing role of patient-centered informed consent, there is need for patient-facing instruments that augment the decision-making process (30). Although further research is necessary to indicate which aspects of patient decision-making are affected by the use of an informational tool such as the one in our pilot study, assessing this tool's effect can contribute to the multidimensional approach to counseling patients and optimizing patient-provider communication (31).

**TABLE 3.** Subjective opinion-based questions posttool

	Total (N = 29)
Using this tool gave me important information	
Strongly agree	11 (38)
Agree	11 (38)
Neither agree or disagree	4 (14)
Disagree	2 (7)
Strongly disagree	1 (3)
Information from this tool assists with my decision	
Strongly agree	9 (31)
Agree	13 (45)
Neither agree or disagree	6 (21)
Strongly disagree	1 (3)
This tool facilitates better communication with my medical team	
Strongly agree	7 (24)
Agree	16 (55)
Neither agree or disagree	5 (17)
Strongly disagree	1 (3)
This tool allows me to be more comfortable with my decision	
Strongly agree	7 (24)
Agree	13 (45)
Neither agree or disagree	8 (28)
Strongly disagree	1 (3)

Table reporting responses to opinion-based questions after use of the tool asked to all participants who completed the pre and post tool survey. Data are presented as n (%) for categories.

**TABLE 4.** Change in treatment preference through tool usage

		Posttool			
		Observation	Radiation	Microsurgery	Still Undecided
Pretool	Observation	25 (78%)	0	0	0
	Radiation	0	0	1 (3%)	0
	Microsurgery	1 (3%)	1 (3%)	0	0
	Still undecided	3 (9%)	0	0	1 (3%)

Matrix showing change in treatment preference pre- and postclinical decision-making tool usage. Missing pretool (n = 1) or posttool (n = 3) preference data were assumed to be unchanged by tool usage.

### Posttool DCS and SWD

Average DCS score improved significantly after implementation of this tool, suggesting it is effective in lowering conflict in decision-making among patients. An analysis of the literature on DCS scores found that patients undergoing decisions regarding medical care had an average DCS score of 33.2 (9,32,33). Scores are even higher for populations deciding on treatment or those making independent decisions (9). Our study demonstrated a pretool average DCS score of 43.6, demonstrating extreme decision conflict that decreased to 37.6 after use of the tool. Interventional tools to assist in decision-making can lower the DCS in comparison with controls and ensure that lower conflict persists in the long term (compared with controls in which the DCS often increases acutely) (32). Additionally, we observed a significant increase in SWD after tool usage. This increase in decisional contentedness is consistent with the decrease in decisional conflict and also has been shown to have high correlation with decisional confidence (14). Ultimately, we observe improvement in numerous facets of the patient experience in decision-making through the usage of our tool.

Notably, we observed differences in the reported likelihood in treatment choice after tool usage. There was a decrease in likelihood to pursue radiation and surgery but no change in likelihood to continue with observation (Table 2). These show that these patients, who have already decided on observation as a treatment modality, become more certain in their decision posttool usage. Although more data are needed to better understand this observation, these preliminary results reiterate the complexity of what modality to pursue when considering the diagnosis of a benign tumor with multiple treatment avenues, each with its own risks and benefits (31). Irrespectively, incorporating follow-up visits after using the tool or following up on long-term views of their decision could be useful in optimizing patient support tools in the future. This can be a critical component contributing to enhanced communication between patient and provider. Evidence suggests that decision support tools can improve patient–physician communication and patient-centered decision-making (9). Despite the preliminary nature of these results, these findings provide direction for future research on decisional conflict and the effect of personalized patient-facing tools on shared decision-making.

### LIMITATIONS

Our sample size of 33 participants for this pilot study was relatively small and resulted in the underpowering of several individual scale questions, which could have provided insight into the observed tool effects. In the context of our pilot study, the objective was to explore how patient decision-making could be enhanced at our institution with additional, interactive, and personalized information. This limitation also affects the generalizability of our conclusions. This was further hindered by recruiting VS-only patients who had initially decided on observation during the clinic visit, introducing a significant bias in evaluating the tool's effect. Moreover, not enough data were included to enable our tool to be predictive in the way other CDS systems function. In contrast to providing an assessment of the likelihood of different outcomes associated with each treatment option, our study focused on the presentation of information to assist in decision-making. A predictive tool is possible as more data from VS patients are collected and, based on the results of this study, would be an appropriate next step in future research.

### CONCLUSION

The implementation of a decision-making tool after diagnosis of VS significantly improved high decisional conflict among patients in this study. Our results indicate that additional, interactive, and customized information available to patients assists with comfort and communication in the setting of a difficult treatment decision. The results of this study provide a basis for developing future predictive tools that account for additional features influencing outcomes and assisting patients in making meaningful decisions.

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