

Taste and Smell Problems: Validation of Questions for the Clinical History

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Complaints of taste and smell dysfunction unaccompanied by symptoms of neurological or nasal problems are not uncommon. However, "I can't taste" is not necessarily an accurate symptom description. Complaints tend to reflect the common confusion between taste sensations (that is, salt, sour, sweet, bitter) and flavor sensations (including taste, smell, temperature, and texture). A number of questions have been identified that help classify symptoms according to the type of dysfunction (taste, smell, or both): whether the problem is quantitative (reduced or absent sensation) or qualitative (distorted sensations); and what might have caused the dysfunction. Directed questioning can yield a clinical history that predicts chemosensory function and identifies the most likely cause of the problem. Questions were assessed by comparing the self-reports of taste and smell symptoms to the clinical evaluation of chemosensory function for 101 new patients seen in the Taste and Smell Center at the University of Connecticut Health Center in 1983.

Taste and smell complaints unaccompanied by obvious signs or symptoms of neurological or nasal problems are not uncommon [1,2]. Unfortunately, there is no validated set of questions to use to obtain a clinical history of taste and smell symptoms. Standard texts on physical diagnosis usually suggest a line of questioning for patients with chemosensory complaints, but specific questions designed to predict probable cause are not provided [3,4]. Therefore, we were interested in validating the questions we use to obtain the clinical history of our patients' taste and smell symptoms. Judging by the inquiries received over the past few years from a variety of health care professionals, such a validated set of questions could be useful additions to health assessment surveys in the areas of environmental health [5] and occupational medicine, as well as various projects involving special clinical populations (for example, elderly denture wearers, hospitalized psychiatric patients, and the like).

Patients presenting to the Taste and Smell Center at the University of Connecticut Health Center are primarily self-referred and have a chemosensory problem as the chief complaint. Questions used for obtaining a clinical history of a chemosensory

problem, such as reduced smell function (hyposmia) or distorted taste sensations (dysgeusia), were developed during the first two years of patient evaluations, 1981–82. In order to assess validity in indicating clinically measured taste and smell function and utility in predicting the probable cause of the symptoms, responses to questions about taste and smell symptoms were compared to the clinical evaluations for 101 patients seen in 1983. We report here the results of our assessment of how well patient responses to questions about taste and smell symptoms predict clinically measured taste and smell function. We also report which questions have the greatest predictive value as indicators of the four most common causes of chemosensory symptoms as a chief complaint: nasal or sinus disease, post viral-like upper respiratory infection, head trauma, and idiopathic sensory loss [1,2].

METHODS

The list of questions under study was included in a self-administered registration survey sent to all prospective patients. The study group ($N = 101$) consisted of all patients who were evaluated at the Taste and Smell Center in 1983 who had also completed the same version of the registration survey. Data from each study patient's registration survey were coded and combined with selected information from the clinical evaluation [1]. Clinical variables included taste and smell function diagnoses and the clinically determined probable cause of the dysfunction.

Quantitative smell and taste function were assessed using tests developed at the Taste and Smell Center [6,7,8]. The smell test consists of two parts: a threshold test for absolute sensitivity to butyl alcohol, and a ten-item odor identification test. The threshold test is a two-alternative, forced-choice task; starting with the weakest, a dilution series of butyl alcohol is paired with a water blank. Stimulus pairs are presented in plastic squeeze bottles to one nostril at a time. The patient's task is to select the bottle with the "smell." The threshold is that dilution step where the patient is able to choose correctly the bottle with the butyl alcohol four trials in a row. The odor identification task is also administered to one nostril at a time. On each trial a patient is asked to close his or her eyes, sniff the stimulus presented in an opaque plastic jar, then say what the item is. The patient is given a list of 20 odor names (including the ten test items plus ten other odors not on the test) from which to select the answer. The patient is given corrective feedback after each trial. Each item is presented twice to each nostril. A composite smell function score is calculated, based on the performance scores on each test [6,8].

The taste test consists of a sip-and-spit task of quality identification and intensity rating of several concentration levels of sodium chloride, sucrose, citric acid, and quinine hydrochloride. Patients are also asked to rate the loudness of several decibel levels of a 1,000 Hz tone. For patients with no known hearing problems, the inclusion of tones permits a comparison between a patient's perception of taste and auditory sensations. Based on data from normal control subjects [8], the loudness of tones (from soft to loud) roughly matches the intensity of the solution concentrations (from weak to strong). A taste function score is calculated based on the intensity ratings given to the strongest solutions and the loudest tones [7,8].

The clinical evaluation of parosmia (odor quality distortions or phantom odors) and dysgeusia (taste quality distortions) is based on the patient's responses to a structured interview administered by a trained staff member at the time of the clinic visit. It includes an assessment of the recency in onset of the problem: the frequency, duration,

and severity of occurrences; and the most recent occurrence. A patient is considered to have parosmia or dysgeusia if, in the opinion of the interviewer, the patient is able to describe the problem in some detail and has had a recent (within six months) occurrence.

Clinically assigned probable cause is based on the medical findings (for example, X-ray results) and the history taken at the time of the patient's visit [1].

Associations between self-report and clinic assessment were examined using two-by-two contingency table analyses (χ^2 or Fisher's exact tests, $p < 0.05$; Statistical Analysis System [SAS]). For this purpose, self-reports were transformed into dichotomous variables and compared to the presence or absence of a particular clinical characteristic. Self-reported smell function (normal or abnormal), for example, was compared to clinically diagnosed nasal/sinus disease (present or absent). These analyses identified a subset of questions significantly associated with clinical outcomes.

Test characteristics (sensitivity, specificity, predictive values) were calculated for this subset of questions. A Bayesian approach (that is, conditional probability) was used to evaluate the usefulness of a particular question or sequence of questions. Conditional probability analysis has been used previously to help determine the predictive value of a symptom (such as chest pain) as an indicator of a particular disease (for example, coronary artery disease) [9,10].

RESULTS

The 101 patients in the study included 59 males and 42 females ranging in age from 10 to 76 years with an average age of 49.4 years. Nearly half (45.6 percent) of the patients in this study group reported having had a taste or smell problem for less than one year; 24.0 percent for one to three years; 10.1 percent for three to five years; 11.4 percent for five to ten years; and 8.9 percent for over ten years.

The clinical assessment of quantitative olfactory function showed that 90 percent of the patients had abnormal function: 47 percent of these 101 patients had no sense of smell (anosmia), 43 percent had reduced olfactory sensitivity (hyposmia). The remaining 10 percent were normosmic. Results of the clinical assessment of taste function suggested that none of the 101 patients was ageusic (taste function absent); 32 percent appeared to have somewhat reduced sensitivity, and 68 percent had normal taste function.

Clinical assessment of quality distortions suggested that 13.9 percent of the patients probably had parosmia, an equal number appeared to have a dysgeusia, and 5.9 percent appeared to suffer from both. The clinical impression agreed with 15 out of 48 (31 percent) of the patients' self-reports that parosmia was present and 48 out of 53 (91 percent) of the reports that parosmia was absent. The clinical impression agreed with 14 out of 35 (40 percent) of the patients who reported dysgeusia present and 60 out of 66 (91 percent) who reported dysgeusia absent.

The clinically determined likely causes of the chemosensory problem for these 101 patients were nasal or sinus disease such as nasal polyposis, chronic sinusitis, allergic rhinitis (32.7 percent); post viral-like upper respiratory infection—that is, a history of flu-like illness immediately prior to the chemosensory loss (17.8 percent); head trauma (11.9 percent); and miscellaneous causes—for example, cranial surgery, dental problems, toxic exposures (8.9 percent). Of the remaining patients, 5.9 percent had multiple probable causes, and in 22.8 percent the cause was unknown.

Table 1 lists the test characteristics for questions used to screen for quantitative taste and smell function as measured by the clinical tests. The sensitivity and specificity of each question were calculated from the sample data. Predictive values are given for three different taste or smell dysfunction prevalence values. Prevalence of olfactory dysfunction at our Taste and Smell Center is high; 0.90 for the study group

TABLE 1
Screening Questions for Quantitative Chemosensory Function: Test Characteristics and Predictive Values^a

Chemosensory Dysfunction	Test Characteristics ^b			Predictive Values ^c		
	SENS	SPEC	ERR	PREV ^d	PV+	PV-
<i>Smell</i>						
1. Do you have trouble smelling? (<i>N</i> = 93)	0.95	0.64	0.09	0.10	0.23	0.99
				0.30	0.53	0.97
				0.90	0.96	0.59
<i>Taste</i>						
1. Do you have trouble tasting? (<i>N</i> = 70)	0.79	0.13	0.64	0.10	0.09	0.85
				0.30	0.28	0.59
				0.90	0.89	0.06
2. Do you have trouble tasting salt, sweet, sour, bitter? ^e (<i>N</i> = 80)	0.60	0.74	0.30	0.10	0.20	0.94
				0.30	0.50	0.81
				0.90	0.95	0.17

^aCalculations based on data from *N* patients (given after each question)

^bTest characteristics:

SENS = Sensitivity = True Positives (TP)/[TP + False Negatives (FN)]

SPEC = Specificity = True Negatives (TN)/[TN + False Positives (FP)]

ERR = Error Rate = (FP + FN)/Population

^cPredictive values:

PV+ = Positive Predictive Value

= Probability (*p*) of disease present (DIS+) given a positive response (R+); that is,

$$p(\text{DIS+}/\text{R+})$$

$$= \frac{p(\text{DIS+}) \times p(\text{R+}/\text{DIS+})}{p(\text{R+})}$$

Bayes' Theorem

$$= \frac{(\text{PREV})^d(\text{SENS})}{(\text{PREV})(\text{SENS}) + (1 - \text{PREV})(1 - \text{SPEC})}$$

Calculation Formula

PV- = Negative Predictive Value

= Probability (*p*) of disease absent (DIS-) given a negative response (R-); that is,

$$p(\text{DIS-}/\text{R-})$$

$$= \frac{(1 - \text{PREV})(\text{SPEC})}{(1 - \text{PREV})(\text{SPEC}) + (\text{PREV})(1 - \text{SENS})}$$

^dPREV = Prevalence of disease (for example, chemosensory dysfunction)

^ePatients were asked to rate each taste quality (salt, sweet, sour, bitter) on a four-point scale: (1) as strong, (2) less strong, (3) very weak, (4) no taste, as compared to its taste before the problem began. The sum of responses could range from a minimum of 4 (all tasted "as strong") to a maximum of 16 (all had "no taste"). A sum >8, that is, at least one of the qualities tasted "very weak," was considered a positive response to the question; ≤8 was considered negative. This breakpoint of 8 produced a significant χ^2 (= 6.79, *df* = 1, Fisher's exact *p* < 0.01) when compared to clinical taste function test results.

TABLE 2
Screening Questions for Nasal/Sinus Disease (NSD) or Post-Upper Respiratory Infection (URI) as Probable Cause of the Chemosensory Problem: Test Characteristics and Predictive Values^a

Question	Probable Cause	Test Characteristics			Predictive Values		
		SENS	SPEC	ERR	PREV	PV+	PV-
1. Do you have trouble smelling? ^b (<i>N</i> = 93)							
	NSD	1.0	0.18	0.53	0.05	0.06	1.0
					0.20	0.23	1.0
					0.30	0.34	1.0
	URI	1.0	0.14	0.72	0.05	0.06	1.0
					0.20	0.22	1.0
					0.30	0.33	1.0
2. Does smell sensitivity fluctuate? ^c (<i>N</i> = 84)							
	NSD	0.59	0.67	0.36	0.05	0.09	0.97
					0.20	0.31	0.87
					0.30	0.43	0.79
	URI	0.33	0.55	0.49	0.05	(0.06)	(0.96)
					0.20	(0.23)	(0.84)
					0.30	(0.34)	(0.76)
3. Do you have trouble tasting salt, sweet, sour, bitter? ^c (<i>N</i> = 81)							
	NSD	0.31	0.62	0.49	0.05	(0.06)	(0.96)
					0.20	(0.22)	(0.83)
					0.30	(0.32)	(0.74)
	URI	0.69	0.71	0.30	0.05	0.11	0.98
					0.20	0.37	0.90
					0.30	0.50	0.84

^aRefer to footnotes of Table 1 for definitions of Test Characteristics, PREV, and Predictive Values.

^bAll patients in the study group who were subsequently diagnosed as having NSD or post-URI entered the clinic complaining of a smell problem. As a result, test sensitivity and negative predictive value equal 1.0.

^cPredictive values in parentheses (PV+ and PV-) are based on *negative* and *positive* responses, respectively; that is, for this question $PV+ = p(DIS+/R-)$ and $PV- = p(DIS-/R+)$.

(included in Table 1) and 0.85 for our clinic population [1]. Prevalence of taste deficits is 0.34 for the study group and 0.32 for our clinic population.

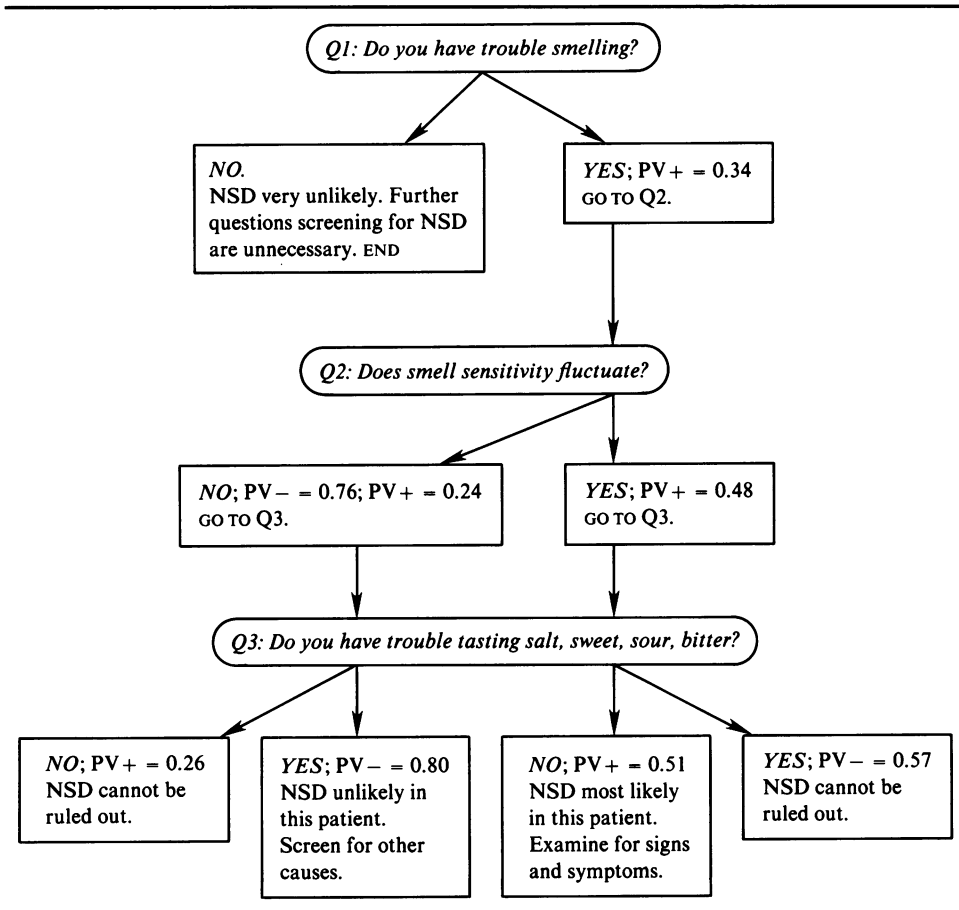
Table 2 lists test characteristics for three questions that were particularly useful in screening for the top two causes of chemosensory dysfunction: nasal/sinus disease (NSD) and post viral-like upper respiratory infection (URI). Again, sensitivity and specificity were based on the sample data, and predictive values are given for three different disease prevalence values.

Tables 3 and 4 illustrate the use of responses to three screening questions asked in sequence to estimate the likelihood of NSD (Table 3) or URI (Table 4) as the cause of the chemosensory problem.

DISCUSSION

It seems that a good way to screen for olfactory deficit is simply to ask patients to describe their ability to smell. The sensitivity of such a direct question is high (0.95) and suggests that, in general, nearly all patients (95 percent) who score in the abnormal range on an olfactory function test will self-report a loss of olfactory function. The specificity (0.64) suggests that although most of the patients who do not

TABLE 3
Using Responses in Sequence to Estimate the Likelihood of Nasal/Sinus Disease (NSD) in a Patient Presenting to the Taste and Smell Center^a
(Prevalence of NSD = 0.30)

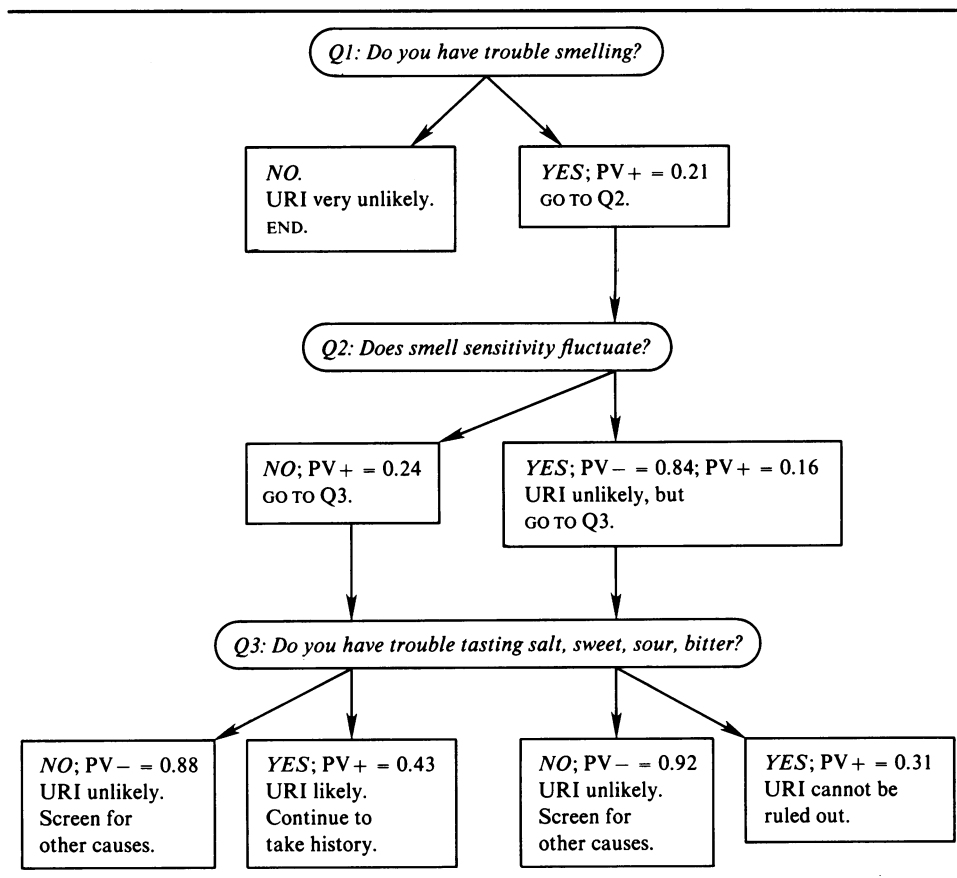


^aRefer to c, Table 1 for definitions of PV+ and PV-. Note that the prevalence of disease is "revised" after each response in the questioning sequence. For example, the initial prevalence of NSD is 0.30 and is used to estimate the PV+ after Q1. This revised prevalence (0.34) becomes the disease prevalence value for estimating the PV+ of Q2.

complain of smell function loss will score in the normal range, some will score in the abnormal range. One might expect the positive predictive value of such a direct question to be high (0.96 for our patients; refer to Table 1) in a population where the prevalence of olfactory deficit is high. But the predictive values (positive and negative) are greater than the prevalence of disease (present and absent) for a wide range of prevalence figures (Table 1). This result suggests that direct questioning about olfactory function is a valid way to screen for olfactory dysfunction in many different clinical settings.

The specificity of this question is perhaps partially a function of the age of the population tested. It should be noted that, in our sample, all of the patients who did not complain of olfactory function loss yet scored in the abnormal range (4 out of 11

TABLE 4
Using Responses in Sequence to Estimate the Likelihood of Post Viral-like Upper Respiratory Infection (URI) in a Patient Presenting to the Taste and Smell Center^a
(Prevalence of URI = 0.19)



^aRefer to a, Table 3.

non-complainers) were over the age of 55. There is evidence to suggest that olfactory function declines gradually with age [11,12,13]. It is possible that for many people the loss of olfactory function is too gradual to be bothersome or even noticeable. The application of age-corrected norms to olfactory function tests would probably improve the specificity of this question somewhat.

It may seem obvious that a patient's response to a direct question concerning the ability to taste or smell would be a highly accurate way to screen for chemosensory dysfunction. We have confirmed this assumption for the sense of smell. However, the specificity of a similarly straightforward question about taste function is poor (0.13) and the overall error rate is high (0.64) (refer to Table 1). For example, 87 percent of those who report a taste problem in fact have no measurable taste deficit (false-positive rate). Patients appear to overreport taste problems because of the common use of the word taste to mean flavor. Flavor perception comprises olfactory, tactile, and thermal, as well as taste, sensations. Thus, it is difficult to interpret loss of taste as a chief

complaint since the patient could be referring to any of the component sensations of flavor.

A more useful way to screen for actual loss of taste function is to ask about the ability to perceive the four taste qualities. When the self-report on each of the qualities is pooled (refer to *e*, Table 1), the sensitivity and specificity of this question are good (0.60 and 0.75, respectively). The positive and negative predictive values are greater than the prevalence of taste dysfunction for a range of prevalence values.

The assessment of a patient's qualitative chemosensory complaint (parosmia or dysgeusia) will become more reliable as objective criteria take the place of subjective impressions. Meanwhile, our impressions to date suggest that patients tend to overreport qualitative chemosensory problems. It appears that responses to questions concerning quality distortions are best used to rule out a problem: for example, quality distortion questions had high values (0.86 to 0.91) for predicting the absence of quality distortion problems among our patients.

The probable causes of the chemosensory problems identified in the study population (see Results) are representative of those found in the larger population of patients seen at the Taste and Smell Center [1]. Table 2 lists the test characteristics for three questions used to screen for the two most common specific causes: nasal/sinus disease (NSD) and post viral-like upper respiratory infection (URI). Positive and negative predictive values are also given for several disease prevalence values. The sensitivity of the first question ("Do you have trouble smelling?"), is "perfect" since all of the patients in the study group who were subsequently diagnosed with the disease (NSD or post-URI) had entered the clinic complaining of a smell problem. As a result, all of the estimates for the negative predictive values are also "perfect"; that is, if the patient does not complain of a smell problem, the probability that the disease is absent is 1.0. However, the question should not be dismissed as worthless for use outside a Taste and Smell Clinic. As can be seen in Table 2, the likelihood of disease in the presence of a smell problem (positive predictive value) is greater than the prevalence of disease for a range of prevalence values.

A positive response to the second question listed ("Does smell sensitivity fluctuate?"), increases the likelihood that the patient has NSD, while a negative response increases the likelihood that post-URI is the cause (refer to *c*, Table 2). It appears that among patients suffering from nasal/sinus disease, a temporary return of smell function occurs occasionally. This experience is rarely reported by those whose smell problem is caused by post-URI.

Taste abnormalities have been associated previously with post-URI [1,14]. As may be seen in Table 2, the sensitivity and specificity of question 3 ("Do you have trouble tasting salt, sweet, sour, bitter?"), are high when it is used to screen for URI. Also interesting is that a positive response to this question approximately doubles the likelihood of disease for each of the prevalence values given. When used to screen for NSD, a *negative* response is the best predictor of presence of disease (refer to *c*, Table 2).

Tables 3 and 4 illustrate the use of responses to these three questions when asked in sequence to estimate the likelihood of NSD (Table 3) or post-URI (Table 4) as the cause of the chemosensory complaint. The flow diagram in each table is for a patient presenting to the Taste and Smell Center. The prevalence values used are those of the Taste and Smell Center population. Disease prevalence values would no doubt be different for different clinic situations, and corresponding estimates of likelihood of

disease can be calculated using the formulas given in *a*, Table 3. Using this questioning strategy, and for any value of NSD prevalence, the likelihood of NSD is greatest for the patient who has a fluctuating problem with smell function and no trouble tasting salt, sour, sweet, or bitter. For the example given, the likelihood of NSD was increased from 0.30 to 0.51. Using the same series of questions, the probability of post-URI is most likely for the patient who has a smell problem that does not fluctuate and who has trouble tasting salt, sweet, sour, and bitter. In the example given, the probability of post-URI is increased from 0.19 to 0.43.

It is our feeling that the patients in this study as well as the others who have come to the Taste and Smell Center are representative of patients who might present to a clinician with a chief complaint of chemosensory dysfunction. These are not the patients with signs and symptoms of nasal polyps or neurological problems and *secondary* taste and smell complaints, who might present to an ear, nose and throat or a neurology clinic. A patient whose taste or smell problem is the chief or only complaint is most likely to have one of four causes of the chemosensory problem: nasal/sinus disease, post-URI, head trauma, or idiopathic sensory loss.

The use of these questions at the beginning of the medical history can help the clinician evaluate a patient's taste and smell symptoms, estimate the likelihood of the probable cause, then appropriately select any subsequent diagnostic tests (for example, quantitative chemosensory testing, sinus X-rays, or neurologic evaluation).

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