Paparella: Volume II: Otology and Neuro-Otology

Section 2: Audiology

Chapter 7: Computer Automation, Audiometric Technology, and Screening in the Hearing Health Care Practice

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> *The bewilderments of the eyes are of two kinds and arise from two causes, either from coming out of the light or from going into the light, which is true of the mind's eye, quite as much as the bodily eye.*
>
> Plato, The Republic, Book VII, "Allegory of the Cave"

This chapter is concerned with several interrelated issues. The first issue is related to computer automation, the second to technological innovation in audiometric equipment, and the third to screening methods and application of automated techniques, all as they impact hearing health care.

Implicit to any discussion of automation, technology, and screening strategies and new protocols for hearing health care management is the understanding that computer applications in medical care, which are less than a quarter century old (Gardner, 1985), have effected far-reaching changes. The decade of the 1980s reverberates from an explosion of technologic innovations impacting the world in general and health care in particular. Cost of computer logic decreases 25 per cent a year while computational speed continues to increase, now some 200 times more efficient than 25 years ago; energy consumption and physical size of computers have decreased 10.000 times (Toong and Gupta, 1982). The exponential diffusion of technologies impacts not only the costs but also the system (Angus, 1988) of health care as we move into the 1990s.

How we "see" the world has changed in less than a generation. Knowledge is overflowing, to the point that at times it seems we cannot absorb it all. We often feel overwhelmed and "blinded" by the continuous input of myriad bits and pieces of new information. We may feel that we have no practical system for storage or generation of clarifiers to expand initial data into meaningful components. Until we organize our information units so that we can look at them in terms of today's technology (Souhrada, 1989), we will be confused in the new light, much as those "blinded" individuals were when leaving Plato's cave for the real world of light. It is not the power of the computer that has brought computer technology and innovation to medical practice; rather, it is the need for medical information management - the recording and retrieval of data that tax the historical manual systems in use (Barnett, 1984). The computer is needed to bring light to the mass of data being generated in health care. As a side benefit, screening activities may also be simplified by computer use.

The field of health care has become more complex because of three interacting factors. First, population continues to grow. The survival rate of children beyond the traumatic months following birth and the early years has improved considerably. Our senior citizens continue

to make up an increasing percentage of our overall population because of extension of life, to the point that we now look at the geriatric population as the *young* old and *old* old.

Second, there is an increasing emphasis on reducing health care costs and on cost containment whether the issue is related to DRGs, HMOs, or PPOs. Cost-efficiencies from a health care management perspective require existing personnel both to encourage and to handle growth in case load without expansion of personnel. This cost-efficiency pressure is related specifically to this chapter. Cost constraints suggest development of computerized screening resources and preventive health care strategies (Elmslie and Rosser, 1986), preferably using personnel outside the specialty practice (Johnson, 1984).

Third, technologies continue to evolve that permit greater storage and processing of data. Data may be utilized in the present or stored for future processing (Rosati et al, 1975; Stillman et al, 1976; Lee et al, 1984). Decisions related to altering protocols and implementing new strategies for storage of data are made more complex when applying these technologies to screening programs. Complexity increases as new technologies evolve daily. Utilization of computer technologies makes cost-efficiencies feasible under certain conditions when all cost factors are noted (Covvey and McAlister, 1980b) and improves quality assurance for the health care consumer and third-party payor (Barnett, 1984).

The screening-oriented discussion that follows requires the following redefinition and clarification of vocabulary and concepts.

Coding. Coding may be defined generally as the computer programming that processes data (Covvey and McAlister, 1980a, b). For purposes of this chapter, coding includes the processing of screening data to the point of referral generation.

Data Base. This is a set of related, computer stored files, which are conceptualized, structured, stored, analyzed, and reported so as to derive useful information (Bobula, 1985).

Decision Making. This is defined here as the arbitrary decision that results in referral to the specialty practice. The decision-making process in screening involves resolution of philosophical issues related to level of care, point of referral, evaluation of known hearing loss, and structure of health care management.

Disks. These are one type of magnetic media for storing information entered into a computer. Three disk systems currently are in use; the most universally used are the floppy 5.25 inch and 3.5 inch diskettes, with hard disk systems becoming more common.

Information. Information is derived from data and consists of knowledge of facts or relationships (Bobula, 1985).

Method. Method is the specific protocol chosen to implement a screening program and initiate referral to a specialty practice.

Patient Profile. The patient profile is a summary of all information concerning a patient, in which all available data are organized by visit (Given et al, 1985).

Recall. This is defined here as the ability to access information within a data base, the information pool in which all client screening information resides. The screening data base may be part of a larger data base that incorporates many pieces of information within a specialty clinic. Recall incorporates concepts related to formatting the way in which data are saved and is related to both hardware and software issues (Christensen and Stearns, 1984).

Record. In this chapter, a record is a set of computer storage units (ie, *fields*, which comprise a complete set for an entity) (Bobula, 1985).

Screening. Screening is a procedure or protocol that results in a decision for further service (Johnson, 1984). For the purposes of this chapter, that further service is related to further evaluation of hearing loss, the goal being to manage ear disease medically, surgically, or through rehabilitation involving management of client listening environments or through amplification. Such service decisions "cost" (Turner and Nielsen, 1984). If the further service is really required, screening has made a true identification for service. If further in reality is not needed, screening has made a false-positive decision. If further service is needed but screening has failed to identify the need, screening has made a false-negative decision. Additional costs incurred in the first instance can be readily justified. In the second and third instances additional costs may not be so readily justified. A screening program must demonstrate an acceptable identification or "hit" rate (Turner et al, 1984).

Setting. Setting is the site of service. For out purposes, the setting focus is the specialty service office (eg, otolaryngology, audiology, neurology, pediatric service). The concept of setting can be expanded beyond the specialty office, however, because primary practice settings may be integrated into the specialty practice for screening purposes, depending on the method of, and hardware used in, screening. Traditional specialty clinics have utilized a variety of "outreach" strategies to bring clients into the practice. These strategies have incorporated various types of screening that historically have been used for defining referral. A broader concept of setting may be appropriate, depending on the targeted population and whether the screening strategy used is based on age, high-risk status, communication adequacy, environment, clinic, or institution (Johnson, 1984). The borders of a physical setting may be expanded through use of computer terminals and other integrating strategies (Arbogast and Dodrill, 198; Elmslie and Rosser, 1986).

Additional computer-oriented terminology has been discussed elsewhere (Bobula, 1985).

Computer Automation in the Hearing Health Care Practice

Techniques to facilitate hearing health care and reduce costs for services involve modification of labor-intensive charting systems used in record-keeping and billing. Effectiveness of the traditional medical record has been limited by problems that have added to its costliness: limited access to discrete pieces of information, one-site accessibility, inconsistent chart organization, illegibility, laborious data retrieval, and physical limitations due to mechanical problems in adding to the chart record (Barnett, 1984; Gardner, 1985).

Incorporation of computer technology in health care applications has been rapid in the last decade and a half. Early use was in physiologic data monitoring. Later, relay of data from

distant points was instituted. Actual reports can now be generated from integrated data bases. Closed-loop control and decision-making tools are found in medical applications. It is clear that computers can assist in record-keeping, data management, and decision-making (Gardner, 1985). This progression of use stems from increasing applications of computers for a variety of tedious activities including algebraic manipulations, sorts and searches, information storage and retrieval, data base management, modeling and simulation, artificial intelligence activities, graphics, image processing, pattern recognition, and discrete and continuous mathematical computation (Evans, 1985). Resources for technologic advice and innovation within professional organizations evolved by the close of the 1980s (Souhrada, 1989).

From a practical standpoint, the hearing health care practice can utilize computer technology now and can apply it to screening activities. Client data may be segmented into registry information containing basic demographic information (eg, name, sex, birth date, address, phone number, health insurance plan, significant family data) and client encounter information (eg, presenting problem, summary of services by procedure code, diagnosis) (Elmslie and Rosser, 1986).

Methodology in Computer Selection

Use of computers is becoming commonplace, and tales of mistakes and woe in a variety of settings are part of computer folk literature. Problems in the health care practice usually are the result of a communication failure, often between the business manager of a practice and the health care users of a system. Software is emerging that can guide decision-makers through the acquisition of new technology (Johnson, 1988). Banahan (1985) has suggested a methodology involving seven steps for selecting a computer for a clinical practice that minimizes problems.

Education

Step I in choosing a computer system must wed the education of the office manager and the health care practitioner. This education process occurs by means of conventions, workshops, exhibits, demonstrations, and so forth, as well as through the perusal of introductory books, magazines, and journals. Also valuable are site visits to offices already using computer equipment and software and discussions with health care providers, administrators, *and* actual computer users in those settings (Banahan, 1985).

Assessment

In Step 2, assessment of current health care practice procedures, evaluation of existing procedures, and determination of areas of potential improvement are included. Qualitative and quantitative data generated in this step are used to develop requirements for a specific proposed computer system. Office management personnel are more likely to have the objectivity and expertise needed in this evaluation process (Banahan, 1985), but administrators need to know how and where to get information on technology to determine its effects on their facilities (Souhrada, 1989). Reliance on standardized analysis programs to the extent that systems managers fail to address user questions or problems must be avoided (Given et al, 1985), and this must start at the point at which a system design is evaluated.

Crucial to the assessment in this second step is examination of how a practice works and who performs office tasks. Who are the providers in this hearing health care practice? What are the sites of the practice? Who are the active and inactive clients? What kind of new clients come to the office each year? How many office visits are there each day? What kind of billings are generated each month? Personal employee interviews to assess opinions, determine impressions, and evaluate attitudes help to identify employee relation issues affecting initiation of computer use and suggest needed support activities to assure successful computer use in the practice (Banahan, 1985).

Computerization Potential

Step 3 uses information generated in step 2 to identify office functions amenable to immediate computerization. It prioritizes these and identifies additional areas that may be computerized in the future. Several computer applications are feasible: patient registration, tracking, and recall systems; billing and collections; third-party payor processing; practice management reports; payroll and accounts payable; general ledger; inventory control; medical records; test result recording and word processing; and telecommunications (Banahan, 1985; Krantz et al, 1989).

Request for Proposal

Step 4 generates a request for proposal to be submitted to vendors (Banahan, 1985). Objectives are specified, questions identified, and a decision scheme proposed (Given et al, 1985). The request for proposal includes sections on general information (eg, objectives, hypothesis for meeting those objectives, evaluation criteria, timetable/deadline information, contract data, contact person); practice background (eg, history, philosophy, future expectations) (Banahan, 1985); detailed requirements and specifications (eg, functions to computerize, data base development and management, accessibility, security, artificial intelligence activities desired for manipulation of data, simulation requirements) (Banahan, 1985; Evans, 1985); vendor requirements, specifications, training and maintenance requirements, space limitations, and costs (Banahan, 1985).

Review Strategies

When the request for proposal has been distributed, step 5, consisting of review and evaluation, commences. Banahan (1985) has suggested that vendor responses should be scored by specification category using a point scale that weights items according to successful usage at existing facilities as well as cost. A secondary evaluation (step 6) gleans additional information for the higher scoring proposals (eg, company references, company organization, specific operating systems and applications, documentation, and company set-up/training/support operations). This secondary evaluation is also the point at which demonstrations and hands-on trials are obtained (Banahan, 1985).

Choice

Step 7, the final step, entails the actual choosing of the computer system and implementation of purchase contract. All set-up and operations responsibilities are spelled out by a contract that is reviewed by an attorney before initiation (Banahan, 1985).

In closing his detailed summary on computer selection for the medical practice, Banahan (1985) suggests the following:

> Converting the practice (from a manual system) will not be as simple as buying a computer, plugging it in, and turning on the power. After the system has been selected, supplies must be ordered, modifications to the office must be made, personnel must be trained, and the office functions converted to computer ... The decision-making process ... take(s) a considerable amount of time and effort and will involve a variety of people in the practice ... The success of a new computer system is directly proportional to the amount of time and effort spent in making the (computer) decision.

A practice will be interested in equipment that allows data base development and management, artificial intelligence development, and simulations (Evans, 1985). These activities can be developed on a practice-customized basis (Bobula, 1985), but existing software already meets many alternative application needs. Currently available working systems (eg, COSTAR, TMR, STOR, Pocket Record, Caduceus, REGENSTRIEF, ONCOCIN, PKC, and DUCHESS) have been reviewed and summarized (Lloyd, 1985).

Whatever system is ultimately chosen, it will be concerned with creation of client files, entry of encounter data, storage of that information, and accessing that material as appropriate. The file created and updated ultimately becomes the client's bill (Packer, 1985). Client profiles established from laboratory and encounter data assist in making decisions (Given et al, 1985). Screening activities constitute one kind of encounter and decision-making activity. Practice profiles may be derived using categories such as age, sex, diagnosis, medication, history feature, and so forth, which facilitate clinical research utilizing either retrospective or prospective formats (Elmslie and Rosser, 1986).

Audiometric Technology and Office Automation

Many new technologies have become available to audiologic and otolaryngologic practices in the last several years. Computer innovations (Yanz and Siegel, 1989) allow direct entry of audiologic and vestibular laboratory data into the client encounter record. Data may be stored in a computerized system distinct from the office system and transmitted on command via modem or direct interface to the office system.

Improvements in microprocessing chip technologies accelerate changes in data management. The ways of obtaining hearing-related data and the ways that those data are stored for future recall and evaluation are changing (Birck and Lilly, 1985). Cost economies unheard of a decade ago for data processing are now becoming available. These will be discussed briefly as they relate to screening and hearing health care services.

Technology and the Health Care Service Process

Technology cannot be discussed in isolation. Task analysis in the practice must be evaluated and technology brought to bear on the discrete tasks identified. This is a different process from a discussion of screening strategies because it is very site-specific and deals with information storage strategy. Data relating to client care fall into a number of categories: (1)

basic client descriptive data, (2) client history data, (3) encounter or extenuation data, and (4) client management data.

Basic Client Descriptors

The client essentially comes to a practice with a variety of descriptive information, such as age/birth date, sex, address, phone number, and third-party payor status. The client also presents with a complaint that may have been evaluated elsewhere. A CPT procedure code (Coy et al, 1990) may have to be generated for third-party billing purposes. These descriptors must be entered into a chart system of some sort for future reference and also for establishing a file for recording appropriate charge-related billing information after clinical evaluation. Strategies for definition of computerized file structures have been reviewed by Bobula (1985).

Client History Descriptors

History features in a hearing health care context include several categories of descriptor, such as those related to physical complaints, sensory disabilities, etiologic factors for sensory problems (noise exposure, head trauma, and so forth, in the case of hearing loss), familial/congenital problems, medications, and surgery. Several feature-analysis approaches exist in the literature; Table 1 is an example of a tedious pass/fail descriptor system suitable for entry via computer.

Table 1. Data History Summary - Distinctive Feature Analysis

(Circle Manifestation or Interpretation of History.)

1. Vague complaints
2. Somnolence
3. Impaired hearing
4. Impaired understanding
5. Global headache
6. Frontal headache
7. Temporal headache
8. Occipital headache
9. Parietal headache
10. Sinus-type headache
11. Head trauma
12. Nausea
13. Vomiting
14. Vertigo (unpredictable)
15. Vertigo with position change
16. Violent vertigo
17. Fatiguing vertigo
18. Dizzy on stooping
19. Dizzy on rising
20. Dizzy on turning
21. Feeling of falling to right

22. Feeling of falling to left
23. Feeling of falling forward
24. Feeling of falling backward
25. Feeling of rising
26. Feeling of descending
27. Sensation of objects spinning
28. Sensation of body spinning
29. Constant vertigo
30. Episodic vertigo
31. Vertigo at least once a week
32. Vertigo several times a month
33. Recent vertigo an entirely new situation
34. Recent vertigo similar to episodes over years
35. Vertigo relieved in some positions
36. Lightheadedness
37. Swimming sensation in head
38. Pressure in head
39. Blackouts
40. Aura heralding seizure
41. Unsteadiness feelings
42. Staggering gait
43. Sudden onset of dizziness
44. Dizzy onset associated with emotional upset
45. Earache/ear discomfort
46. Runny ear at present
47. History of runny ear
48. Sense of fullness or stuffiness in ear
49. Sensitivity to some sounds
50. Ringing or humming tinnitus
51. Buzzing tinnitus
52. Waterfall or wind-type tinnitus
53. Clicking or popping tinnitus
54. Other head noises
55. Tinnitus present all the time
56. Tinnitus present better than 50% of time
57. Tinnitus rarely present
58. Tinnitus usually concomitant with dizziness
59. Diplacusis
60. Fluctuating hearing
61. A better ear for speech
62. Poor understanding
63. Aching jaw
64. Facial pain
65. Mastoid pain
66. Facial numbness
68. Corneal anesthesia
69. Numbness of side of body
70. Hoarseness

71. Stiffness/tenderness of neck
72. Neurologic deficits
73. Paresthesias
74. Incoordination
76. Ataxia
77. Dysmetria
78. Dyssynergia
79. Dysdiadochokinesia
80. Dysarthria
81. Intention tremor
82. Dysphagia
83. Past-pointing
84. Otitis externa
85. Otitis media
86. Otitis interna (including cochlear/vestibular systems)
87. Ototoxic drugs in history
88. Spinal lesion
89. Fever
90. Response to antibiotics (re hearing/balance change)
91. Response to nonantibiotic medication (re hearing/balance change)
92. Cholesteatoma
93. Fistula test positive
94. Epilepsy
95. Rotatory nystagmus
96. Horizontal nystagmus
97. Vertical nystagmus
98. Coarse nystagmus (increased amplitude, decreased frequency)
99. Fine nystagmus (decreased amplitude, increased frequency)
100. Spontaneous nystagmus
101. Positional nystagmus
102. Spontaneous nystagmus altered by positionals
103. Positional nystagmus altered by spontaneous movements
104. Fatiguing nystagmus
105. Gaze nystagmus
106. Absence of nystagmus between episodic attacks
107. Absence of fixation suppression
108. Nystagmus more pronounced with eyes open than closed
109. Asymmetry of optokinetic responses
110. Canal paresis on calorics
111. Directional preponderance on calorics
112. Exaggerated caloric response
113. Bizarre caloric response
114. Hyperactive caloric response
115. Hypoactive caloric response
116. Sensorineural hearing loss
117. Conductive hearing loss
118. Mild hearing loss (25-40 dB HL)
119. Mild to moderate hearing loss (45-55 dB HL)

120. Moderate hearing loss (55-70 dB HL)
121. Severe hearing loss (70-90 dB HL)
122. Profound hearing loss (greater loss than 90 dB HL)
123. Complete hearing loss (no response to any sound)
124. Recruitment
125. Cochlear tone decay or cochlear acoustic reflex decay
126. Retrocochlear tone decay or retrocochlear acoustic reflex decay
127. Reduced discrimination (70-90% on W-22s)
128. Poor discrimination (30-70% on W-22s)
129. Very poor discrimination (0-30% on W-22s)
130. Carhart notch present
131. Progressive hearing loss
132. Presbycusis
133. Fluctuating audiometric thresholds
134. Asymmetry of hearing function
135. Positive urea test
136. Lues
137. Abnormal ABR
138. Abnormal MLR.

Client Encounter Descriptions

Encounter descriptors record what was done in the evaluation. For otologic purposes, it means recording procedures and results of the head and neck evaluation. For audiologic purposes, it is a matter of recording the procedures and results of a hearing evaluation.

Historically audiometric test results were recorded on a graphic or digital audiogram. The development of the automatic or Békésy audiogram allowed the client to record hearing thresholds with relatively little intervention by formal testing personnel. The latest innovation in audiometry is the use of an algorithm that allows the client to interact directly with a computer during pure-tone threshold assessment. The computer establishes thresholds with little intervention by testing personnel. Microprocessor-mediated audiometry allows screening of many clients with little personnel time committed. Such screening establishes true thresholds not significantly different from those produced through audiologist-mediated testing (Cook and Creech, 1983).

Client Management Descriptors

Several alternatives may present for management of a hearing health care complaint. The management may be primarily medical, surgical, therapeutic, or prosthetic. Therapy may be physician-, and audiologic-, or speech-language pathology-guided, and may include components of occupational or physical therapy. Each alternative must be coded.

Integrating Change Into the Specialty Practice

Audiometric equipment is becoming digitalized. Equipment which is analog in operation may still be made quasidigital with circuitry that converts analog information into a digital format. This technological innovation has made possible audiometric interface with

a variety of computer and computerized recording and storage devices.

Obtaining hearing performance information about a client would appear to be a relatively straightforward operation involving a subject who responds to hearing stimuli, a system for providing those stimuli, and a method of recording responses. The audiologist has historically assumed the responsibility for providing the stimuli and recording the responses. We are at a point in microprocessing technology where the audiometer need not be an audiologic albatross, but rather a device that frees up the audiologist's time to deal with rehabilitative concerns related to hearing loss.

Audiometry initially was limited to vacuum tube technology, then to transistor technology, and then to a variety of hybrid technologies. Microchip innovations in the 1980s made it possible to test a client without the tester having to manually record results. This is true for immittance devices and for pure-tone audiometry. "Smart" testing devices with built-in memory as hardware or devices that convert small computers to audiometric testing tasks are now available (Yanz and Siegel, 1989).

These evolving devices make it feasible to record and process audiographic and vestibular laboratory information in the office computer. This integration of testing equipment with the computerized client record charting system brings a new dimension to the concept of audiometric screening. In summary, offices can be readily computerized so that client records are established and maintained in a convenient form. Audiometric equipment capable of interfacing with those computerized records exists now. Screening programs and other activities that involve volumes of clients can utilizes these technologies.

The Screening Program and Hearing Health Care

Hearing screening seeks to identify those individuals at risk for hearing loss. The purpose is to treat any existing otologic disease process and to eliminate hearing loss. Treatment through use of amplification, auditory training, or management of the listening environment is appropriate when hearing loss cannot be ameliorated through medical or surgical management. Two basic questions must be dealt with in setting up a screening program: (1) Who are the people to be screened? (2) What measures define pass/fail on the screening instrument?

There are corollary questions as well: Where will the screening take place? Who will administer the screening? What equipment will be used? How will the data be recorded and saved? How will they be processed? How will follow-up for hearing health care services be implemented?

Screening may be used as an outreach tool to bring people into a practice, as a routine in-house tool for identifying existing clients who need further service, or for both purposes. Screening implicitly involves further service for those who fail the screening tests. It should be complex enough to identify those needing that additional service, but not so complex that time and energy spent in screening is redundant at the time that further service is obtained. These philosophical issues must be balanced at the time the screening program is designed. In the following discussion the numbers in parentheses are related to the screening flow chart.

Setting

Screening may take place in a variety of medical and nonmedical community setting. Settings may be grouped into four broad categories: nonmedical hearing conservation programs, nonphysician health care programs, physician-directed programs, and community resource programs. Any or all of these screening programs may be operative in a given community.

Nonmedical Hearing Conservation Programs

Nonmedical hearing conservation programs are not screening programs per se but may nevertheless function like screening programs because of the referrals that result. Programs within the public schools are a good example. The schools' primary interests are related to having children hear in the classroom and learn at potential. The schools must refer children for evaluation when hearing is poor or ears are unhealthy. Identification and referral by public schools in the USA have a monetary dimension, since classroom dollars may be linked to school-billed Medicaid hearing services, to special education funds related to P.L. 94-142, and to specific state laws impacting services for children with handicaps. It is important to recognize the schools' mandate requiring that hearing-impaired students should be maintsreamed in regular classrooms where this is educationally feasible, and to be aware of the need for evaluation to support integrated programs. Referrals by the schools may be to the primary or specialty practitioner.

Unfortunately, the hearing health care practitioner may fail to understand the screening system used by the schools that resulted in the medical referral. Hearing-related disorders in children do not have to be overtly organically based (eg, chronic middle ear effusion) but may be related to special perceptual problems such as auditory imperception, poor processing of auditory information, and so forth, which in turn may be organically based or familial in origin. Whether the hearing loss is organic in an otologic sense or is functional, it is proper for a school to obtain consultation to rule out a medical basis for a child's classroom hearing problems.

Industrial hearing conservation programs also generate referrals. The impetus for industrial programs has come especially from the Occupational Safety and Health Administration. Referrals for ear-related health care may occur for a variety of reasons (eg, ear canal occlusion due to cerumen, ear discharge noted at time of threshold evaluation, significant change in hearing function from previous measurement). Industrial hearing conservationists have noted that hearing specialists may be tempted to treat all such referrals as Workmen's Compensation "cases" rather than as individuals identified as being at risk for treatable hearing disorders.

Nonphysician Health Care Programs

Various nonphysician community programs may result in specialty referral. One example - the autonomous speech and hearing centers - tends to refer clients for services after partial evolution, often to a degree beyond that of school and industrial hearing conservation programs. Personnel evaluating clients in this setting are often audiologists; however, a variety of community volunteers including community physicians may be involved in evaluations

resulting in referrals.

Another nonphysician community program is connected with mental health centers. Mental health halfway houses and other halfway settings have similar hearing health care interests. Physicians may or may not be involved in this type of program. As the name suggests, the mental health center is primarily concerned with mental health wellness. Hearing loss and other "incidental" problems that impact mental health are of concern in such programs. Routine screening programs for a variety of disorders may be ongoing and may result in referrals.

Physician-Directed Programs

In physician-directed screening programs, the primary care physician, whether family practitioner, general practitioner, gynecologist, or pediatrician, identifies hearing problems and utilizes screening protocols to initiate referrals. Physicians in nursing homes and hospitals either directly or indirectly through support staff can identify potential hearing loss and initiate referrals to specialty practices.

Community Resource Programs

Two other screening program sites tend to be overlooked. The first is related to the hearing aid industry. Hearing aid salespeople often offer "free hearing tests" as part of hearing aid promotions. Referrals before hearing aid fittings are appropriate and criteria have been delineated by the Federal Drug Administration (Catlin, 1978; Schiff and Cohen, 1978). Federal Drug Administration hearing aid regulation allows for client waiver of formal physician evaluation. The growing move by physicians to dispense hearing aids may encourage the use of waivers by hearing aid vendors in some communities. When commercial hearing and dispenser screening activities are ongoing in a community, it is appropriate for the physician to provide reasonable assurance to the program that the salesperson will not lose a client because of a hearing health care referral. That is, the physician will not want to discourage referrals from commercial hearing aid vendors because the physician is viewed as a competitor to the hearing aid salesperson. Taking care to minimize hearing aid dealer concerns about business compromise when a client with a hearing loss is referred from a dealer is an ethical issue and a screening issue related to client follow-up in the dispensing specialty office.

The second community resource program setting that may be overlooked encompasses wellness advocacy: this is the "health fair". Health fairs may be sponsored by a variety of organizations including employee associations, industries, health departments, and community development organizations. A goal of the health fair is to encourage normal individuals to monitor their health through a variety of screening tests, including blood screening for metabolic diseases, spirometry for lung capacity and emphysema, and blood pressure screening for hypertension. Hearing testing is also performed at health fairs. Typically, such health fair screening results in referral to the primary practitioner; however, referral to a specialty practice for follow-up may occur in larger communities.

Personnel

Persons involved in screening programs range from unsophisticated community volunteers to volunteers of the medical community.

Minimally Trained Community Volunteers

In any community, a pool of individuals will usually come forward to donate time for worthwhile projects. Volunteers have been used in a variety of screening settings, such as school screenings operated by parent-teacher-student associations; state fair screening booths operated by community noise control agencies, health departments, or wellness agencies; and maternal and child health agency screenings operated by health departments. The services of community-based volunteers are especially valuable when the screening system uses questionnaires or mechanical activities because there is no judgment requirement by the volunteers.

The Lions, SERTOMA, service sororities and fraternities, church groups, hospital and nursing home service leagues, and other community service leagues, and other community service organizations are potential sources of community volunteers. Professional hearing health care provider organizations may be recruited for community-based screening programs on occasion, but these tend to be uninterested in long-term screening programs and those related to a specific referral practice.

There are considerable problems in recruiting volunteers. If a specialty practice has sufficient resources to operate a recruitment drive for volunteers, the efforts are commendable. Unfortunately, such recruitment resources often do not exist. Because recruitment often must rely on the efforts of potential community organizations of volunteers, the specialty practice must have a convincing argument for community screening that can be accepted by the voluntary organization. The why, how, when, where, and who questions may be addressed in approaching any volunteer or volunteer group, with emphasis placed on hearing health care altruism.

Minimally Trained Office Staff and Health Aides

Resources within the specialty practice include clerical and nonprofessional support staff. This group consists of close-at-hand people with various talents who can assist at short-term hearing screening programs. Use of office personnel for longer-term screening programs must be weighed carefully. Their long-term use may tax regular specialty practice activities and result in problems that compromise hearing health care rather than facilitate services to the health care consumer.

Professional Support Staff

Nurses, speech-language pathologists, and audiologists in the specialty practice may be tapped for short-term screening duties. Long-term screening programs generally cannot utilize members of the professional support staff because their income-generating clinical service skills would be unavailable during clinic hours. If specialty clinic office hours are limited, long-term screening programs may be operated outside these hours. Thus is cost-

effective when professional personnel are salaried employees but may increase clinic overhead if they are hourly employees. Use of professional staff permits timely referral decisions and requires minimal training for screening protocols.

Physicians

Primary care practitioners, and specialty practitioners may serve as screening personnel. Their involvement usually results from routine office procedures that flow from everyday clinical evaluations. The task in recruiting physicians to a screening program is to provide a screening tool that will help the physician make an appropriate referral. As screening protocols become more elaborate, physicians tend to delegate screening activities to support personnel. Therefore, physician-oriented screening protocols should be kept simple to minimize overhead costs associated with physician delegation of screening procedures to support personnel.

Screening Instruments

Screening instruments run a gamut ranging from paper and pencil to computer devices.

Questionnaires

The questionnaire is the simplest form of screening instrument. Its depth may be considerable, but it may be as simple as "Do you have a hearing problem? Circle Yes ... No." Questionnaires are desirable for use by unsophisticated personnel. Answers are "black and white", allowing for virtually instantaneous referral decisions. Table 2 is an example of a simple questionnaire; if any of the responses are positive, referral to the specialty practice for follow-up is appropriate.

Ear Checks

An ear check is a higher level of screening that involves evaluation of the external auditory canal to the tympanic membrane. Referral to a specialty practice is appropriate if the canal is occluded with cerumen, a foreign body is present in the canal, the canal is moist with debris and drainage, or the tympanic membrane has a perforation. A nonphysician hearing health care provider may be able to make these judgments. The Federal Drug Administration has indicated that any hearing aid dealer should be able to refer clients to physicians for follow-up if obvious ear problems are present. Unfortunately, abnormal conditions in the ear may not be evident even to a typical nurse; therefore, a training experience will be necessary to demonstrate to screening personnel how to recognize and distinguish the normal and abnormal ear on visual inspection.

Tuning Fork Tests

The Weber, Rinne, and Bing tuning fork tests may be used for screening, provided that background noise levels are not excessive. Tuning fork tests are common in many physicians' officers and are readily adaptable for screening with little personnel training time. Persons performing the procedures do not have to understand why the fork tests work so long as referral criteria are clearly established. An audiometer bone oscillator at a suitable intensity

may be used as the tuning fork stimulus when forks are not available for a screening program. Referral to a specialty practice is appropriate when the stimulus is not heard or when a conductive loss is indicated.

Table 2. Screening Questions for Determination of People at Risk for Hearing Problems

(Directions: Circle the phrase that describes your complaint.)

1. Difficulty understanding/hearing
2. Earache
3. Balance problems (like spinning, moving, or falling)
4. Ear discharge/drainage
5. Noise in head or ear: ringing, buzzing, hissing, chirping, roaring
6. Changes in hearing from day to day
7. Unequal hearing between ears
8. Use of drugs which seem to cause head noises or balance problems
9. Family hearing loss or ear problems
10. Ear fullness or stiffness
11. Sensitivity to loud sounds
12. Work history around machinery, assembly line, farm equipment
13. Ear surgery history
14. History of ear disease
15. Use of hearing aid
16. Head injury history with hearing change
17. Others complain of your hearing ability.

If the following information is completed, you have failed this screening and have been scheduled for a further evaluation:

Appointment Date _____

Appointment Time _____

Appointment Place _____

Please call ( ) _____ to confirm this appointment.

Pure-Tone Testing

An audiometer can be used for a simple pass/fail screening at one or several frequencies or it can be used for a pure-tone air conduction audiogram. Background noise levels must not be excessive; even in relatively quiet screening areas, suprathreshold screening levels must be used. Referrals are indicated when the screening floor is exceeded (ie, when a client fails to hear at a specific level or alternatively when a client's pure-tone hearing acuity lies outside normal expectations defined for the screening process).

Pure-tone testing can be quite complex and can supply complete audiometric data. The audiogram ceases to be a screening instrument in such cases and becomes a clinical tool. Such detailed screening is not cost-effective even when performed by computer and is a poor use of personnel time in most instances, particularly when specifications for limiting background noise are not met (American National Standards Institute, 1971).

Immittance Tests

Tympanograms are a useful screening tool. They allow a quick assessment of conductive hearing loss and middle ear status. Tympanometric screening data can be supplemented by hearing information when immittance equipment contains circuitry to accomplish acoustic reflex screening or pure tone audiometry. Typically, the use of immittance equipment requires some training of screening personnel, particularly to recognize when the probe tip is occluded by inappropriate pressure on the canal wall. With the recent addition of self-diagnostic circuitry to some equipment, a naive operator can be informed by display that the probe tip is occluded.

Recording Systems

Results of screening programs can be recorded in a variety of ways. The degree of integration of screening activities into the specialty practice will dictate the recording system used.

Paper and Pencil Narratives

The historical paper and pencil narrative is the most inefficient system that can be used in a screening program. This method involves writing out results in long-hand or perhaps typing them. Unless the reporting protocol is rigorous, it is limited by format and inconsistency of data reporting. This method may be reasonably efficient for screening of small numbers of people when personnel time is ample.

Check Lists

Check lists involve establishing a form listing all potential screening results on a card or sheet of paper. Data can be entered by personnel or the client himself during the screening process (see Table 2). Protocol may require screening personnel to fill out the form. A referral box or disposition line is appropriate. The address(es) for referral follow-up should on this type of form as well as appointment data; a contact phone number also is appropriate. A carbon form of the check list allows a record for the screening system and a copy for the client.

Data Processed For Computer

Screening information may be prepared for computer processing at the time of information entry onto forms. Some data entry systems require punching data onto typical IBM cards; the IBM Port-A-Punch Board and other template systems provide pre-scored holes in computer cards for this purpose. Such card systems produce information ready for computer processing (eg, assignment of follow-up appointment spots, type of hearing loss

identified). These cards are processed after the client leaves the screening area and require clean follow-up at another time. Alternatively, optical scanning systems that rely on graphite marking or punching use cards or ordinary sheets of paper. Data entries are optically scanned by people or machines. When scanned by machines, the coding for computer may be entered into a client encounter record directly with appropriate scanning technology.

Such marking and punching systems are becoming obsolete with the advent of portable, home, and desktop computers. The extra step of data coding is unnecessary when the data can be entered directly into a portable computer or terminal. There was renewed interest in the use of bar coding in clinical applications at the close of the 1980s, however (Longe, 1989).

Computer-Interactive System

Rapid computer innovations have made available many data recording options to screening programs. Portable home and desk-top computers can be made interactive with screening personnel or even with clients. Small computers can be placed into a terminal mode and can interface with a "home office" computer by telephone modem, becoming an extension of that office computer. In either system, data may be entered in response to "user-friendly" prompts from the computer visual display screen as information about each individual is processed. Responses are recorded and put on disk. Appointment times for referrals can be initiated by the computer while the client is still responding to prompts and can even provide a "hard copy" referral appointment record for the client. Such "paperless" recording systems are desirable and possible with BASIC programming competence but may be more efficient when designed in a lower-level coding language by more sophisticated programmers.

Decision-Making Matrix

Once the screening instrument is administered, data must be processed, decisions made, referrals made, and consultation appointments established. There are three possibilities for review of screening data.

Predetermined Referrals

The simplest referral decision strategy sets predetermined pass/fail criteria. The client is automatically referred to the specialty practice when any of the fail criteria are triggered. This decision does not allow for special cases in which hearing loss is present but referral may be inappropriate.

Site-Reviewed Referrals

The next most complex decision strategy allows personnel at the screening site to make decisions on the overall pattern of data. Such on-site review of data allows for dealing with special patterns within the screening material. For example, a person with noise-induced hearing loss need not be referred when etiology is clear and compensation skills are adequate for daily living. The same may be true for a geriatric client with mild higher-tone sensorineural hearing loss when adequate compensation skills are present for daily living.

Professional Review Referrals

The most complex decision-making strategy is that which involves a professional review of the screening data prior to discharge of the client from the screening protocol and before making a decision for referral. This is the least efficient screening strategy and a poor use of professional time, tying up fully trained personnel for a task that could be made automatic or semiautomatic.

Table 3 examines potential screening referral criteria for items 18 to 22. Criteria must be clearly delineated when using community volunteers.

Table 3. A Strategy for Referral

Screening Tool	Full/Referral Criteria
Questionnaires	Refer for any positive item.
Ear checks	Refer for any discharge, cerumen occlusion, abnormal shape.
Tuning fork tests	Refer for weak hearing acuity, strong Weber lateralization, bone conduction better than air conduction on Rinne tests, or positive Bing test
Pure-tone tests	Refer for screening failures at 25 dB level at 0.5 and 3 kHz in children and adults less than 50 years of age; refer older adults at failure at 25 dB at 0.5 and 35 dB at 3 kHz.
Immittance tests	Refer for any flat tympanogram or type C tympanogram in which negative pressure is greater than - 150 mL water pressure; refer for absent acoustic reflexes.

Specialty Practice Scheduling

Screening programs generate consultations. In many instances, a client leaves the screening setting with a vague idea that something is wrong and that he or she should see someone about it. When screening is completed, the client must be given something "in-hand" that will provide sufficient information about what action to take after the screening failure.

Walk-In System

A screening system that is office-oriented may direct the client identified as at high risk for hearing loss directly to the specialty office. There the client can be seen immediately or a formal appointment can be made for a future clinic visit. Some specialty offices are adept at handling walk-in clients and can accommodate new clients immediately. Others have to utilize the future appointment strategy with walk-in clients.

Phone-In System

An alternative to the walk-in system is the phone-in system. In this strategy, phone numbers are provided for the client to call for information and appointment. A modification of this system is to provide a formal appointment at the time of discharge from the screening protocol, with the client directed to call to confirm the appointment.

Computer Time-Slot Generated Appointment

There are many ways of incorporating computer assistance into the management of the screening client. Scheduling is one such activity. Appointments may be made directly at the time of discharge from the screening setting, where there is direct interface via terminal with the specialty office by phone line. Direct appointments also may be made prior to discharge without this interface. A small computer with a word processor or suitable program can allocate a reasonable number of office-reserved scheduling slots for appointments for screening failure. This ongoing list of appointments in the word processor or appointment program may be updated as people fail the screening tests. If a printer is available at the screening site, the client can be given a formal printed appointment time directly from the computer program. Formal appointment data can be delivered to the specialty clinic office at the end of a suitable screening period via modem or simply by carrying a diskette back to the office.

Specialty Practice Services

There is a quandary in dealing with screening-generated referrals. The screening data may be tainted, depending on the screening tool and the level of competence of screening personnel. Should all individuals failing a screening at a remote site using naive personnel be seen by an otolaryngologist, particularly in a busy practice? Should there be some kind of verification of screening result prior to medical evaluation? Should screening data be accepted as valid automatically and physician intervention be sought?

Rescreening Protocol

Screening procedures by design are meant to be short and cost-effective. They may be repeated to verify their results with relative ease prior to medical intervention. Alteratively, a second-level screening activity may be appropriate. For example, a child may fail a school hearing and, prior to medical referral, may be referred to a central school facility for standard pure-tone audiometry in a sound booth. In an ear specialty office, audiologic management may be appropriate prior to formal physician intervention. People who pass the secondary screening may be discharged from the office without additional expense, whereas the cases of those with documented problems can be worked up in greater detail and the client then be seen by a physician with full audiologic information, saving time and further scheduling problems. Potentially, this response to the screening case load is the most economical for the health care consumer; it is not as cost-effective for the consumer whose third-party payor requires physician referral for such services prior to evaluation.

Medical Evaluation

Another alternative places the specialty physician in a screening role. All clients failing a screening program in the model are seen by a physician, with the physician referring selected clients for audiologic evaluations. This model may be a poor use of physician time for large-volume screening programs, depending on case load generated and time available. It also is likely to result in higher overall costs for the health care consumer.

Baseline Evaluation

The third response procedure, baseline evaluation, assumes that all clients referred from screening programs are valid clients and should be fully evaluated. All such clients entering the specialty practice thus receive full physician and audiologic services, so that a true baseline for hearing is established for each respective new client. This response tends to be the most expensive for the health care consumer but produces the highest level of hearing health care.

Consultation Follow-Up

Good public relations demand follow-up of screening program referral sources. Appropriate gratitude should be expressed to volunteers, operators of screening sites, loaners of equipment, and so forth. Special follow-up is appropriate in certain instances.

Sharing of Evaluation Data

A screening that occurs in another health care setting and results in a referral typically requires a specialty clinic to return the client to the referral source along with evaluation data generated in the specialty clinic. Unfortunately, some specialty clinics fail to recognize the propriety of providing information to screening sites that may be paying for referral and assessment (eg, educational and industrial hearing conservation programs). Needles to say, feedback of results to professionally managed screening sites - indeed, to all referral sources - is appropriate to assure future referrals and continuity of hearing health care management.

Additional Service

Evaluation of individuals referred through a screening program may result in referrals for additional service. Neurologic, metabolic, audiologic, otologic and other consultations may result because of the initial visit of the screening-referred client to the specialty office, dependent on the level of service available in that office.

Summary

Automation continues to impact health care many levels including the level of screening activities. Screening may be integrated into computerized data processing applications already existing within a practice. Alternatively, screening may be a separate activity that precedes a client's formal encounter with a hearing health care practice. This chapter has examined computer applications to medical record processing, has discussed innovations in audiometric equipment utilized in the hearing health care practice, and his explored the screening/specialty practice interface.

Box. Parameters Involved in Screening Program Decisions

Setting

Nonmedical hearing conservation programs

1. Schools
2. Industry

Nonphysician health care programs

3. Speech and hearing centers
4. Mental health centers

Physician-directed programs

5. Primary care practitioners
6. Nursing homes
7. Hospitals

Community resource programs

8. Hearing aid promotions by dispensers
9. Health fairs

Personnel

10. Minimally trained community volunteers
11. Minimally trained office staff
12. Health aids
13. Nurses
14. Speech-language pathologists
15. Audiologists
16. Primary care practitioners
17. Specialty practitioners

Screening instruments

18. Questionnaires
19. Ear checks
20. Tuning fork tests
21. Pure-tone testing
22. Immittance tests

Recording systems

23. Paper and pencil
24. Check lists
25. Data processed for review referrals
26. Computer-interactive systems, disk, tape
27. Computer-interactive systems, modem

Decision-making matrix

28. Predetermined narratives
29. Site-review referrals
30. Professional review

Specialty practice scheduling

31. Walk-in system referrals
32. Phone-in system for appointment
33. Computer time-slot generated appointment
34. Rescreen before referral

Secondary or rescreening

35. Physician "gate-keeper" referral
36. Baseline study and referral

Disposition

37. Evaluation results to referral source
38. Further evaluation/referral to other health care providers.