DEPARTMENT OF VETERANS AFFAIRS

REHABILITATION RESEARCH AND DEVELOPMENT

NATIONAL CENTER FOR REHABILITATIVE AUDITORY RESEARCH

VA MEDICAL CENTER, PORTLAND, OREGON

ANNUAL REPORT

JANUARY 1, 2007 – DECEMBER 31, 2007

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I. BACKGROUND

Vision

Our vision is to be the national leader in rehabilitative auditory research and development, and a national resource for veterans, their families, health care professionals, and the community at large.

Mission

The mission of the National Center for Rehabilitative Auditory Research is to benefit veterans and the nation by alleviating the communicative, social and economic problems resulting from auditory system impairments.

Relevance to Veteran Population

Auditory disabilities affect veterans of all ages and represented the most prevalent individual service-connected disability among veterans receiving compensation benefits from the Veterans Benefits Administration in fiscal year 2006 (VBA, 2006). More than 839,907 veterans were identified as having service-connected auditory disabilities that required compensation from the VBA. In FY 2006, total compensation to veterans exceeded $1.2 billion for hearing loss and tinnitus disabilities, an increase of 18% in the last year and 56% increase since 2002. Furthermore, an estimated 1.5 million additional veterans are service-connected for their hearing loss and tinnitus, but do not receive compensation. Most importantly for our veteran population, hearing loss and tinnitus can have a life-long negative impact on communication and quality of life.

VA research, while targeting veterans, provides significant benefit to all Americans. The VA's support of auditory rehabilitation research is equally important for veterans receiving compensation, for the millions of veterans who have a non-compensable hearing loss, and for the nearly 35 million individuals in the United States who are affected by hearing loss. This communication disorder—the most common chronic health condition in all age groups—profoundly affects social, vocational, and psychological functions (Ruben, 2000). The communication difficulties caused by auditory disabilities interfere with treatment of patients who have hearing impairment, as well as with the delivery of effective health care in general. Moreover, the incidence of hearing loss increases dramatically with age: about 40-45% of people over age 65 years have some degree of hearing loss, with the number increasing to about 83% in individuals over 70 years of age (Cruickshanks et al., 1998). In the 30 years between 1990 and 2020, it is projected that the number of veterans over 85 years will have increased by 568%; while the median age of veterans is projected to increase from about 58 years today, to over 62 years by 2020. As the population ages, the high incidence of hearing disabilities among veterans and the general population will create unprecedented demands for hearing healthcare services within the Department of Veterans Affairs (VA) and the private health care industry.

Unique Role of the NCRAR

The NCRAR was established in 1997, just began its third five-year funding cycle, and is currently one of thirteen Centers of Excellence (CoE) funded by the VA Rehabilitation Research and Development (RR&D) Service. It is the only such center dedicated to the discovery and delivery of cutting-edge solutions to auditory dysfunction. The NCRAR is also unique among auditory research facilities because of its focus on the rehabilitation of auditory dysfunction and translation of research findings into audiology clinical practice. The Center uses a multi-disciplinary approach that includes both basic and clinical research components to bring diverse

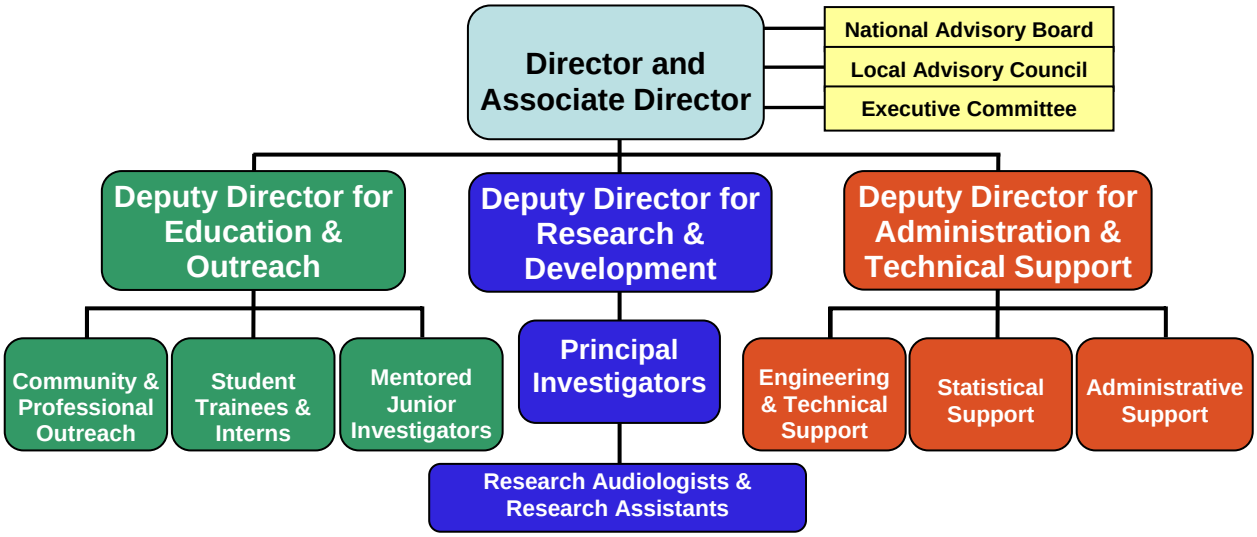
perspectives and solutions to common auditory problems. Our research strategy encompasses the progression from basic theoretical research to clinical care, including three major research areas: the *diagnosis and assessment* of auditory dysfunction, the development of *rehabilitation* approaches and techniques, and the *prevention* of hearing loss. We carry out clinical trials, develop technologies, and play an important role in cultivating the next generation of auditory researchers through education and mentoring programs. Furthermore, we serve as a resource for rehabilitative auditory research through the dissemination of research findings and patient information to rehabilitation professionals throughout the nation, ultimately benefiting veterans whose quality of life is diminished by hearing impairment. Core funding of the Center has been effective in developing one of the country's premier centers for auditory research, and has facilitated the acquisition of investigator-initiated research funds from diverse sources. The NCRAR is a VA research facility, staffed by VA researchers, carrying out rehabilitation research and development projects of high priority to the hearing health care of veterans.

The NCRAR contributes uniquely to the VA RR&D CoE portfolio. Our goals include continuing existing lines of research while incorporating research initiatives of priority importance to current and future generations of veterans. CoE funding allows the Center to advance these research, education, and training initiatives with a highly productive team of core investigators and associated scientists throughout the country and internationally.

Plan of Operations

The NCRAR plan of operations currently in place successfully directs activities in support of our mission to improve the lives of veterans with hearing disability through clinically relevant auditory rehabilitative research. Administration and operations of the NCRAR have been highly successful in support of its development over the years, and only modest changes have been necessary to accommodate this growth in facilities and staff. The structures and administrative controls described below are designed to coordinate activities from a broad base of resources, including collaborating institutions, to facilitate research, provide educational opportunities and disseminate research information to professionals and to the public. The plan of operations also includes mechanisms for personnel management of Center staff, and the sharing of information and collaboration of research ideas among internal and external investigators.

NCRAR Organizational chart



II. SUMMARY OF PROGRESS FOR CALENDAR YEAR 2007

Stated Goals and Objectives

Consistent with the NCRAR's *Vision*, *Mission* and five-year strategic plan, our focus has been on: 1) improving the lives of hearing-impaired veterans and their families by advancing the discovery of new knowledge and technologies that optimize auditory rehabilitation, developing and rigorously evaluating useful innovations in the laboratory, and applying rehabilitation research solutions to clinical practice; 2) educating and influencing the rehabilitation community by disseminating evidence-based research findings and developing best practice procedures; 3) maximizing the availability and optimal use of core, shared equipment and facilities resources including grant administration (pre- and post-award) and technical support (biostatistics and engineering) services; 4) cultivating innovation and synergy of intellectual resources among multidisciplinary professionals including audiologists, public health specialists, auditory research scientists, rehabilitation engineers, educators and administrators; and 5) supporting core researchers and key collaborators whose programs and projects are in turn, supported from a variety of federal, public and private sources to effectively leverage the center's core funding. Specific goals and objectives included:

- Add an OAE recording feature to our proprietary AudioTest Software Suite invention to enable recording of SFOAE, DPOAE, and other types of OAE responses. We also will add a new Confidence Ranking feature to the AudioTest Software Suite, which will enable subjects to indicate their level of confidence in response to questions presented through the AudioTest questionnaire interface.
- Continue the development of our proprietary AnalyzeOAE software to incorporate new signal processing algorithms into OAE.
- Continue to build capacity through recruitment and mentoring of pre- and post-doctoral fellows, rehabilitation research scientists, scholars and rehabilitation engineers who are deemed appropriate candidates for Research Career Development, Research Career Scientist, and other VA and non-VA research career development program opportunities including the following:
  - Career Development Award-2 candidates (F. Gallun, PhD; M. Molis, PhD; M. S. Lewis, PhD)
  - Career Development Transition Award candidate (D. Konrad-Martin, PhD)
  - Career Scientist candidate (G. Saunders, PhD)
- Develop independent study materials related to hearing impairment for the VA System-Wide Training program sponsored by the VA Employee Education System, including a 14-module, web-based tinnitus training course (20 hours of training) for VA audiologists.
- Develop patient and family education booklets for veterans with tinnitus.
- Development of a formal auditory research and rehabilitation engineering training program for medical school residents and fellows, and engineering students.
- Develop the ability to use an identical set of words selected from a standard word recognition list in order to assess: 1) word recognition performance; 2) perceptual encoding speed; and 3) working memory in patients with diminished speech understanding ability.
- Dr. Saunders will serve as President of the Academy of Rehabilitative Audiology.

- Formalize partnerships to pursue funding for the establishment of a Translational Hearing Research Center in Portland, OR.
- Further increase the diversity of leveraged funding.
- Host a third biennial international conference in Portland, OR during the Fall 2007, and subsequently produce and distribute the conference sessions on DVD and video. Gabrielle Saunders will serve as Conference Chair, Christine Kaelin and Carolyn Landsverk will serve as Co-Organizers, and Dawn Konrad-Martin will serve as Chair of the Scientific Program Committee for the conference entitled, 'Hearing Therapies for the Future'. The conference will be held on September 27-28, 2007 at the World Trade Center in downtown Portland, OR.
- Implement a formal summer auditory research program for pre-doctoral AuD students.
- Initiate/expand research collaborations/clinical trials with:
  - Frye Electronics, Inc., Tigard, OR
  - Phonak Inc., Warrenville, IL
  - Sonitus Medical, Inc., Woodside, CA
  - Sound Pharmaceuticals, Inc., Seattle, WA
  - The Smith-Kettlewell Eye Research Institute, San Francisco, CA
- Initiate collaborations with vestibular/balance disorder rehabilitation researchers.
- Initiate new studies in rehabilitation of blast-related and noise-induced auditory injury, rehabilitation strategies based on neural plasticity of the central auditory system, and telehealth and web-based audiological services and programs.
- Interface with the RR&D Technology Transfer Program to facilitate partnering with appropriate private industry organizations to have innovative, clinically useful tools (e.g., AnalyzeOAE and AudioTest Software Suite applications, computer automated Tinnitus Evaluation System, Non-invasive Glucose Monitoring method and device using otoacoustic emissions, and OtoID device) translated into clinical practices at other VAMCs and the nation.
- Recruit and hire an accomplished electrophysiology researcher with expertise in human auditory neuroscience, electrophysiologic measurement of central auditory function, and plasticity of the central auditory system.
- Recruit and hire a hearing-aid researcher with expertise in hearing aid technology and fitting algorithms.
- Seek and obtain approval of funding for the following NCRAR initiatives:
  - "Central auditory processing disorders associated with blast exposure"
  - "Development of an automated test to assess the presence of tinnitus"
  - "DoD/VA joint incentive fund sharing initiative- hearing loss prevention program"
  - "Ecological momentary assessment in hearing research"
  - "Effect of training on central auditory function in multiple sclerosis"
  - "Integrating auditory and visual information to improve hearing aids"
  - "Limiting inflammation in bacterial meningitis by targeting host immune pathways"
  - "Multi-discipline assessment of blast victims for cognitive rehabilitation"

- "New strategies for sound-based tinnitus relief"
- "Noninvasive blood glucose monitoring using otoacoustic emissions"
- "Prevention of cisplatin ototoxicity with the antioxidant α-lipoic acid"
- "Supplementing hearing aids with computerized auditory training"
- "The impacts of dual-sensory impairment on daily function"
- "The Veterans' Hearing Loss Prevention Program: Improving Hearing Health"
- "Using chronic pain models to develop tinnitus evaluation and treatment methods"

- Seek and obtain external funding to support education and training program activities.
- Sponsor additional clinical research seminars, and work with the VA Audiology and Speech Pathology Program Office and the VA Employee Education System to develop and produce additional satellite broadcasts using the VA Employee Education System satellite network and V-Tel systems.
- Work to develop hearing loss prevention and hearing conservation programs and practices that should become part of clinical rehabilitation strategy throughout the VA and DoD health care systems, and the nation.

Goals and Objectives Achieved

The NCRAR met and exceeded nearly all its goals and objectives for 2007 while building VA research capacity through the recruitment, retention, support and mentoring of the next generation of VA auditory rehabilitation researchers and rehabilitation engineers. Paramount to the NCRAR's success in achieving its goals and building VA research capacity has been our ability to accommodate additional staff and associated research and development activities through the construction of dedicated VA Center of Excellence facilities and the provision of core, shared equipment and support services. The following are several of the NCRAR's most notable achievements during 2007:

- Developed a test using our proprietary AudioTest Software Suite to determine the pace and certainty with which listeners are able to recognize words in ongoing speech. Variants of this test are being explored which would enable the use an identical set of words selected from a standard word recognition list to assess: 1) word recognition performance; 2) perceptual encoding speed; and 3) working memory in patients with diminished speech understanding ability.
- Developed an 18-module, web-based tinnitus training course (30 hours of independent study training materials) for VA audiologists (collaborative project involving James Henry, PhD, NCRAR; Tara Zaugg, AuD, NCRAR; Paula Myers, PhD, James A. Haley VAMC; and Martin Schechter, PhD, Portland VAMC).
- Develop patient and family education booklets for veterans with hearing loss and tinnitus.
- Disseminated research results to professionals through 21 publications in scientific peer-reviewed journals and books, with an additional 26 manuscripts in press (6), under review (7), or in preparation (13), 11 articles in non-peer review publications, 58 presentations made at professional conferences, meetings and symposia, and 12 presentations to VA medical center professionals, veterans and members of the general community.

- Disseminated VA RR&D NCRAR research achievements to a broad spectrum of professional and lay audiences as a result of sponsoring 16 clinical research seminars, as well as at roundtables, workshops, and community talks.
- Diversified and expanded its funding portfolio, particularly from extramural funding agencies.
- Dr. Saunders served as President of the Academy of Rehabilitative Audiology.
- Enhanced the functionality of our proprietary AnalyzeOAE software by incorporating new signal processing algorithms into OAE, which supports a curve-fitting tool that can be used to fit suppressed OAE growth curves to determine auditory compression metrics in test subjects.
- Enhanced the functionality of our proprietary AudioTest Software Suite invention by adding an OAE recording feature that enables recording of SFOAE, DPOAE, and other types of OAE responses. We also added a new Confidence Ranking feature to the AudioTest Software Suite, which enables subjects to indicate their level of confidence in response to questions presented through the AudioTest questionnaire interface.
- Hosted our third biennial international conference entitled, 'Hearing Therapies for the Future' and accompanying pre-conference clinical practice workshop entitled, "Best Practices in Hearing Loss Prevention" in Portland, OR during the fall of 2007. The conference sessions were recorded and disseminated on DVD via the Employee Education System, while proceedings from the conference are to be published in a forthcoming special issue of the scientific peer-reviewed journal *Seminars in Hearing*.
- Hosted Pamela Souza, PhD, as a Visiting (Auditory) Scientist.
- Initiated/fulfilled rehabilitation research and development collaborations with:
  - Otothera Inc., Winston Salem, NC
  - Australian Catholic University, North Sydney, Australia
  - Cleveland Clinic Foundation, Cleveland, OH
  - DoD, U.S. Army Garrison, Fort Bragg, NC
  - DoD, U.S. Army Madigan Hospital, Fort Lewis, Tacoma, WA
  - DoD, Army Audiology and Speech Center, Walter Reed Army Medical Center, Washington, DC
  - Howard Leight Industries, San Diego, CA
  - James A. Haley VAMC, Tampa, FL
  - James H. Quillen VAMC, Mountain Home TN
  - McMaster University, Ontario, Canada
  - Oregon Health & Science University, Oregon Graduate Institute, School of Science & Engineering, Departments of Biomedical Engineering and Computer Science & Engineering, Portland, OR
  - Petroff Audio Research, Inc., Marina Del Ray, CA
  - Polytrauma and Blast-Related Injuries Quality Enhancement Research Initiative (QUERI), Rehabilitation Centers (Minneapolis, MN; Palo Alto, CA; and Tampa, FL)
  - Intensive Care Unit and Nursing Research Programs, Portland VAMC, Portland, OR

- RR&D Center for Aging Veterans with Vision Loss, Decatur-Atlanta, GA
- Sonitus Medical, Inc., Woodside, CA
- University of Maryland, College Park, MD
- University of South Florida, Tampa Bay, FL
- University of Washington, Seattle, WA

- Mentored and trained a bright group of auditory rehabilitation researchers, including the following career development awardees:
  - Frederick Gallun, PhD, Career Development Award-2
  - Dawn Konrad-Martin, PhD, Advanced Research Career Development
  - Michelle Molis, PhD, Associate Investigator
  - M. Samantha Lewis, PhD, Research Career Development
  - Mitchel Turbin, PhD, Disability Supplement
- Proceedings from the NCRAR's fall 2007 biennial international conference sessions were broadly disseminated on DVD and video.
- Received approval of funding to support the following NCRAR initiatives:
  - "Central auditory processing disorders associated with blast exposure"
  - "Development of an automated test to assess the presence of tinnitus"
  - "DoD/VA joint incentive fund sharing initiative- hearing loss prevention program"
  - "Effects of training on central auditory function in multiple sclerosis"
  - "Hearing therapies for the future"
  - "Modeling auditory integration in people with impaired hearing"
  - "Multi-discipline assessment of blast victims for cognitive rehabilitation"
  - "Noninvasive blood glucose monitoring using otoacoustic emissions"
  - "Prevention of cisplatin ototoxicity with the antioxidant α-lipoic acid"
  - "Pre-doctoral summer training program in auditory research"
  - "The ability to make multiple auditory judgments about non-speech stimuli"
- Received approval of a five-year T-35 Predoctoral Short-Term Training grant from the National Institute on Deafness and other Communication Disorders to provide a summer research training experience for up to four AuD students per year. The NCRAR was one of only three auditory research training programs in the nation to receive one of new training program awards from the NIH-NIDCD in 2007, with the other two auditory research programs being Boys Town National Research Hospital in Omaha, Nebraska, and Vanderbilt University in Nashville, Tennessee.
- Received $270,000 in emergency equipment funding to purchase equipment necessary to support OIF/OEF rehabilitation research and development activities.
- Served as the U.S. Government Agency repository for receiving, protecting, utilizing and releasing data contained in the DoD Defense Occupational Environmental Hearing Readiness System Hearing Conservation (DOEHRS-HC) database.

Future Goals and Objectives

The NCRAR will continue to use its highly successful model of providing dedicated facilities, shared equipment, research and development support resources, and start-up needs for its core group of auditory rehabilitation researchers to shape its future. We will continue to encourage and support the synergistic effect of multidisciplinary intellectual resources from rehabilitation researchers, educators, rehabilitation engineers and key collaborators whose programs and projects are in turn supported through a variety of federal, public and private funding sources to maximally leverage the Center's core funding. Specific future goals and objectives include:

- Continue to enhance and optimize the functionality of our AudioTest Software Suite.
- Complete the inverse filtering algorithm project to optimize speaker calibration methods and performance characterization in the anechoic chamber.
- Continue development of OAE Analysis routines.
- Continue to build capacity through recruitment and mentoring of pre- and post-doctoral fellows, mid- and junior-level clinical research-scientists, scholars and rehabilitation engineers who are deemed appropriate candidates for the VA Career Development Program, or other non-VA research career development program opportunities including the following:
  - Career Development Award-1 candidate (S. Melamed, PhD)
  - Career Development Award-2 candidates (M. Molis, PhD; M. S. Lewis, PhD)
  - Career Development Transition Award candidate (D. Konrad-Martin)
  - Research Career Scientist candidate (G. Saunders, PhD)
- Continue to help shape the field of audiology through continued involvement in leaderships roles in professional organizations.
- Continue to support and mentor NCRAR clinicians and junior investigators in order to help them to develop as clinical scientists.
- Determine if evidence exists in older adults for abnormal auditory nerve compound action potential (CAP) recovery following the presentation of a high intensity tonal conditioner. The rationale for this line of research is based on the finding that CAP recovery from forward masking shows two distinct slopes, possibly indicative of contributions by low spontaneous rate and high spontaneous rate auditory nerve fibers (Murnane, Prieve, Relkin, 1998). CAP recovery functions in quiet-aged gerbil were consistent with a loss of low spontaneous rate fibers (Schmiedt, Mills, and Boettcher, 1996), but only direct measures in humans will determine whether loss of low spontaneous rate activity contributes to reduced temporal processing ability in older adults.
- Develop additional patient education booklet for veterans and their families, as well as for health care professionals.
- Development of formal auditory rehabilitation research and rehabilitation engineering training programs for medical school residents and fellows, and engineering students.
- Further increase the ratio and diversity of leveraged funding.
- Host a fourth biennial international conference in Portland, OR during the Fall 2009, and subsequently produce and distribute the conference sessions on DVD and video.

- Initiate/expand research collaborations/clinical trials with:
  - Frye Electronics, Inc., Tigard, OR
  - House Ear Institute, Los Angeles, CA
  - Phonak Inc., Warrenville, IL
  - Sensimetrics Corporation, Somerville, MA
  - Sonitus Medical, Inc., Woodside, CA
  - Sound Pharmaceuticals, Inc., Seattle, WA
- Initiate collaborations with Faye Horak, PhD (Neurological Sciences Institute, Oregon Health & Science University) and Scott Mader, MD (Rehabilitation and Long Term Care, Portland VAMC) in the area of vestibular/balance disorder rehabilitation research, particularly as relevant to meeting the needs of returning OIF/OEF veterans who have suffered blast-trauma related injuries.
- Initiate new studies in rehabilitation of blast-related and noise-induced auditory injury, rehabilitation strategies based on neural plasticity of the central auditory system, telehealth and web-based audiological services and programs, and community re-integration for individuals with significant hearing impairments or dual sensory (hearing and vision) loss.
- Interface with the RR&D Technology Transfer Program to facilitate partnering with appropriate private industry companies to have innovative, clinically useful tools (e.g., AnalyzeOAE and AudioTest Software Suite applications, computer automated Tinnitus Evaluation System, Non-invasive Glucose Monitoring method and device using otoacoustic emissions, and OtoID device) translated into clinical practices at other VAMCs and throughout the nation.
- Make significant contributions to the planning, execution and outcomes of the TBI State of the Art (SOTA) conference to take place in Arlington, VA from April 30-May 2, 2008.
- Proceedings from the NCRAR's fall 2007 biennial international conference sessions will be broadly disseminated on DVD and video.
- Publish conference proceedings from the NCRAR's fall 2007 biennial international conference entitled, "Hearing Therapies for the Future" in a special issue of *Seminars in Hearing*. Dr. Konrad-Martin will serve as special guest editor of this issue that will be devoted solely to publishing proceedings from the NCRAR conference.
- Recruit and hire a productive electrophysiology researcher with expertise in human auditory neuroscience, electrophysiologic measurement of central auditory function, and plasticity of the central auditory system.
- Recruit and hire an established and productive hearing-aid researcher with expertise in hearing aid technology and fitting algorithms.
- Seek and obtain approval of funding for the following NCRAR initiatives:
  - "A portable audiometric monitoring device (the OtoID)"
  - "Brainstem representation of the temporal characteristics of pitch"
  - "Development of a biological interface for the cochlear implant"
  - "Ecological momentary assessment in hearing research"
  - "Hearing loss and the perception of complex sound"

- "Integrating auditory and visual information to improve hearing aids"
- "Noninvasive blood glucose monitoring using otoacoustic emissions"
- "Supplementing hearing aids with computerized auditory training"
- "The impacts of dual-sensory impairment on daily function"

- Obtain additional external funding to support education and training program activities.
- Sponsor additional clinical research seminars, and work with the VA Audiology and Speech Pathology Program Office and the VA Employee Education System to develop and produce additional satellite broadcasts using the VA Employee Education System satellite network and V-Tel systems.
- Work to develop hearing loss prevention and hearing conservation programs and practices that should become part of clinical rehabilitation strategy throughout the VA and DoD health care systems, and the nation.

Plan Adjustments

Auditory research and development activities at the NCRAR serve a high-priority area relevant to meeting the rehabilitation needs of veterans, among whom hearing loss (#1 condition) and tinnitus (#2 condition) were the most prevalent service-connected disabilities for veterans who received compensation benefits in fiscal year 2006 according to the Veterans Benefits Administration (VBA, FY2006), at a combine cost of $1,210,228,404. Tinnitus (#1 condition) and hearing loss (#2 condition) also were the most prevalent disabilities among veterans who began receiving compensation benefits for the first time in FY2006, and when combined represented nearly 17% of all disability claims and an increase of 18% in the last year. The prevalence of auditory disabilities creates a tremendous demand for auditory rehabilitation services, and provides a broad patient base for clinical trials, strategies and outcomes measures. To meet the needs of current and future veterans, the NCRAR will expand its focus on rehabilitative auditory research and development by extending established lines of research while integrating new research directions in the following priority areas: 1) rehabilitation of blast-related and noise-induced auditory injury; 2) rehabilitation strategies based on neural plasticity of the central auditory system; 3) telehealth and web-based audiological services and programs; and 4) strategies to optimize community reintegration outcomes for individuals with significant hearing impairment or dual sensory (hearing and vision) loss.

III. PROJECT REPORTS

VA Submissions (n = 8; total requested funding = $4,637,600)

Title: A portable audiometric monitoring device (the OtoID)

Principal Investigators: Stephen Fausti, PhD; Debra Wilmington, PhD

Co-Investigators: Bonnie Wakefield, PhD, RN; Wendy Helt, MA

Funding Agency: VA RR&D Total Requested Funding: $580,300

Timeframe: Three years requested (pending outcome of scientific merit review)

Objectives: Despite evidence that early identification and monitoring can reduce the hearing loss associated with therapeutic treatment with ototoxic medications, practices have not been implemented as a standard of care in medical centers or outpatient clinics due to time-consuming procedures and limitations in audiometric testing equipment. This rehabilitation engineering continuation proposal seeks to enhance and consolidate the OtoID into a single unit to support the collection, automatic and secure transfer and archiving of non-identifiable patient data irrespective of test location. The new system will include an automated software program that will enable ease of use by not only audiologists, but also by non-audiologists including personnel in polytrauma and oncology units at remote locations, and by patients in their homes. Also, the development and deployment of an automated and secure data transfer system will enable the transmission of non-identifiable patient data to an audiologist who can promptly identify hearing threshold changes and recommend potential treatment options. Successful completion of this project is likely to result in the translation of the NCRAR's evidence-based $1/6^{th}$ octave SRO ototoxicity early identification methodology into practice as the standard of care for patients receiving ototoxic drugs. The widespread implementation of ototoxicity monitoring best practices will provide clinicians the critical information and opportunity to minimize or prevent the progression of hearing loss into the speech communication range, ultimately improving treatment options for patients and preserving the quality of life following treatment.

Plan: The work required to accomplish this goal includes the following three primary development areas: 1) Development of an Integrated Hardware Platform to simplify the user interface; 2) Development of an Automated Software Platform that enables patients to self-monitor ototoxicity and securely transfer data to a centralized server; and 3) Evaluation of new Clin-OtoID hardware and software platforms for use within ototoxicity studies.

Methods: Normal hearing, cochlear hearing impaired subjects, and hospitalized patients not receiving ototoxic medications will be tested by an audiologist using the Automated SRO Monitor Application both in the sound booth and on the hospital ward. Once the performance of the newly designed hardware and software platforms is evaluated, the new system will be evaluated with normal and cochlear impaired subjects, by an audiologist and by a non-audiologist. Finally, subjects Receiving Ototoxic Medications will be tested from VAMCs located in Portland, OR, Nashville, TN, and Tampa, FL and subjects at home. Subjects will include patients who are receiving therapeutic treatment with the aminoglycoside antibiotics amikacin, gentamicin and tobramycin, or the anti-neoplastic chemotherapeutic agents cisplatin or carboplatin.

Findings to Date: There are no findings to report at this time as this proposal is currently pending outcome of February 2008 scientific merit review.

Title: Auditory rehabilitation from the perspective of the significant other (CDA–2 application)

Principal Investigator: M. Samantha Lewis, PhD

Mentors: Gabrielle Saunders, PhD; Robyn Cox, PhD; Donald Austin, MD, MPH

Funded Agency: VA RR&D Total Requested Funding: $633,600

Timeframe: Four years requested (pending outcome of February 2008 scientific merit review)

Objectives: The success of a hearing-aid fitting is impacted by many factors including patient attitudes towards hearing loss (Jerram & Purdy, 2001) and pre-use expectations regarding hearing-aid outcomes (Cox & Alexander, 2000). Just as patient attitudes and pre-use expectations impact the rehabilitation process, it is logical to assume that the attitudes and pre-use expectations of the patient's spouse may also impact rehabilitation outcome. At this time, this relationship has yet to be examined in part perhaps due to the lack of tools for assessing them. The primary purposes of this study are: 1) to evaluate recently-developed companion questionnaires that assess the pre-use expectations of, and post-use satisfaction with, hearing aids from both the patient's and the spouse's perspective and 2) to collect preliminary information regarding the relationship between spousal pre-use expectations and satisfaction with hearing aids from both the patient's and the spouse's perspective.

Plan: The main research question to be addressed in this project is: Does spousal pre-use expectations effect post-use satisfaction with hearing aids from both from the patient's and the spouse's perspective? This is a prospective, cohort study in which pre-use expectations will be well-characterized and related to post-use satisfaction at 4-6 weeks. During the course of her Research Career Development award, Dr. Lewis developed companion questionnaire sets, one for the patient with hearing loss and one for the spouse. One set of questionnaires assesses pre-use expectations of hearing aids, while the other assesses post-use satisfaction. These questionnaires were designed: 1) to compare and contrast the differences between the pre-use expectations of and the post-use satisfaction with hearing aids that are reported by the spouse and by the patient with hearing loss; and 2) to determine whether or not spousal pre-use expectations are associated with hearing-aid satisfaction. At this time, further evaluation of these questionnaires is required. Specifically, factor analysis, Chronbach's alpha, and analyses of test-retest reliability should be conducted in order to assess the reliability and internal consistency of the questionnaire and to determine which questions create meaningful subscales and to eliminate non-meaningful or redundant questions.

Methods: One hundred forty-eight couples will be recruited to participate. All participants will undergo a comprehensive audiometric evaluation and complete a routine case-history form, a mental-status questionnaire, the pre-use expectations questionnaire, and the post-use satisfaction questionnaire. The pre-use expectation questionnaire will be completed prior to the partner with hearing loss receiving a hearing aid. The post-use questionnaire will be completed 4-6 weeks after the hearing aid is fit. A few days after each questionnaire is completed, the subjects will complete the questionnaire again in order to assess the test-retest reliability. Covariates, such as degree of hearing loss, will also be analyzed. Additionally, pair-wise comparisons will be conducted comparing spousal responses and patient responses. Furthermore, correlation analyses between each of the subscales on the questionnaires will be conducted in order to obtain preliminary information regarding the relationship between spousal pre-use expectations and satisfaction with hearing aids from both the patient's and the spouse's perspective.

Findings to Date: There are no findings to report at this time as this proposal is pending outcome of a February 2008 scientific merit review.

Title: Brainstem representation of the temporal characteristics of pitch (CDA–1 application)

Principal Investigator: Sarah Melamed, PhD

Mentors: Marjorie Leek, PhD; Stephen Fausti, PhD

Funding Agency: VA RR&D Total Requested Funding: $172,400

Timeframe: Four years requested (pending outcome of February 2008 scientific merit review)

Objectives: Individuals with hearing loss often comment that amplified speech does not sound "natural". Impaired pitch perception may result from multiple changes in auditory function. One goal of the proposed research is to establish the importance of temporal fine structure processing in the auditory system as it relates to pitch perception. A secondary goal is to further understanding of how hearing impairment degrades the representation of pitch in the central auditory system, specifically at the level of the brainstem. This research will explore how damage to the auditory system is expressed through a loss of auditory processing capabilities. Another significant aspect of the proposed research is to obtain evidence relating temporal processes of pitch perception to pitch encoding in the brainstem using electrophysiological measurement techniques.

Plan: Approximately 14 individuals, with an equal number of normal hearing and hearing impaired listeners, will be recruited to participate in this study at the National Center for Rehabilitative Auditory Research (NCRAR). Standard audiometric testing will be performed to verify eligibility. Behavioral psychoacoustic and auditory electrophysiologic testing will be performed on all participants.

Methods: Participants will be seated in a sound-treated booth and listen to a variety of sounds designed to evaluate pitch perception. For the psychoacoustic task, participants will listen to a set of sounds and be asked to make a judgment as to which of the sounds they heard was different in pitch compared to a standard sound. For the auditory electrophysiological measure, participants will be seated in a comfortable chair and listen to the same set of sounds used in the psychoacoustic task. They will not have to respond or make any judgments about these sounds in any way. Measures of neural activity will be recorded from surface electrodes placed on their head. All measures are non-invasive. Analysis of behavioral pitch discrimination will be performed by assessing the strength of the pitch perception associated with various stimuli. Analysis of phase and latency of peaks in the evoked response waveform will be performed on the electrophysiological measurements. In addition, a correlation analysis will be performed between the behavioral measurements and the objective electrophysiological measurements.

Findings to Date: This study is pending outcome of a February 2008 scientific merit review, so there are no findings to report at this time.

Title: Development of a biological interface for the cochlear implant

Principal Investigator: Allen Ryan, PhD

Co-Principal Investigator: Stephen Fausti, PhD

Funding Agency: VA RR&D Total Requested Funding: $721,500

Timeframe: Three years requested (pending outcome of February 2008 scientific merit review)

Objectives: The primary objective of the proposed study is to develop improvements to the cochlear prosthesis or cochlear implant. The cochlear implant employs electrical stimulation to activate auditory neurons in patients that have lost their hearing due to the death of inner ear sensory cells. This device is now widely used to treat the deaf, and is increasingly used for patients with small amounts of residual hearing. It provides substantial benefit for the profoundly deaf, but the performance of even the most successful patients is far lower than that achieved by normal hearing listeners. In addition, there have been recent concerns regarding infection that can lead to meningitis. The proposed research program is designed to improve the cochlear implant by combining device engineering and biological approaches. Performance will be enhanced by decreasing the distance between the electrodes and cochlear neurons, so that more channels of information can be delivered, and by increasing the survival of cochlear neurons. Safety will be enhanced by improving the seal around the base of the implant, to exclude infection. These goals will be achieved by producing a biological interface between the implant and the tissues of the inner ear.

Plan: The first phase of this program is to identify factors to which the tissues of the cochlea will respond with growth toward, and adherence too, implant materials. Experiments are proposed to explore the guidance of nerve fibers from cochlear neurons toward the implant using soluble factors, extracellular matrix molecules and repulsive signaling molecules. Additional studies will evaluate the growth of neurites through three-dimensional substrates that can link a cochlear implant to the region of the spiral ganglion. Further studies will develop artificial sensory epithelia in order to maintain cochlear nerve fibers at the surface of the implant.

Methods: Identification of factors critical for the growth of spiral ganglion neurites are first evaluated in vitro. Explants of adult spiral ganglion are exposed to soluble and surface-bound factors that can serve as growth substrates or provide guidance for nerve fibers. Factors that prove successful in vitro will then be tested in vivo, by introducing them into the adult cochlea.

Findings to Date: We have continued to study adult spiral ganglion neurons to determine their responses to guidance factors previously studied in immature neurons. Adult neurons respond to both neurotrophin-3 (NT-3) and brain-derived neurotrophic factor (BDNF), although with reduced intensity compared to young neurons. Adult neurons also respond to patterned laminin and fibronectin in a manner identical to young neurons. We have evaluated collagen and hydrogels in vivo, and found that neither is well maintained. Additional gels are being tested. We are evaluating new factor for guidance, including nertrins and bone morphogenetic factor. In addition, we have tested BDNF for its ability to guide neurite growth in a microchannel device, and found that unlike NT-3 it is not effective. Finally, we are evaluating latex microspheres as potential substrates for neurite guidance factors. Funding for the proposed study is pending outcome of February 2008 scientific merit review.

Title: Improving vowel perception by hearing-impaired listeners (CDA–2 application)

Principal Investigator: Michelle Molis, PhD

Mentors: Marjorie Leek, PhD; Stephen Fausti, PhD

Funding Agency: VA RR&D Total Requested Funding: $535,200

Timeframe: Four years requested (reviewed August 2007, approved for 02/01/08 start date)

Objectives: This plan has as its goal the transition of Dr. Molis to the role of independent researcher at the NCRAR. The aim of the research is to describe and quantify the cues that distinguish among vowel sounds for hearing-impaired listeners and that will have implications for the development of new hearing aid processing strategies and rehabilitative auditory training programs that may enhance speech intelligibility and reduce listening effort in hearing-impaired veterans.

Plan: Normal-hearing and hearing-impaired listeners will perform a number of perceptual tasks that will provide information about their vowel identification and discrimination abilities. The outcomes of these tasks will be used to develop a quick and reliable method to identify the optimal examples of vowel categories for individual listeners. In a second phase, vowel recognition will be compared among stimuli that have been modified in order to match listeners' optimal vowels to a greater or lesser degree.

Methods: The experiments in this study will be carried out in two phases. In the first phase, normal-hearing and hearing-impaired listeners will be asked to make judgments of identity, quality, and distinctiveness of synthesized vowel stimuli. Responses will be made via a button box or touch screen terminal. These experiments will assess category membership and vowel quality based on the auditory characteristics of the stimuli and the peripheral auditory processing of the listeners. In the second phase, the vowels of monosyllabic words will be altered to make them more or less similar to the best examples of each vowel category based on the kinds of information collected in the first phase. Hearing-impaired listeners will be asked to identify the words in order to assess speech understanding. The results of these experiments will evaluate the impact of vowel quality on speech intelligibility.

Findings to Date: The study period has not yet begun; therefore there are no findings to report at this time.

Title: New strategies for sound-based tinnitus relief

Principal Investigator: James Henry, PhD

Co-Investigators: Ken James, PhD; Marjorie Leek, PhD; David Lilly, PhD; Tara Zaugg, AuD

Funding Agency: VA RR&D Total Requested Funding: $379,900

Timeframe: Three years requested (pending outcome of February 2008 merit review)

Objectives: Tinnitus masking (TM) is a method of treatment that uses sound in specific ways to provide immediate relief from tinnitus. Normally, treatment with TM involves the use of wearable ear-level devices (maskers and masker/hearing aid combination instruments). Although TM is effective for many patients, the method is limited because the ear-level devices are capable of generating only broadband noise. This limitation prevents the use of digitally synthesized sounds, including those that have been designed specifically to facilitate tinnitus relief. In addition, treatment with TM takes advantage of the common effect of residual inhibition (RI – reduction in tinnitus loudness following masking noise) by encouraging patients to attempt to achieve RI on their own. However, there are no clinical procedures for determining the acoustic factors that produce the greatest RI effect. Our working hypothesis is that the efficacy of TM can be improved by systematically identifying sounds that optimize RI and tinnitus relief. Once identified, these sounds can be used to provide ongoing treatment through the use of wearable equipment. Recent technological developments have made available wearable devices that can be used for this purpose.

Plan: Computerized algorithms will be developed to present sounds systematically to 100 subjects who experience bothersome tinnitus. Using the tinnitus evaluation system (TES) that we developed, the automated algorithm procedures will identify sounds that are optimal for achieving RI (Study 1) and tinnitus relief (Study 2).

Methods: For Study 1, subjects will complete psychoacoustic testing to systematically identify the sounds (from a library of 23 sounds) and the temporal and amplitude parameters of those sounds that produce maximum RI. The objective of Study 1 is to develop an intermittent-stimulus protocol for each subject that can produce sustained RI. Study 2 will involve testing to identify sounds that are most effective in reducing the annoyance caused by tinnitus. Fifty sounds will be evaluated for this purpose, including sounds emulated from the Neuromonics method of treatment.

Findings to Date: There are no findings to report at this time as this proposal is pending outcome of scientific merit review.

Title: Supplementing hearing aids with computerized auditory training

Principal Investigator: Theresa Hnath Chisolm, PhD

Co-Principal Investigators: Richard Wilson, PhD; Gabrielle Saunders, PhD

Funding Agency: VA RR&D Total Requested Funding: $960,500

Timeframe: Three years requested (pending outcome of February 2008 scientific merit review)

Objectives: Research data clearly demonstrate many beneficial treatment effects from hearing aid intervention, however, wide individual variation in treatment outcome is also documented. To improve the outcomes of hearing aid intervention, other components of auditory rehabilitation can be considered. With the advent of easy access to home computers home-based computerized adaptive auditory training is a possibility. There are no data examining whether auditory training can improve outcomes of standard-of-care hearing aid intervention, particularly in the VA population who differ from the general adult hearing loss population, in many self-report domains of hearing aid outcome. In this study we will assess the relative efficacy of supplementing standard-of-care hearing aid intervention provided to adult veterans with hearing loss, with auditory training administered via a commercially available computer-administered auditory training program; and, with a "placebo" auditory training paradigm, consisting of "directed listening" activities for specified periods of time.

Plan: The study will take place at three test sites. The primary site is the Bay Pines VA Healthcare System, Bay Pines, FL, with the National Center for Rehabilitative Auditory Research at the Portland VAMC, Portland, OR and the James H. Quillen VAMC, Mountain Home, TN as participating sites. Equal numbers of participants will be recruited and tested at each site. Subjects will be hearing aid users with at east 4-weeks experience with use. The study is a multi-site, randomized controlled, parallel group clinical trial to assess the efficacy of at home PC-based auditory training as a supplement to standard-of-care hearing aid intervention in veterans treated for hearing loss, with or without previous hearing aid experience. Participants will be randomly assigned to one of three groups: Group 1 participants will receive standard-of-care hearing aid intervention and complete the 4-week auditory training program. Group 2 participants will receive only standard-of-care hearing aid intervention. Group 3 participants will receive standard-of-care hearing aid intervention and complete 4-weeks of placebo auditory training, consisting of directed listening to books-on-tape. Short term outcome immediately post-training and longer term outcome at 6-month post-training will be evaluated and compared across groups.

Methods: Participants will attend four test sessions. During Session 1 the informed consent process will be completed, baseline assessments will be made to ensure participants meet the study inclusion criteria, unaided testing of predictor variables will be completed and all hearing aids will be assessed for correct functionality. Subjects will then be randomly assigned to their study group. Session 2 will occur 4 weeks after session 1. During this visit, performance on the primary and secondary outcome measures will be assessed, as will performance on predictor variables. Participants in Groups 1 and 3 will then receive training in the use of the auditory training or directed listening programs. Session 3 will occur at the end of the 4-week experimental training period. During this session all participants will be retested on the primary and secondary outcome measures to assess short-term intervention outcome. Session 4 will occur at 7-months post-study enrollment (i.e. 6-months post training completion for Groups 1 and 3), when participants will be retested on all outcome measures to examine long-term outcome.

Findings to Date: None. This is proposal is pending outcome of scientific merit review.

Title: The impacts of dual-sensory impairment on daily function

Principal Investigator: Gabrielle Saunders, PhD

Co-Principal Investigator: Katharina Echt, PhD

Funding Agency: VA RR&D Total Requested Funding: $654,200

Timeframe: Three years requested (reviewed March 2007, not funded)

Objectives: Surveys show that as many as 21% of adults over 70 years of age have dual sensory impairment (DSI) - a combination of hearing loss and vision loss. However, the VA Dual Sensory Loss Consensus conference of 2004 revealed a lack of research regarding the functional impacts of DSI on daily life, and on how the combined effects of vision and hearing impairments affect everyday function. The goal of this proposal is to examine the impact of DSI on objective and subjective measures of everyday function with the overarching goal of developing rehabilitation strategies that are empirically informed. To this end, we will use a performance-based measure (Observed Tasks of Daily Living-Revised, ODTL-R) and a self-report measure (the World Health Organization Disability Assessment Schedule II, WHO-DAS II) to characterize the impact of DSI, while accounting for factors including severity and duration of impairments, cognition, education, age, and co-morbidities.

The following questions will be addressed. Q1: How does dual sensory impairment impact everyday function as measured by a standardized performance instrument, the ODTL-R? Q2: How do reports of activity limitations/participation restrictions by individuals with DSI differ from normative data obtained from individuals without sensory impairment, as measured by the WHO-DAS II? Q3: Will difficulties measured and reported by individuals with DSI be influenced by severity and duration of the sensory impairments, cognitive status, education, age, and comorbidities? Q4: Will there be different subgroups of individuals with DSI who exhibit similar functional impacts and thus for whom different interventions and rehabilitation strategies are indicated?

Plan: This project is a collaborative study between investigators at the National Center for Rehabilitative Auditory Research in Portland OR, and the Center of Excellence for Aging Veterans with Vision Loss in Atlanta GA. One hundred twenty five individuals will participate at each site. All participants will have dual sensory impairment. The study will require two visits to the laboratory.

Methods: Following the consent process, subjects will undergo tests of hearing loss, vision loss and cognitive function to determine whether they meet the study criteria. Subjects meeting the criteria will complete questionnaires regarding the impact of hearing loss and vision loss on daily function, complete a performance-based measure of function and additional measures of cognitive status. Along with analyses examining the impact of DSI upon function and self-report, discriminant function analysis will be used to extract subgroups of individuals for whom different treatment and rehabilitation strategies will be developed.

Findings to Date: The proposed study was reviewed, but not funded and therefore there are no findings to report.

VA Approvals (n = 5; total 2007 funding received = $322,722)

Title: Central auditory processing disorders associated with blast exposure

Principal Investigator: Marjorie Leek, PhD

Co-Principal Investigator: Stephen Fausti, PhD

Co-Investigator: M. Samantha Lewis, PhD

Funding Agency: VA RR&D 2007 Funding Received: $45,300

Timeframe: 10/01/07 – 09/30/10

Objectives: The incidence and nature of central auditory dysfunction in warfighters who are exposed to high-explosive blasts while serving in combat have not been clearly determined. Using a battery of behavioral and neurophysiological tests, we propose to evaluate central auditory function and vestibular function in warfighters who have been exposed to explosive blasts. We will collaborate with the Army Audiology & Speech Center at Walter Reed Army Medical Center (WRAMC). The research will be coordinated at the National Center for Rehabilitative Auditory Research (NCRAR) at the Portland VA Medical Center, and data collection will take place both at the NCRAR and at WRAMC. The study objectives are to determine whether there are certain central auditory processing disorders that are often associated with exposure to high-explosive blasts, and whether there is spontaneous recovery of central auditory function with time after blast exposure, how much recovery may be expected, and how rapidly it occurs.

Plan: From 80-100 patients will be recruited at Walter Reed Army Medical Center to participate in this research study. Soldiers returning from OIF/OEF are identified at intake as having been exposed to high-explosive blasts. A battery of central auditory processing tests will be administered to participants as soon as possible after their arrival at WRAMC. Those patients who demonstrate aspects of central auditory processing disorder will be invited to participate in further testing nine months later. Those subjects will be brought to the NCRAR at the Portland VA Medical Center for two to three days of auditory testing. They will undergo the same battery of central auditory tests as they experienced at WRAMC. Control subjects will be recruited who do not have a history of blast exposure and who are matched in age, gender, and audiometric configuration with the experimental subjects. Control subjects will be tested at the NCRAR site.

Methods: The battery of tests includes behavioral tests to assess dichotic and temporal processing, neurophysiologic measures, vestibular testing to indicate any dysfunction to balance and vestibular processes, and tinnitus evaluated by questionnaire. Results of each test will be evaluated against norms established in the literature and against performance by control subjects. Differences will be analyzed using t-tests comparing experimental and control scores, as well as correlations among scores on the various tests within the battery.

Findings to Date: This study was just initiated. However, there are no findings that have been published regarding the incidence of central auditory processing disorders in this population.

Title: Development of an automated test to assess the presence of tinnitus

Principal Investigator: James Henry, PhD

Co-Investigators: Kenneth James, PhD; Martin Schechter, PhD

Funding Agency: VA RR&D 2007 Funding Received: $100,700

Timeframe: 10/01/07 – 09/30/10

Objectives: Veterans can claim tinnitus (ringing in the ears) as a service-connected disability, which is occurring with alarming frequency. As of September, 2005, over 339,000 veterans were service-connected for tinnitus, which equates to about $418,000,000 per year in tinnitus disability compensation (VA Office of Policy and Planning). Although about 50,000 tinnitus-disability claims are being approved annually, veterans do not undergo any formal testing to document the actual existence of their tinnitus. We have developed computer-automated methodology to conduct a battery of clinical tests to quantify various psychoacoustic aspects of tinnitus. We have used this methodology to test individuals who do not have tinnitus to determine how they respond to these tests. Results have shown characteristic differences between people who do have tinnitus versus those who do not. These preliminary data suggest that a more formalized test can be developed to test for the existence of tinnitus. The primary objective of this project is to develop a fully documented test for identifying the presence/absence of tinnitus. The test is referred to as the Tinnitus Perception Test (TPT).

Plan: A preliminary project will be conducted to assess two procedures that are expected to improve the effectiveness of the TPT: (1) Bekesy audiometry (automated audiometry that has been used to detect hearing-loss malingering); and (2) the forced-choice double staircase (FCDS) procedure (the only test that has been shown to obtain reliable measures of tinnitus pitch). Throughout the proposed study period, the automated system will continue to be beta-tested at four VA Audiology clinics so that system modifications can be made to optimize clinical testing performance.

Methods: *Project 1* (Years 0-1) will require software and hardware engineering to incorporate Bekesy and FCDS capabilities into the automated system. Forty subjects with tinnitus and 40 without tinnitus will each be tested with these procedures over two sessions. *Project 2* (Years 1.0-3.0) will involve development of the TPT and evaluation of the prediction model with 320 subjects (160 with tinnitus and 160 without). For *Project 3* (all sites—Years 0-3), four VA Audiology clinics will beta-test the system with 300 veteran patients. Based on feedback from the audiologists, system refinements will be made and incorporated at each site on an ongoing basis.

Findings to Date: Thus far, the software and hardware engineers have been preparing the Tinnitus Evaluation System to conduct the Bekesy and FCDS tests.

Title: Effect of training on central auditory function in multiple sclerosis

Principal Investigator: Dennis Bourdette, MD

Co-Principal Investigator: Stephen Fausti, PhD

Co-Investigators: M. Samantha Lewis, PhD; Debbie Wilmington, PhD

Funding Agency: VA RR&D 2007 Funding Received: $48,175

Timeframe: 10/01/07 – 09/30/10

Objectives: Multiple sclerosis (MS) is an inflammatory disease of the central nervous system that affects approximately a substantial number of veterans. Although peripheral hearing loss is rare in this population, almost half of MS patients with normal pure-tone thresholds present with hearing difficulty. We hypothesize, that this may be due, in part, to central auditory processing (CAP) deficits caused by focal loss or destruction of myelin sheath (demyelination) in the auditory nervous system. The purpose of the present investigation is to assess thoroughly the CAP deficits for individuals with MS. Additionally, since there is evidence that the brain is plastic and capable of being retrained, this investigation also will examine whether or not the implementation of an auditory training program can improve central auditory function for these individuals.

Plan: In a previous study, test materials were developed to evaluate auditory function in individuals with and without MS. For this new study, central auditory function will be further characterized and potential rehabilitative strategies will be examined. Experimental subjects will be recruited from the Portland VAMC, from the Oregon Health & Science University and from the general community. Control subjects will be matched to the subjects with MS with respect to age, gender and audiometric configuration.

Methods: Five general types of evaluations will be employed over multiple study sessions. First, a neurologist will review the subject's medical history and perform a neurologic exam to confirm MS diagnosis. Second, peripheral auditory function will be evaluated using a standard set of routine audiometric tests. Additionally, subjects will complete a case history and series of hearing handicap inventories. Third, a battery of behavioral procedures will be used to characterize central auditory processing. Fourth, auditory evoked potential studies will be performed. Emphasis here will be upon evoked potentials whose putative neural generators lie within the central auditory nervous system. Fifth, subjects will receive evaluation via magnetic resonance imaging to determine site and amount of neural activation during dichotic listening and auditory temporal processing. After evaluation, MS subjects will be enrolled either into an auditory training program to evaluate possible improvements in auditory function or to complete crossword puzzles for a four-week time period. After the four-week time period has passed, the aforementioned evaluation procedures will be repeated for all subjects with MS.

Findings to Date: There are no findings to report at this time.

Title: Modeling auditory integration in people with impaired hearing (CDA–2)

Principal Investigator: Frederick Gallun, PhD

Mentors: Marjorie Leek, PhD; Stephen Fausti, PhD

Funding Agency: VA RR&D 2007 Funding Received: $74,372

Timeframe: 09/01/07 – 08/31/11

Objectives: This plan has as its goal the transition of Dr. Gallun to the role of independent researcher at the NCRAR. Associated with this goal is a research plan focused on understanding (through experimentation and computational modeling) the cognitive processes of combining and selecting auditory information.

Plan: Experimental work will involve four groups of 30 normally-hearing and 30 hearing-impaired listeners (both divided between older and younger listeners) who will participate in four cycles of experimental testing and computational modeling. Mentors will be Drs. Fausti and Leek from the NCRAR, Dr. Colburn from Boston University and Nathaniel Durlach of M.I.T. The research and mentoring will involve 1) the behavioral experiments; 2) the design of a computational model focused on the problem of combining a binaural model of multicomponent sound processing with a frequency-selectivity model; and 3) using the predictions and explanations provided by the model to generate a more complete theoretical description of the difficulties experienced by older and hearing-impaired listeners in complex auditory environments.

Methods: The task of the listeners will always involve detection of a 2 kHz amplitude-modulated tone in the presence of various masking tones. In different conditions, maskers will differ from the target in terms of harmonicity, amplitude-modulation or binaural relationships. The basic computational model will describe and predict how frequency-weighting functions are applied to the binaural information available across the frequency spectrum of the stimulus. Extensions of the model will involve sensitivity to amplitude modulation and harmonicity. The project will require stages of model building followed by stages of experimental testing, with each stage influencing the next until accurate predictions are achieved.

Findings to Date: The funding of this project has only just started, therefore there are no findings to report at this time. However, experimental programs have been developed and are being tested. Initial results suggest that the design is appropriate for the collection of usable data in a reasonable number of testing sessions and that there are no insurmountable stimulus design issues.

Title: Prevention of cisplatin ototoxicity with the antioxidant α-lipoic acid

Principal Investigators: Stephen Fausti, PhD; Debra Wilmington, PhD

Funding Agency: VA RR&D 2007 Funding Received: $54,175

Timeframe: 10/01/07 – 09/30/10

Objectives: To reduce the cochlear damage, and resultant hearing loss, caused by therapeutic treatment with the chemotherapeutic drug cisplatin. The ototoxic effects of cisplatin are mediated by the formation of reactive oxygen species which cause oxidative stress resulting in apoptotic cell death of the outer hair cells. Antioxidant treatment has been successful in a number of animal models as a protective pharmacological intervention for ototoxic-induced hearing loss. This translational study will link the successful use of otoprotectants in animals to the establishment of clinical protocols in patients receiving ototoxic medications. Behavioral conventional and high-frequency audiometry and their correlation with laboratory markers of oxidative stress will be used to determine the ability of alpha-lipoic acid therapy concurrent with administration of cisplatin to minimize the incidence, delay the onset, and/or reduce the magnitude of ototoxic hearing loss.

Plan: The effectiveness of antioxidant therapy concurrent with cisplatin treatment will be evaluated in a randomized double blind placebo study by assessment of behavioral conventional and high-frequency pure-tone behavioral thresholds and will be correlated with malondialdehyde (MDA) levels as a marker of oxidative stress and serum concentrations of lipoic acid.

Methods: Subjects will include human patients who are scheduled to receive cisplatin. Patients will be given either the antioxidant therapy or the placebo to be taken orally every day during cisplatin treatment and continued for one month post-treatment. MDA and lipoic acid levels will be obtained at the beginning of each cisplatin treatment to measure the oxidative state of the patient and serum concentration of lipoic acid. Creatinine clearance (24 hour urinary creatinine/plasma creatinine) will be used at this time to measure renal function. Behavioral audiometric thresholds for frequencies from 500 Hz to 20 kHz will be obtained to serve as the baseline audiogram that will be used for hearing sensitivity measurement during the subject's enrollment. From the obtained thresholds, the behavioral sensitive range for ototoxicity (SRO) will be determined. These seven frequencies will constitute the behavioral SRO to be monitored for each test session, including follow-up. During and at one and three months post-treatment, hearing sensitivity in the SRO will be measured to detect early changes in hearing sensitivity.

Findings to Date: Only one patient has been enrolled and completed the protocol to date.

Ongoing VA Funded (n = 18; total 2007 funding received = $3,161,723)

Title: A biological interface for rehabilitation with a cochlear implant

Principal Investigator: Allen Ryan, PhD

Co-Principal Investigator: Stephen Fausti, PhD

Funding Agency: VA RR&D 2007 Funding Received: $227,200

Timeframe: 04/01/05 – 03/31/08

Objectives: The cochlear implant employs electrical stimulation to activate auditory neurons in patients that have lost their hearing due to the death of inner ear sensory cells. This device is now widely used to treat the deaf, and is increasingly used for patients with small amounts of residual hearing. It provides substantial benefit for the profoundly deaf, but the performance of even the most successful patients is far lower than that achieved by normal hearing listeners. In addition, there have been recent concerns regarding infection that can lead to meningitis. The proposed research program is designed to improve the cochlear implant by combining device engineering and biological approaches. Performance will be enhanced by decreasing the distance between the electrodes and cochlear neurons, so that more channels of information can be delivered, and by increasing the survival of cochlear neurons. Improving the seal around the base of the implant, to exclude infection, will enhance safety. These goals will be achieved by producing a biological interface between the implant and the tissues of the inner ear.

The general principles studied in this program will also be applicable to other health problems of veterans. Improved interfaces between electrode arrays and neurons could also be applied to veterans with visual deficits and in spinal cord injury.

Plan: The first phase of this program is to identify factors to which the tissues of the cochlea will respond with growth toward, and adherence too, implant materials. Experiments are proposed to explore the guidance of nerve fibers from cochlear neurons toward the implant using soluble factors, extracellular matrix molecules and repulsive signaling molecules. Additional studies will evaluate the growth of neurites through three-dimensional substrates that can link a cochlear implant to the region of the spiral ganglion. Further studies will develop artificial sensory epithelia in order to maintain cochlear nerve fibers at the surface of the implant.

Methods: Identification of factors critical for the growth of spiral ganglion neurites are first evaluated in vitro. Explants of adult spiral ganglion are exposed to soluble and surface-bound factors that can serve as growth substrates or provide guidance for nerve fibers. Factors that prove successful in vitro will then be tested in vivo by introducing them into the adult cochlea.

Findings to Date: We have continued to study adult spiral ganglion neurons to determine their responses to guidance factors previously studied in immature neurons. Adult neurons respond to both neurotrophin-3 (NT-3) and brain-derived neurotrophic factor (BDNF), although with reduced intensity compared to young neurons. Adult neurons also respond to patterned laminin and fibronectin in a manner identical to young neurons. We have evaluated collagen and hydrogels in vivo, and found that neither is well maintained. Additional gels are being tested. We are evaluating new factor for guidance, including nertrins and bone morphogenetic factor. In addition, we have tested BDNF for its ability to guide neurite growth in a microchannel device, and found that unlike NT-3 it is not effective. Finally, we are evaluating latex microspheres as potential substrates for neurite guidance factors.

Title: Associate Investigator Award

Principal Investigator: Frederick Gallun, PhD

Mentors: Marjorie Leek, PhD; Stephen Fausti, PhD

Funding Agency: VA RR&D 2007 Funding Received: $44,112

Timeframe: 11/01/06 – 10/31/07

Objectives: The goal of this award was to provide interim support for Dr. Gallun as he applied for funding under the VA RR&D Career Development program.

Plan: Drs. Leek and Fausti will serve as mentors in the grant writing process and in moving forward Dr. Gallun's research experience and familiarity with the goals and methods of rehabilitation research.

Methods: Individual meetings with the two mentors will supplement the grant writing process and drafts of the career development grant will be read and critiqued by the mentors. Simultaneously, Dr. Gallun will interact with the other PIs at the NCRAR in order to learn from them about their areas of expertise. In this way, Dr. Gallun will progress towards the ability to generate and carry out an independent research program that is appropriate to the translational goals of the NCRAR.

Progress to Date: Funding of the Career Development Award – 2 application was obtained based on the initial submission, with a projected start date of July 1, 2007. Due to a delay in the availability of funds, funding of the project did not occur until October 4, 2007. Funding was provided for four years, covering Dr. Gallun's salary as well as $50,000 per year in research funds. As obtaining the CDA2 was the primary goal of the AI award, this represents substantial progress. Along the way, Dr. Gallun participated in one-on-one tutorials with Dr. Leek concerning spectro-temporal modulation, Dr. Konrad-Martin regarding the use of otoacoustic emissions as a clinical tool, and visiting scholar Dr. Pamela Souza on the impact of hearing-aid compression on temporal envelopes. All three of these conversations have since resulted in collaborative research projects, and the collaboration with Dr. Souza has resulted in the submission of a manuscript to the journal *Ear & Hearing* (Gallun first author, second revision submitted) and work is ongoing on two further extensions of the work reported in the manuscript.

Title: Associate Investigator Award

Principle Investigator: Michelle Molis, PhD

Mentor: Marjorie Leek, PhD

Funding Agency: VA RR&D 2007 Funding Received: $84,556

Timeframe: 02/01/06 – 01/31/08

Objectives: The Associate Investigator Award provides Dr. Molis with an opportunity to receive research training and mentoring in the area of speech perception by hearing-impaired individuals. This training will help her to develop as an independent research investigator.

Plan: The training program for Dr. Molis encompasses formal and informal learning, supervised research, and independent research. Dr. Molis continues to work closely with Dr. Leek in the development and implementation of research activities that address the temporal processing of complex sounds, like speech, in individuals with hearing loss.

Methods: The methods and techniques used in investigations of speech perception by hearing impaired individuals include speech synthesis, statistical analyses, and computer modeling of the response of the impaired auditory system to speech and other complex sounds.

Progress to Date: Dr. Molis continues to make progress in her development as an independent research scientist. In December 2006, she was awarded an Early Clinical Investigator award through the Oregon Health Sciences University (OHSU) Medical Research Foundation. The focus of that proposal is the perception of vowels by hearing-impaired listeners in the presence of a competing background noise. Preparations for this study are ongoing. More recently, Dr. Molis was awarded a VA Career Development Award-2 (CDA-2) thereby advancing her VA research career. That proposal includes experiments that expand further on her studies of speech perception by hearing-impaired listeners with the long-term goals of informing new signal processing strategies and training programs for hearing-impaired listeners.

Other accomplishments during the period of the AI award included assisting in the development of a speech perception and hearing research laboratory, programming experiments on the computer, and collaborating with her mentor, Dr. Marjorie Leek, as well as researchers at OHSU, the University of Connecticut, and Walter Reed Army Medical Center. The Associate Investigator Award is the first step towards an independent research career.

Title: Clinical applications for time-compressed speech tests

Principal Investigator: Marjorie Leek, PhD

Funding Agency: VA RR&D 2007 Funding Received: $157,600

Timeframe: 10/01/06 – 09/30/09

Objectives: The incidence of hearing loss increases substantially with age making it the third most common chronic condition after high blood pressure and arthritis in older Americans. The most common complaint of people with hearing loss is that speech is particularly difficult to understand in background noise, even with a hearing aid. Older listeners have even greater difficulty than younger listeners with similar hearing loss. In addition to hearing loss, other non-auditory factors may be involved in the ability of a listener to benefit from certain hearing aid amplification strategies in various background competitions. One suggested reason for poor compliance is the limited ability of older listeners to benefit from cognitively demanding complex signal processing algorithms available in modern hearing aids (Lunner, 2003; Plomp, 1994). An efficient method of determining how individual cognitive status might affect potential hearing aid benefit would be an important clinical tool to facilitate appropriate selection of hearing aids. The primary objective of this study is to determine whether an efficient speech recognition test known to be associated with cognitive deficits in older listeners can be used as an indicator of potential hearing aid benefit.

Plan: The proposed investigation will examine the interaction of working memory and hearing aid compression method on speech recognition in three types of background competition for older listeners. There will be two phases to this study. In the first phase, elderly adults will be evaluated on a number of tests of auditory processing, cognitive capacity, and compressed speech. Subjects who score in the top and bottom quartiles on the compressed speech test will be invited to participate in phase 2 of the study. In the second phase, these subjects will be tested on several speech-in-noise tests under three conditions of hearing aid settings. It is hypothesized that subjects who score high on time-compressed speech will be successful users of hearing aids with fast compression characteristics, while low-scorers will require different compression settings.

Methods: The tests will begin with a basic audiological workup including auditory processing tests of temporal resolution. The time-compressed speech (TCS) test along with neurocognitive tests and two auditory temporal processing will then be administered within the same session. In the second phase of the experiment, the HINT test will be used in each of the three competing conditions for each of three types of amplification: one channel linear, two channel with fast time-compression constants and two channel with slow time compression constants.

Findings to Date: There are no findings to report yet. Phase 1 data collection is currently underway.

Title: Disability Supplement Award

Principal Investigator: Mitchel Turbin, PhD

Mentors: James Henry, PhD; Kenneth James, PhD; Joseph Istvan, PhD

Funding Agency: VA RR&D 2007 Funding Received: $107,837

Timeframe: 11/01/05 – 10/31/08

Objectives: This award is intended to provide supplemental salary support for Dr. Turbin as he makes progress toward establishing himself as an independent research scientist. The NCRAR provides mentoring, training, and appropriate office and rehabilitation research space provisions. Dr. Turbin also is provided with research administration and technical support services, as well as access to scientific literature and clinician researchers in many complementary disciplines.

Plan: Dr. Turbin serves as Principal Investigator for the RR&D Merit Review project entitled, "Randomized Trial of a Brief Patient-Centered Aural Rehabilitation Model." The study is a randomized dual site parallel investigation comparing typical VA audiology (hearing aid rehabilitation alone) with typical VA audiology plus a one-session group Aural Rehabilitation intervention. In addition, under the mentorship of senior NCRAR colleagues listed above, Dr. Turbin will prepare and submit papers for peer-reviewed journals, and presentations for national and regional scientific and professional conferences and meetings. Dr. Turbin also will devote himself to the preparation and submission of additional Merit Review proposals to be submitted to the VA, NIH and other appropriate funding agencies.

Methods: Dr. Turbin routinely consult with Drs. Leek, Henry, James and Istvan, and other senior NCRAR colleagues during the process of preparing articles for peer-review publication and research proposals for submission to appropriate funding agencies.

Progress to Date: Dr. Turbin is engaged in preparing articles for publication in peer-reviewed journals during this award period: "Partial Hearing Loss: Roles for Psychologists," *Professional Psychology: Practice and Research* (in preparation); and "Biopsychosocial Audiology: 'Patient-centered' May Not Be What You Think," *Journal of the American Academy of Audiology* (in preparation). Dr. Turbin presented a poster at the 2007 NCRAR Biennial International Conference: *Hearing Therapies for the Future.* The poster was entitled: *Patient-Centered Audiology: Communication Skills for Communication Disorders Professionals.* He presented a seminar at a national program in Rehabilitation Counseling Deaf and Hard of Hearing Adults at Western Oregon University, and has given other presentations in Oregon to scientific and consumer audiences. Primarily, Dr. Turbin participated with Drs. Henry and Istvan in preparing and submitting an NIH RO3 proposal entitled, "Ecological Momentary Assessment of Hearing Disorders" (pending outcome of scientific merit review). An offshoot proposal in the same subject area was submitted to the Oregon Health & Science University Medical Research Foundation, but was declined. Drs. Turbin and Istvan developed an internet based questionnaire to query consumers on their experiences with various counseling services provided by their hearing aid dispensers (to be offered online in 2008). Dr. Turbin has begun work on a project examining the efficacy of rehabilitation groups for veterans with combined hearing and vision loss (to be submitted to a funding agency in 2008). In the interest of maintaining some of the "hands-on" skills he has developed, and in service to NCRAR and the Portland VA Medical Center, Dr. Turbin serves as the Disabilities Special Emphasis Program Manager for the Portland VA Medical Center's Equal Employment Opportunities Program. He participated in a three day training seminar for this role in March 2007, and has convened workgroups tasked with hiring additional staff with disabilities to the PVAMC workforce.

Title: Frequency tuning and word recognition speed in older adults (ARCD Award)

Principal Investigator: Dawn Konrad-Martin, PhD

Mentors: Marjorie Leek, PhD; Stephen Fausti, PhD; Douglas Keefe, PhD

Funding Agency: VA RR&D 2007 Funding Received: $164,784

Timeframe: 07/01/06 – 06/30/09

Objectives: Diminished frequency tuning caused by hearing loss can reduce spectral contrasts within the cochlear excitation pattern evoked by speech, even for hearing-impaired listeners fitted appropriately with hearing aids. We hypothesize that such distortions in the speech signal place greater demands on the cognitive resources of older adults when compared to young adults, reducing speech processing accuracy and speed. Objectives are to determine: 1) whether physiological estimates of frequency tuning based on response delays of tone-burst-evoked OAEs predict psychophysical tuning measures in young and elderly subjects; and 2) the extent that age and losses in sensitivity and frequency tuning alters the accuracy, speed and confidence with which listeners are able to identify words presented in "real time".

Plan: Subjects are older and young adults with normal or impaired hearing. Experiments assess listeners' performance on a time-gated word recognition task, in which word recognition is evaluated as a function of the portion of the word presented. Performance on this task is thought to be related to how well an individual can follow rapid ongoing speech. Reduced frequency tuning is assumed to reduce speech spectral contrasts. Effects of abnormal frequency tuning on time-gated word recognition are therefore compared for older- and young adults. Cochlear frequency tuning is estimated using OAE and psychophysical measurements performed in the same subjects.

Methods: Four groups of 20 individuals will serve as subjects (80 total subjects): 1) normal-hearing older subjects; 2) hearing-impaired older subjects; 3) normal-hearing young adult subjects; and 4) hearing-impaired young adult subjects. Older subjects are > 63 years with normal hearing or cochlear hearing loss (high frequency pure-tone-average [HFPTA] = 30-50 dB HL). Young subjects will be 18 to 35 years old with normal hearing or with cochlear hearing loss (HFPTA = 30-50 dB HL). Procedures include pure-tone audiometric assessment of conventional and ultra-high frequencies, physiological assessment (tympanometry and OAEs), psychophysical assessment (growth of masking), and real-time word recognition assessment (time-gated speech test). A battery of tests screens for depression and attention disorders and evaluate cognitive function.

Progress to Date: Time-gated word data have been collected in 11 normal-hearing young adults, 5 normal-hearing older adults and 6 hearing-impaired older adults. Consistent with the literature, older, hearing-impaired adults require greater word initial input for the correct recognition of words than do young, normal-hearing subjects. Preliminary data show that older adults with normal hearing require less word initial input to be highly confident about the identity of a word than do either young, normal-hearing adults or older, hearing-impaired adults. Young, normal-hearing adults and older, hearing-impaired adults perceive that they need to hear more of the word than they actually do for correct word identification. Perceptions about performance matched actual performance comparatively more closely for older, normal-hearing adults. Physiological estimates of frequency tuning based on OAEs have been made in a subset of these subjects.

Title: Hearing rehabilitation from the perspective of the significant other (RCD Award)

Principal Investigator: M. Samantha Lewis, PhD

Mentors: Gabrielle Saunders, PhD; Robyn Cox, PhD

Funding Agency: VA RR&D 2007 Funding Received: $125,069

Timeframe: 07/01/05 – 06/30/08

Objectives: Although hearing aids improve communicative performance, they do not entirely remedy hearing dysfunction. Factors such as patient pre-use expectations have been shown to impact post-use satisfaction. It is thus logical to assume then that the spouse's pre-use expectations and perhaps also post-use satisfaction may impact hearing-aid outcome as well. At this time, however, these factors have yet to be examined. The purpose of this investigation is to put in place the tools for examining the pre-use expectations of, and the post-use satisfaction with, hearing aids from the spouse's perspective by developing assessment questionnaires. To accomplish this task, two routinely used and standardized questionnaires, the Expected Consequences of Hearing aid Ownership (ECHO) and the Satisfaction with Amplification in Daily Living (SADL) will be used as a starting point and adapted accordingly. Pilot questionnaires will be developed based upon these questionnaires and from information obtained during interviews with non hearing-impaired spouses of individuals with mild to moderately-severe sensorineural hearing loss. These questionnaires will allow hearing professionals to assess the impact that hearing aids have on the individual with hearing loss, as well as his spouse. With this information, they will be better able to tailor their counseling to the needs of the family unit and better understand the relationship between the perceptions of the spouse and the user.

Plan: Two new questionnaires will be developed for clinical use with the spouse. The first questionnaire will query the spouse regarding her pre-use expectations about hearing-aid outcome. The second questionnaire will query the post-use satisfaction experienced by the spouse with amplification. The questionnaires will be developed modeling the format of the ECHO and the SADL and adapted to the spouse's perspective. Additional questions will be developed and current questions modified using data collected during interviews with non hearing-impaired spouses of individuals with hearing impairment and their hearing-impaired partners. Data obtained from these interviews will be coded into common themes and used for questionnaire development.

Methods: In order to create two new questionnaires for clinical use with the spouse, this project will be completed in two phases. In the first phase, spousal pairs in which the individual with hearing impairment is considering getting hearing aids will be interviewed in order to develop pilot questionnaires. Once these questionnaires are developed, individuals with hearing loss and their non-impaired spouses will review both sets of questionnaires. The pre-use expectation questionnaire will be reviewed prior to the partner with hearing impairment receiving a hearing aid and the post-use questionnaire will be reviewed approximately six weeks after the hearing aid is fit. Patients and their spouses will be solicited for their opinions regarding the format and wording of the questionnaires. These questionnaires will be revised based upon this feedback.

Progress to Date: The items and the format of the questionnaires are now finalized and ready to be used. Assessment of the psychometric properties, as well as the test-retest reliability of these questionnaires has been proposed in a future grant.

Title: Investigation of individualized objective measures for the early detection of ototoxicity

Principal Investigators: Stephen Fausti, PhD; Marilyn Dille, PhD

Funding Agency: VA RR&D 2007 Funding Received: $108,400

Timeframe: 04/01/06 – 03/31/10

Objectives: There are over 200 medications that can adversely affect hearing. Therapeutic treatment with ototoxic drugs, particularly the aminoglycoside antibiotics and the chemotherapeutic agent cisplatin, can produce cochlear damage. Patients receiving these ototoxic drugs are at risk for incurring irreversible hearing loss that can adversely affect communication abilities. There is a clear need for a time-efficient, objective testing protocol to provide early detection of ototoxic-induced hearing impairment in patients who are unable to respond reliably to behavioral auditory tests.

Plan: This proposal will investigate and establish objective testing protocols suitable for clinical evaluation of all patients receiving ototoxic drugs. The effectiveness of individualized narrow-band auditory brainstem response (ABR) and fine resolution distortion product otoacoustic emission (DPOAE) will be evaluated relative to pure tone behavioral thresholds, the "gold" standard for early detection of ototoxicity. In order to develop an objective, clinically useful monitoring tool for early detection of ototoxic processes, the following objectives will be addressed: 1) to determine the extent to which individualized narrow-band ABRs and fine resolution DPOAEs provide early identification of hearing sensitivity changes in patients receiving ototoxic drugs. This will be accomplished by comparing changes in narrow-band ABRs and fine resolution DPOAEs to changes identified in behavioral pure-tone thresholds; 2) to determine which of the two individualized objective methods, narrow-band ABRs or fine resolution DPOAEs, provide the earliest evidence of change in relation to behavioral test results. The time of change occurring for the ABR and DPOAE methods will be compared to the time of change for the behavioral tests; and 3) to determine if the most effective individualized objective measure for early detection of ototoxicity established in the research laboratory is as reliable and sensitive on the hospital ward.

Methods: Individualized narrow-band ABR and fine resolution DPOAE data will be collected in conjunction with $1/6^{th}$ octave behavioral data in a large sample of patients who are at risk for developing ototoxicity. Equipment has been modified to maximize effective testing methods. During drug treatment, individualized narrow-band ABR and fine resolution DPOAE objective testing protocols will be used to assess hearing function within each patient's individualized sensitive range for ototoxicity. Behavioral threshold test results will be compared with the ABR and the DPOAE measures of hearing function. These comparisons will be made from results obtained in the laboratory and then the most effective measure will be tested at bedside with a portable unit.

Findings to Date: 720 medical charts have been reviewed with enrollment of 14 subjects and an additional 4 subjects enrolled but excluded. Preliminary findings to date included apparent changes in threshold or loss of ABR response and loss of DPOAE response or reduced number of frequencies contributing to the response when hearing thresholds changed in some chemotherapeutic subjects. These results will be formally analyzed in the near future.

Title: Ototoxicity Identification (OtoID) Device

Principal Investigator: Stephen Fausti, PhD

Co-Investigators: Roger Ellingson, MSCSE; Wendy Helt, MA

Funding Agency: VA RR&D 2007 Funding Received: $140,913

Timeframe: 07/01/04 – 06/30/08

Objective: The primary objective of this rehabilitation engineering proposal is to develop our prototype unit into a user-friendly, portable, computer-automated audiometer-like device that performs individualized ototoxicity early monitoring using the evidence-based 1/6th octave sensitive range for ototoxicity (SRO) methodology.

Plan: The project seeks to develop our prototype unit into a second-generation OtoID device. Key elements to successful completion of the project include: 1) hardware improvements to the prototype circuitry; 2) the development of custom-programmable SRO software applications to perform time-efficient and user-friendly ototoxicity early identification; 3) the development of PC-based data collection and reporting applications; and 4) field testing of the OtoID device in sound attenuation booths and hospital ward rooms at the Portland VAMC, in hospital ward rooms at distant site VAMCs, and in patients' homes.

Methods: The work proposed is divided into three phases: 1) hardware upgrades; 2) software application development; and 3) data collection and reporting system. Phase I focused on upgrading the hardware to support computer-controlled output range switching, ambient noise measurement, performance verification, non-volatile storage, and telephone communication. Phase II focused on developing the software applications for ototoxicity testing, including the automated output ranging circuitry, support for ambient noise measurement, and performance verification. Phase III has focused on specification of the telemedicine-based data collection, reporting and sharing system, as well as extensive system reliability and sensitivity verification.

Findings to Date: The OtoID currently consists of: 1) a handheld computer; 2) a prototype custom module; and 3) Sennheiser HDA200 headphones. The unit operates on a custom application that: 1) generates pulsed, stereo, pure-tone stimuli; 2) provides stylus pen-enabled touch-pad control of frequency selection, calibrated sound level selection, and muting functions; and 3) supports on-screen recording and saving of hearing thresholds. Currently there are three ototoxicity monitoring software applications that operate on the PDA: OtoIDcal, OtoID, and OtoIDchk. These applications are used by the audiologist to calibrate the OtoID system and to execute the SRO protocol for ototoxicity monitoring. All three applications are graphical, display-oriented that enable an audiologist or patient to use a stylus pen on the PDA screen for navigation, data entry and report generation. Data collection has been completed with control subjects in the sound booth and in hospital ward rooms while using the ambient noise measurement subsystem. The ambient noise measurement subsystem automatically brackets out acceptable ambient background noise levels during subject testing and indicates when noise levels are too high to continue testing. This ensures accurate, repeatable monitoring results regardless of whether testing is performed in the research laboratory, at bedside, or in patients' homes. Comparisons were made between results obtained while testing in the sound booth and in a hospital ward room over two test sessions. Test results from thirty ears demonstrated comparable results.

Title: Progressive intervention program for tinnitus management

Principal Investigator: James Henry, PhD

Co-Principal Investigator: Paula Myers, PhD

Co-Investigators: David Hickam, MD, MPH; Kenneth James, PhD; Martin Schechter, PhD

Funding Agency: VA RR&D 2007 Funding Received: $140,850

Timeframe: 10/01/06 – 09/30/09

Objectives: The 2004 VA Annual Benefits Report indicates that tinnitus is the third most common individual service-connected disability. As of September 30, 2005, there were 339,573 veterans who had been awarded a service connection for their tinnitus, with annual compensation amounting to over $418,000,000 (Office of Policy and Planning, VA Central Office). In addition to being a major expense for VHA, tinnitus is a health care problem that is inadequately addressed at most VA medical centers. Research at the NCRAR has resulted in a model of tinnitus clinical management that is designed for efficient implementation in VA audiology clinics. The objective of the proposed study is to establish the model program at a VA audiology clinic, and to evaluate its efficacy with veteran patients and its acceptability to audiologists and to hospital administration.

Plan: The study is based at the NCRAR, and a prototype tinnitus management program is being established at the James A. Haley (Tampa) VA Medical Center. Audiologists at the Tampa VAMC will be trained to conduct all phases of Progressive Audiologic Tinnitus Management (Progressive ATM). Following training, the program will be implemented with veteran patients. Evaluation of the program's efficacy will involve outcome measures with the veteran patients, and assessment by audiologists and hospital administration.

Methods: During the first year of the study, a comprehensive web-based tinnitus training program for audiologists will be developed. Following development, audiologists at the Tampa VAMC will complete the training program as preparation to conduct each of five levels of intervention: triage, audiologic evaluation, group educational counseling, tinnitus intake assessment, and individualized management. In addition, a patient tinnitus-information booklet will be developed, using principles of low health literacy. During years 2 and 3, veteran patients who complain of tinnitus will be invited to participate in the program. Outcomes will be evaluated separately for clinicians, administrative staff, and patients. Clinicians will be surveyed to determine their level of satisfaction with the program. Administrative staff will be surveyed to determine if the program meets the needs and objectives of the medical center. Patients will be evaluated pre- and post-treatment to determine if participation in the program reduces their perceived tinnitus handicap.

Findings to Date: During the first year of this study, development of the different materials was ongoing. These materials include an 18-module online training course, an 80-page fully illustrated patient education workbook, a two-session group education PowerPoint presentation, and scannable questionnaires for obtaining data.

Title: Randomized trial of a brief patient-centered aural rehabilitation model

Principal Investigator: Mitchel Turbin, PhD

Co-Principal Investigator: Harvey Abrams, PhD

Funding Agency: VA RR&D 2007 Funding Received: $104,763

Timeframe: 04/01/06 – 03/31/09

Objectives: This study compares outcomes of standard VA audiology clinic hearing aid dispensing practices (control treatment) to standard care plus a two hour group Aural Rehabilitation session (experimental treatment). Hearing aids are the primary rehabilitation treatment for alleviating the negative effects of hearing loss, which disrupts communication and consequently impedes normal social, emotional and vocational relations. However, hearing aids cannot fully restore the complex sense of human hearing; some residual communication difficulties remain even with the use of advanced hearing aids. Aural Rehabilitation (AR) groups provide a forum for teaching patients a variety of skills for compensating for those residual communication difficulties. Fiscal realities of the conventional VA and private sector audiology clinics have resulted in relatively few offering AR groups, while traditional multi-session AR formats are truncated into a single session format in most cases where AR is offered. This study seeks to carefully distill ingredients from behavioral medicine, psychology and audiology to produce an optimized AR for our experimental treatment.

Plan: Three hundred and ten veteran participants will be recruited from two study sites: the Portland VA and Bay Pines VA Medical Center audiology clinics. Patients will be enrolled into the study after they have been evaluated for hearing aids but before the hearing aids are fitted. Questionnaires will be administered before hearing aid fitting, eight weeks after fitting, and six months after fitting. Participants will be randomly assigned to either AR or control groups after their baseline assessments.

Methods: All participants in the study take four questionnaires. Our primary instrument (CPHI) measures a range of adjustment behaviors and attitudes specific to hearing loss. Other measures assess personality variables (NEO-FFI), coping styles (WOCQ) and communication improvement for patient specified goals (COSI). The AR groups, "The Living Well with Hearing Loss Workshop," are single two hour sessions facilitated by experienced professionals trained in the patient-centered model of medical care, an approach that emphasizes patients' self management of health and a partnership between patients and providers.

Findings to Date: Research Assistants and Group Facilitators were hired and trained. A Group Facilitator Training Manual was completed and used in their training process. The multimedia Workshop curriculum and multi-site Standard Operating Procedures Manual were finalized early in calendar year 2007. Study team conference calls occur nearly every week. Patient accrual began in March 2007. Several AR Workshops were offered in both Portland and Bay Pines. Otherwise, no data are available to report at this time.

Title: Research Career Scientist Award

Principal Investigator: James Henry, PhD

Funding Agency: VA RR&D 2007 Funding Received: $134,750

Timeline: 04/01/04 – 03/31/09

Objectives: The goal of this award is to provide salary support for a clinical scientist who will contribute to the research program of the VA and the NCRAR through research and leadership activities. The holder of this award provides mentoring and scientific training to junior VA scientists, maintains an active research program relevant to the mission of the organization and to veterans' health care, serves as a resource to the research community, collaborates with other scientists and clinicians, and serves on VA research and other committees.

Plan: Research will be carried out to develop and document methods of assessment and treatment for veterans who suffer from tinnitus. Two RR&D-funded projects are underway during calendar year 2007. One of the studies is a collaborative study with the James A. Haley (Tampa) VAMC. This study is developing and evaluating a comprehensive program of tinnitus management for veterans that is called Progressive Audiologic Tinnitus Management (PATM). The second study, which started this year, is being conducted to develop a computerized test to evaluate the presence of tinnitus. Additional research proposals are under development. In addition, a project is underway that is funded by the Tinnitus Research Consortium to develop a standardized tinnitus outcome instrument. Dr. Henry is Co-PI on that project along with Dr. Mary Meikle. Active mentoring is underway for a junior research investigator at the NCRAR as well as a post-doctoral audiologist.

Methods: The implementation of the RCS award involves preparing grant applications and designing research; developing laboratory resources and hiring and mentoring post doctoral research associates; providing service to national and local professional organizations including reviews of articles and grant proposals; and publishing research findings in national journals and at national meetings.

Progress to Date: To date, studies are underway supported by the RR&D and Tinnitus Research Consortium grants. For the PATM study, we completed a patient-education workbook, 18-module online training course for VA audiologists, and a variety of materials to conduct the randomized clinical trial to evaluate PATM. For the computerized tinnitus evaluation system, the system has undergone hardware and software refinement to enable it to conduct the needed testing. Work on that project is ongoing. The Tinnitus Research Consortium project was completed this year, and a new tinnitus outcome instrument called the Tinnitus Functional Index was developed and documented for validity, reliability, and sensitivity. Five new proposals were submitted during the past year. Collaborations with clinician-scientists at the Bay Pines, Portland, Seattle, San Diego, and Tampa VAMCs have been maintained or newly established. We also are collaborating with the military to develop special methods of addressing tinnitus in TBI patients. Research audiologists and assistants have been hired to work in the laboratory and data collection and ongoing analyses are in progress.

Title: Senior Research Career Scientist Award

Principal Investigator: Marjorie Leek, PhD

Funding Agency: VA RR&D 2007 Funding Received: $175,600

Timeline: 10/01/05 – 09/31/12

Objectives: The goal of this award is to provide salary support for a senior clinical scientist who will contribute to the research program of the VA and the NCRAR through research and leadership activities. The holder of this award provides mentoring and scientific training to junior VA scientists, maintains an active research program relevant to the mission of the organization and to veterans' health care, serves as a resource to the research community, collaborates with other scientists and clinicians, and serves on VA research and other committees.

Plan: Research will be carried out to determine the functional mechanisms of hearing loss and their involvement in deficits in speech understanding by hearing impaired veterans. This work is currently supported by an NIH R01 grant that has been funded for nearly twenty years. Further research funding has been awarded from the Oticon Foundation for a collaborative project with scientists at Walter Reed Army Medical Center to determine the benefit of providing individualized auditory computer models to characterize a patient's impaired hearing, with the ultimate goal of developing improved signal processing in hearing aids. Additional research proposals are under development. Active mentoring is underway for two young scientists who have been awarded VA RR&D Associate Investigator Awards and for another staff scientist at the NCRAR who currently holds a Research Career Development Award. Mentoring is also provided for a post doctoral research associate.

Methods: The implementation of the SRCS award involves preparing grant applications and designing research; developing laboratory resources and hiring and mentoring post doctoral research associates; providing service to national and local professional organizations including reviews of articles and grant proposals; and publishing research findings in national journals and at national meetings.

Progress to Date: To date, studies are underway supported by the NIH grant, and the Oticon Foundation grant, and two VA RR&D grants. Two new proposals were submitted during the past year. In addition, the SRCS is the PI on a newly awarded NIH predoctoral training grant for graduate students in Doctor of Audiology (AuD) programs around the nation. Collaborations with scientists at Walter Reed Army Medical Center, the University of Maryland, and the University of Washington have been maintained or newly established. Research audiologists and assistants have been hired to work in the laboratory and data collection and ongoing analyses are in progress.

Title: The effects of diabetes on processing of verbal communication

Principal Investigator: Stephen Fausti, PhD

Co-Investigators: Donald Austin, MD, MPH; Susan Griest, MPH

Funding Agency: VA RR&D 2007 Funding Received: $195,719

Timeframe: 07/01/04 – 06/30/08

Objectives: The primary objective of this study is to determine whether diabetes related cognitive deficits are associated with greater difficulty understanding speech in adverse listening conditions for diabetic than non-diabetic patients.

Plan: This is a follow-up study conducted by the VA National Center for Rehabilitative Auditory Research at the Portland VA Medical Center, in collaboration with the Department of Public Health & Preventive Medicine, Oregon Health & Science University, located in Portland, Oregon. The study is an observational two-group comparison study, designed to compare the diabetic and non-diabetic patients on a number of auditory and cognitive neural processing tasks and on two types of speech recognition tests.

Methods: Electrophysiologic, physiologic, and behavioral tests are conducted on two diagnostic groups of veterans – diabetic and non-diabetic. Electrophysiologic and physiologic tests will examine cochlear integrity (stimulus-frequency otoacoustic emissions), central brainstem conduction time (rate auditory brainstem studies), and speed of processing (cognitive P300 potentials). Behavioral tests will include clinical and experimental neuropsychological tests as well as speech recognition tests. Written questionnaires elicit data about the potential confounding variables such as coexisting medical conditions, noise exposure history, and health and disability status. Subjects also undergo special tests to detect and quantify peripheral neuropathy, and a small blood sample is drawn to check glycosylated hemoglobin (HbA1C test).

Findings to Date: During the period January 1, 2007, through December 31, 2007, the number of patients tested increased to 229 (135 with diabetes and 94 without diabetes) with 381 total test sessions for this period. During this same period, 16 patients were excluded based on the results of audiometric screening criteria. All participants were recruited from lists of outpatients of the Portland VA Medical Center, Portland, OR. Testing protocols were refined and data quality procedures were incorporated into the routine procedures. Most of the collected data have been subjected to quality control checks for accuracy and consistency and corrections made where indicated. Data reduction is complete and summary variables preparation from raw data is complete. Preliminary analyses have been conducted and high priority variables for final analysis have been identified.

Title: The impact of hearing aid directional microphones on sound localization

Principal Investigator: Gabrielle Saunders, PhD

Co-Investigator: M. Samantha Lewis, PhD

Funding Agency: VA RR&D 2007 Funding Received: $135,232

Timeframe: 04/01/05 – 03/31/09

Objective: The purpose of this study is to investigate the impact hearing aid directional microphones have upon sound localization and speech intelligibility. The use of directional hearing aids represents a promising approach to the problem of speech in noise, but these instruments also impose constraints, such as reduced localization cues. It is important to evaluate both the advantages and limitations of directional hearing aids under realistic conditions of use. The issues to be addressed in the proposed research include an assessment of the magnitude of the improvement in intelligibility, the relative loss in localization ability and its practical consequences (if any) and other possible limitations that may be encountered in the everyday use of directional hearing aids.

Plan: This investigation will compare performance with directional microphones and omnidirectional microphones. Specifically, this investigation will: 1) document the impact of omnidirectional, cardioid and supercardioid microphone polar patterns upon sound localization; 2) evaluate the effect of these microphone polar patterns on speech intelligibility in noise; and 3) determine whether sound localization and speech intelligibility in noise changes differentially over the first few weeks of use for individuals wearing hearing aids with directional versus omnidirectional microphones.

Methods: Seventy subjects will undergo routine audiometric testing, an evaluation of sound localization for low, mid- and high-frequency signals and measurement of speech intelligibility in noise. All subjects will then be fit with a pair of in-the-ear hearing aids with selectable microphone polar patterns. They will undergo aided sound localization testing and speech intelligibility testing, with the microphone polar pattern in the omnidirectional, cardioid and supercardioid modes. Following testing, subjects will be randomly assigned to one of two groups (1) those who will wear the hearing aids in the omnidirectional mode for 24 weeks and (2) those who will wear the hearing aids in the cardioid mode for 24 weeks. Following this, subjects will return to the laboratory for sound localization and speech intelligibility in noise testing.

Findings to Date: Thirty-seven subjects have been entered into the study, of these six subjects have completed the protocol, two have withdrawn, and the remaining twenty-nine subjects are part way through. Data from the participants that have completed the study has been prepared for analysis although data analysis has not yet begun.

Title: The Performance-Perceptual Test (PPT) as a counseling tool

Principal Investigator: Gabrielle Saunders, PhD

Co-Principal Investigator: David Lilly, PhD

Funding Agency: VA RR&D 2007 Funding Received: $72,625

Timeframe: 07/01/05 – 06/30/07

Objectives: Hearing aid dissatisfaction continues to be disappointingly high, even though technology has improved dramatically over the last 10 years or so. Unfortunately, the results of most commonly used self-report measures cannot be directly compared with the results from performance measures since the modes of testing are very different. Thus, it is hard for clinicians to reconcile data from individuals reporting more handicap or less hearing aid satisfaction than would be expected from their performance. In this study, we aim to use a test known as the Performance-Perceptual Test (PPT) to determine whether simple counseling based upon discussion of PPT results can be used to better align perceived and measured ability to understand speech-in-noise and, more importantly, whether such counseling can decrease reported handicap and improve hearing aid satisfaction, regardless of its impact upon perceived hearing ability.

Plan: The study will be conducted over a two-year period. We will determine whether PPT-based counseling can decrease reported handicap and increase hearing aid satisfaction among individuals that underestimate their hearing ability and their hearing aid benefit. The following questions will be addressed: 1) Does a combination of the Performance SRTN and the PPDIS explain the variance in aided reported handicap to the same extent that it explains the variance in unaided reported handicap? 2) Can simple counseling based upon an individual's PPT scores better align an individual's perception of his/her hearing ability with his/her actual hearing ability? 3) Can this counseling successfully decrease unaided and/or aided reported handicap in individuals that underestimate their hearing ability and report excessive handicap for their degree of impairment? 4) Can PPT-based counseling increase satisfaction with hearing aids among hearing aid users that underestimate their hearing aid benefit?

Methods: Hearing aid users will complete the PPT for aided and unaided listening, along with standardized questionnaires measuring reported auditory disability, handicap and hearing aid satisfaction. Following this, subjects will be randomly assigned to one of two groups. Subjects in Group 1 will receive counseling from the experimenter in the form of an explanation and discussion of their PPT results. Subjects in Group 2 will also participate in a discussion with the experimenter, but it will not include an explanation of the PPDIS. Two weeks after enrollment in the study subjects will complete a second set of questionnaires. Ten weeks after study enrollment subjects will return to the laboratory to rerun the test battery. The impact of the counseling upon PPDIS values, reported handicap and hearing aid satisfaction and benefit will be compared across the two groups.

Findings to Date: Seventy-one of the eighty participants have been recruited into the study, 70 of whom have completed the protocol. Preliminary analyses indicated that the both PPT-based and non-PPT base counseling is effective at improving hearing aid use and satisfaction. Further analyses will be conducted once subject recruitment and testing is complete.

Title: Veterans Affairs National Center for Rehabilitative Auditory Research (NCRAR)

Principal Investigator & Director: Stephen Fausti, PhD

Co-Principal Investigator & Associate Director: Dennis Bourdette, MD

Funding Agency: VA RR&D 2007 Funding Received: $925,000

Timeframe: 10/01/97 – 09/30/12

Objectives: Auditory disabilities (hearing loss and tinnitus) affect veterans of all ages and represent the most prevalent individual service-connected disability among veterans receiving compensation from the Veterans Benefits Administration VBA in fiscal year 2006 (VBA, FY2006). More than 839,907 veterans had a service-connected auditory disability that required compensation from the VBA. In FY2006, total compensation to veterans exceeded $1.2 billion for hearing loss and tinnitus disabilities, an increase of 56% since 2002. Furthermore, an estimated one million additional veterans are service-connected for their hearing loss and tinnitus, but do not receive compensation. The high incidence of hearing disabilities among veterans creates a tremendous and growing demand for hearing healthcare services within the Department of Veterans Affairs (VA). Most importantly for our veteran population, hearing loss and tinnitus can have a life-long negative impact on communication and quality of life.

VA research, while targeting veterans, provides significant benefit to all Americans. The VA's support of auditory rehabilitation research is equally important for veterans receiving compensation, for the millions of veterans who have a non-compensable hearing loss, and for the nearly 35 million individuals in the United States who are affected by hearing loss. This communication disorder—the most common chronic health condition in all age groups—profoundly affects social, vocational, and psychological functions (Ruben, 2000). Moreover, the incidence of hearing loss increases dramatically with age: about 40-45% of people over age 65 years have some degree of hearing loss, with the number increasing to about 83% in individuals over 70 years of age (Cruickshanks et al., 1998). In the 30 years between 1990 and 2020, it is projected that the number of veterans over 85 years will have increased by 568%; while the median age of veterans is projected to increase from about 58 years today, to over 62 years by 2020. As the population ages, the problem of hearing impairment will place unprecedented demands on health care. The NCRAR is a comprehensive research organization dedicated to the discovery of effective solutions for veterans' auditory disabilities, and the translation of evidence-based research results into practice throughout the VA healthcare system and the nation.

Plan: The Center uses a multi-disciplinary approach that includes both basic and clinical research components to bring diverse perspectives and solutions to common auditory problems.

Methods: Our research strategy encompasses the progression from basic theoretical research to clinical care, including three major research areas: the *diagnosis and assessment* of auditory dysfunction, the development of *rehabilitation* approaches and techniques, and the *prevention* of hearing loss. We carry out clinical trials, develop technologies, and play an important role in cultivating the next generation of auditory researchers through education and mentoring programs.

Findings to Date: Core funding of the Center has been effective in developing one of the country's premier centers for auditory research, and has facilitated the acquisition of investigator-initiated research funds from diverse sources. The NCRAR is a productive VA RR&D Center of Excellence, staffed by VA researchers, carrying out rehabilitation research and development projects of high priority to hearing health care for veterans and the nation.

Title: Viral induced sensorineural hearing loss: a new treatment strategy

Principal Investigator: Steven Hefeneider, PhD

Co-Investigator: Dennis Trune, PhD

Funding Agency: VA RR&D 2006 Funding Received: $116,713

Timeframe: 10/01/05 – 07/31/07 (project ended prematurely as PI elected to retire from VA)

Objectives: Sudden sensorineural hearing loss (SSNHL) is characterized by hearing impairment or deafness that develops during a short period of time. The etiology of SSNHL is not well defined and a variety of causes have been hypothesized. Viral infection has been reported as an underlying cause and is supported by serologic and histopathologic studies. The mechanism of viral induced hearing loss is hypothesized to be induction of inner ear inflammation. Inflammatory cytokines produced in response to viral disease may interrupt the hair cell and ion homeostatic pathways in the cochlea, resulting in a decrease in function and eventual death of hair cells. This study seeks to develop an animal model of viral labyrinthitis and determine the impact of immune suppression therapies on the progression and extent of hearing loss.

Plan: Recently, a protein from vaccinia virus, termed A52R was reported to inhibit intracellular signaling initiated by PAMP/TLR interaction, resulting in reduced secretion of proinflammatory cytokines produced by immune cells in response to bacterial and viral products. We generated peptide derivatives from the A52R protein and showed that one of these peptides, termed P13, demonstrated significant inhibition of *in vitro* cytokine production in response to bacterial and viral components. Both bacterial and viral products activate the same intracellular pro-inflammatory pathway, via TLRs. The current proposal will examine the effect of peptide P13 therapy on viral induced inner ear inflammation.

Aim 1: Establish in vivo the effectiveness of peptide P13 to inhibit actuation of a viral induced inflammatory response;

Aim 2: Determine the effectiveness of peptide P13 to reduce inner ear inflammation and limit hearing loss in an animal model of viral induced inner ear disease.

Methods: Aim 1will determine whether peptide P13 inhibits pro-inflammatory cytokine secretion from virally stimulated cells in vitro. Established cell lines will be incubated with various concentrations of virus involved in inner ear inflammation and production of pro-inflammatory cytokine secretion quantified by ELISA. Once optimal *in vitro* parameters are established, peptide P13 and a control scrambled peptide will be added simultaneously with the virus and inhibition of pro-inflammatory cytokine secretion determined. Aim 2 will determine whether peptide P13 will limit inflammation and restore hearing thresholds in an animal model of viral induced inner ear disease. Animals will receive bilateral viral injections, one ear with PBS and the opposite ear with various doses of peptide P13. After seven days, hearing levels will again be assessed by ABR, animals will be euthanized and inner ear tissues evaluated histologically for inner ear inflammation.

Findings to Date: Peptide P13 has been demonstrated *in vitro* to be a potent inhibitor of viral-induced cytokine release. The VA asserted ownership and patent rights to an invention disclosed by Dr. Hefeneider as "Identification of a peptide that inhibits toll-like receptor (TLR) signaling: possible application as an anti-inflammatory agent." Dr. Hefeneider retired from the VA so the Oregon Health & Science University could license this innovation to Dr. Hefeneider's private company, Targeted Gene Delivery, Inc., under a Collaborative Technology Administration Agreement.

Non-VA Submissions (n = 7; total requested funding = $5,766,558)

Title: Centralized tinnitus management for TBI patients

Principal Investigator: James Henry, PhD

Co-Principal Investigators: Tara Zaugg, AuD; Paula Myers, PhD

Co-Investigators: Kenneth James, PhD; Daniel Storzbach, PhD

Funding Agency: DoD-U.S. Army Medical Research and Materiel Command-Congressionally Directed Medical Research Programs – TBI Intramural Advanced Technology Award Proposal

Total Requested Funding: $1,485,071 (direct); $282,176 (indirect)

Timeframe: Four years requested (not funded)

Objectives: Tinnitus is a common symptom of traumatic brain injury (TBI) caused by motor vehicle accidents, assaults, falls, gun shot wounds, and blasts. There is growing concern among medical leadership both within DVA and DOD that blast-related TBI is a major problem among returning OIF/OEF veterans. At the Palo Alto VA TBI inpatient unit, 38% of patients with blast trauma have reported tinnitus during the OIF/OEF conflicts. As with other forms of tinnitus, tinnitus associated with TBI usually is a life-long condition that can significantly impact quality of life. No program currently exists to provide clinical management for military personnel and veterans who have tinnitus associated with TBI. The proposed study will develop and evaluate a centralized tinnitus-management program that can be accessible to these individuals from any geographic location.

Plan: The proposed study is a two-group non-randomized observational study. All subjects will have tinnitus requiring intervention. One group will have TBI (of which most are expected to have "probable mild TBI") and one group will not have TBI. The purpose of the study is to determine if the centralized intervention can facilitate successful management of tinnitus in subjects who have TBI compared to those who do not have TBI.

Methods: Military and VA facilities will be contacted to directly target these individuals. Regions of subject recruitment will be added incrementally throughout the first 2.5 years of the study. Individuals with tinnitus will call a special toll-free number to inquire about the study. The research assistant will provide initial screening, set up the first telephone appointment with an audiologist, and mail out materials to the subject. The audiologist will conduct intervention telephone appointments at 2, 4, 6, 12, and 24 weeks. Intervention will consist primarily of efforts to facilitate the subject's use of sound to effectively manage tinnitus. Subjects also will learn about different factors that can impact tinnitus and reactions to tinnitus. Outcomes assessment will be conducted using the Tinnitus Handicap Inventory and the SF-36V at 0, 12, and 24 weeks. We will be attentive to seeing that the program is implemented in such a way as to reach the target population.

Findings to Date: None, the proposed study was reviewed but not funded.

Title: Development of a centralized tinnitus management program

Principal Investigator: James Henry, PhD

Co-Investigator: Paula Myers, PhD

Funding Agency: DoD-U.S. Army Medical Research and Materiel Command-Congressionally Directed Medical Research Programs – TBI Concept Award Proposal

Total Requested Funding: $150,000 (direct); $39,000 (indirect)

Timeframe: One year requested (reviewed, not funded)

Objectives: The prevalence of tinnitus in veterans with combat experience is about 30%. At the Palo Alto VA traumatic brain injury (TBI) inpatient unit, 38% of patients with blast trauma have reported tinnitus during the OIF/OEF conflicts. Tinnitus caused by noise or trauma is usually a life-long condition that can significantly impact quality of life. This proposed study will develop a program for evaluating these veterans to determine factors associated with their tinnitus.

Plan: The program will be centralized and web-based to enable testing of veterans anywhere in the country. We have already developed a comprehensive tinnitus management program for veterans whose tinnitus was caused by noise-induced hearing loss (NIHL)—the typical form of tinnitus experienced by veterans. It is unknown, however, if the tinnitus of veterans with a history of TBI differs from tinnitus caused by NIHL. The main focus of the study is therefore to develop a test battery to detect differences between tinnitus associated with TBI versus NIHL. In addition, this study will develop patient education and clinician training videos to allow our tinnitus management methodology to be broadly disseminated.

Methods: We will use our computerized Tinnitus Evaluation System (TES) as the platform to develop the centralized test battery. The battery will include questionnaires that will capture demographic information, tinnitus history, hearing history, medical history, and cognitive processing ability. The questionnaires will be formatted for administration via the internet. To ensure that tinnitus in this patient population is appropriately characterized, we will collaborate with a VA neuropsychologist who has expertise in the development of cognitive tests for TBI (and PTSD). Remote tinnitus psychoacoustic testing (tinnitus loudness and pitch matching, tinnitus maskability, and residual inhibition) will be developed by the software and hardware engineers who designed and built the TES. The TES currently performs these functions, and modifications will allow the testing to be conducted remotely (which will require use of a small hardware device that connects to any computer and delivers calibrated testing stimuli through earphones). A centralized database will be developed to capture and store all response data. For remote tinnitus management, a video will be developed that will provide veterans with information about tinnitus and specific instructions for developing a personalized tinnitus self-management program. A second video will be developed to augment the online tinnitus training for audiologists that we have already developed. These videos can be DVD- or web-based.

Findings to Date: There are no findings to report as this Concept Award proposal was reviewed, but not funded.

Title: Development of an automated test battery for auditory processing disorders

Principal Investigator: Frederick Gallun, PhD

Funding Agency: DoD-U.S. Army Medical Research and Materiel Command-Congressionally Directed Medical Research Programs – TBI Concept Award Proposal

Total Requested Funding: $132,000 (direct); $35,000 (indirect)

Timeframe: 18 months requested (reviewed, not funded)

Objectives: The goal of this project is to develop a rapid automated test battery to screen adult listeners for central auditory processing disorders. Such disorders are commonly diagnosed in children, but very little work has been done addressing their prevalence in adults. The outcome measure provided by the results of this test battery would eventually be verified with veterans and current military personnel who are at risk of traumatic brain injury (TBI), particularly of the mild form.

Plan: This project addresses the first stage of a multi-part endeavor. In this stage, the programming and engineering work associated with developing the test battery would be accomplished. Once the technology was in place, funding would be sought for the clinical verification phase.

Methods: The test battery would involve four classes of tests, each of which has been associated with brain areas that are likely to be affected in TBI. Tests of binaural processing and timing would assess the integrity of the brainstem, while tests of speech understanding in the presence of competing signals and tests of pattern recognition would assess the integrity of temporal and frontal cortical areas. All of these tests are robust to changes in overall level and can be done in the presence of some amount of background noise, so they are appropriate for a test battery that would be administered under a variety of conditions on a range of equipment,

Findings to Date: There are no findings to report as the proposed study was reviewed, but not funded.

Title: Ecological momentary assessment in hearing research

Principal Investigator: James Henry, PhD

Co-Investigators: Joseph Istvan, PhD; Mitchel Turbin, PhD

Funding Agency: NIH-NIDCD Total Requested Funding: $100,000 (direct); $24,830 (indirect)

Timeframe: Two years requested (reviewed, recommended for funding in 2008)

Objectives: The two most common auditory disorders among aging middle-aged Americans are hearing loss and tinnitus. Approximately 32% of those 55 years of age or older have self-reported hearing loss and about 8% of all adults currently report that they experience a "ringing or buzzing in the ears" daily or "all of the time." Recent data indicate that the prevalence of both hearing loss and tinnitus are increasing in the United States both with and without control for age. However, a much smaller proportion seek treatment for tinnitus or hearing loss. Indeed, only about 25% of those with adult-onset hearing loss currently use hearing aids and some data have shown that only about 37% of adults who say that they have "constant ringing in the ears" have reported this condition to a health care professional. Studies utilizing standard questionnaire methods have shown that those suffering from both hearing loss and tinnitus report that their problems and distress are often episodic, transitory, and situational. Several decades of research in cognitive psychology have shown that there are known and predictable biases in the way people recollect and report health problems and symptoms, particularly that may wax and wane in severity or occur more frequently in specific situations. In an effort to provide a more sensitive measure of the day-to-day real-life experiences associated with health problems, clinical researchers in a variety of fields have turned to a technique known as *ecological momentary assessment* or EMA. It is the objective of the proposed project to conduct pilot studies examining the applications of EMA methods to both hearing loss and tinnitus.

Plan: To utilize EMA, a standard Personal Digital Assistant (PDA) is programmed to signal a patient/participant with an audible or vibratory alert at either preset, random, or participant-chosen time points. This alert serves as a prompt to provide a series of assessments using a PDA stylus and touch screen. By asking individuals to provide reports of symptoms, distress and situations close to the time of occurrence, recall and report biases may be substantially reduced and diurnal or other forms of temporal variation in symptoms or distress may be examined. The findings and methods developed in these two studies will guide future clinical research using EMA technologies. Further, as the technologies underlying portable computing devices and hearing assistive devices converge, these pilot studies may serve as the foundation for a future program of research integrating both audiometric and questionnaire-based data streams in real-life day-to-day settings.

Methods: In Study 1, we will examine temporal and situational ratings of hearing difficulty and distress for a 1-week period before and after 24 research participants have received a new and more technologically advanced hearing aid. In Study 2, we will examine situational and temporal variation in ratings of tinnitus severity and distress for a 2-week period in 24 research participants who have previously reported experiencing severe tinnitus. In both studies, data obtained with EMA methods will be compared to standard clinical assessment tools and methods.

Findings to Date: There are no findings to report at this time as the study has not yet started.

Title: Noninvasive blood glucose monitoring using otoacoustic emissions

Principal Investigator: Eric Wan, PhD

Co-Investigators: Peter Jacobs, MSEE; Stephen Fausti, PhD; David Kagen, MD; Kenneth Ward, MD

Funding Agency: NIH-NIDDK Total Requested Funding: $379,782

Timeframe: Two years requested (scored, recommended for funding with 1/10/2008 start date)

Objective: The long-term goal of this study is to develop a portable handheld device that patients and clinicians may use to monitor blood glucose noninvasively without the need for painful finger sticks. The objective of the proposed research is to determine the extent to which blood glucose levels in diabetic subjects can be measured using masked evoked otoacoustic emissions (OAE). The OAE is a sound generated by the cochlea that provides a noninvasive test of the cochlear mechanical response to acoustic stimuli. There is evidence that suggests that OAE amplitudes and latencies correlate with glucose. Our hypotheses are that: 1) Amplitude and latency measures within an OAE will correlate with blood glucose levels in healthy non-diabetic and in type I diabetic subjects; and 2) There will be a more pronounced correlation when presenting contralateral masking noise while evoking the OAE. To achieve our objective and confirm our hypotheses, we propose the following specific aims: 1) determine whether certain types of audio stimuli and masking conditions evoke OAEs from the cochlea that correlate with blood glucose levels; and 2) develop parametric and non-parametric models that could be used to predict blood glucose levels in a diabetic patient given certain independent variables extracted from the OAE measurement, including amplitude and latency.

Plan: A total of 22 healthy, non-diabetic subjects and 22 diabetic subjects will serve as the subjects in this study. Subjects will be screened to determine which audio stimuli patterns evoke optimal OAE responses to contralateral noise, ipsilateral noise, or both noise types. Test subjects will undergo a glucose tolerance test (GTT) to manipulate their blood glucose levels over a clinically wide range of values. Evoked OAEs will be recorded regularly throughout the GTT. Data analysis will help determine whether a correlation exists between OAE measures and the subjects' blood glucose levels relative to control groups. Mathematical models predicting glucose will be developed and validated using OAE measures.

Methods: All test subjects will be divided into two groups, a Test Group and a Control Group. In the first experiment, healthy subjects will be tested to determine the optimal audio stimulus patterns required to evoke an OAE most significantly affected by noise masking. In the second experiment, healthy subjects will have OAE measurements taken while they undergo a two-hour GTT. During the GTT, the Test Group will ingest a drink containing 75 grams of glucose ½ hour into the study while the Control Group will ingest water. Diabetic subjects will go through the same two experiments described above. Subjects will repeat experiment 2 on consecutive days as we assess short-term drift in the OAE response. Subjects will also be tested approximately 1 month after the initial experiment is run to determine long-term drift in the OAE responses.

Findings to Date: Pilot data was obtained on 6 healthy diabetic subjects. OAEs were measured during a GTT under noise masking conditions. OAEs evoked during contralateral and forward noise masking conditions correlated with glucose in a multivariable linear regression between glucose levels and OAE amplitudes / latencies. A less significant correlation was observed when OAEs were evoked without masking. The preliminary findings support our hypothesis and provide justification for further research.

Title: Portable screening for central auditory deficits in individuals at risk for TBI

Principal Investigator: Stephen Fausti, PhD

Co-Principal Investigators: Frederick Gallun, PhD; Marjorie Leek, PhD

Co-Investigators: Leslie Peters, PhD; Henry Lew, PhD

Funding Agency: DoD-U.S. Army Medical Research and Materiel Command-Congressionally Directed Medical Research Programs – TBI Intramural Advanced Technology Application

Total Requested Funding: $2,772,306 (direct); $366,393 (indirect)

Timeframe: Four years requested (reviewed, not funded)

Objective: The work supported by this award would modify an already existing portable audiometric device to present tests of central auditory processing that can be administered by non-audiologists and that have been used to test the integrity of auditory brainstem, cortex, and interhemispheric pathways, all of which have been shown to be affected by traumatic brain injury. The information collected in the field can then be analyzed by a centrally located audiologist who would either recommend further testing or give an "all clear" for return to duty.

Plan: The specific aims of this project would include: 1) Extending conventional audiometric testing by further development of portable audiometric device to screen for central auditory injury at non-clinical locations remote from a clinical audiology facility; 2) Developing screening versions of tests of central auditory function to suggest possible sites of lesion, as well as evidence of adequate auditory function to support continued fitness for military duty; 3) Evaluating portable screening device for outcome reliability, calibration, and consistency with in-clinic extensive test protocols; and 4) Developing and testing secure communication of data obtained by the portable unit to permit professional clinical audiological interpretation and prognosis of results.

Methods: This is a multi-site collaborative effort between the National Center for Rehabilitative Auditory Research at the Portland VA Medical Center, Tripler Army Medical Center in Hawaii, and the War-Related Injury and Illness Study Center (WRIISC) at the VA Palo Alto Health Care System. The study is divided into hardware development, software development, test design, clinical verification, and network and data transfer. The hardware and software development will involve engineering work in which the capabilities of an already existing device will be enhanced in order to accommodate much more complex testing and operation by non-audiologist technicians. The software and hardware that is developed will support the presentation of short (less than five minute) tests of central auditory function that have been shown, in the test design phase, to produce comparable results to the longer, clinically established versions. The trade-off will come in the reduction of the testing outcome to a simple yes/no decision on whether or not more detailed testing is recommended. Finally, the clinical verification phase will examine the ability of the device and the tests implemented on it to be used in the field by non-audiologist personnel. Verification will also assess the ability of an audiologist, who will be analyzing the information provided remotely by the device, to correctly distinguish patients with known disorders from matched controls. Overall sensitivity and specificity of the testing device will be determined using this "gold standard".

Findings to Date: There are no findings to report as the proposed study was reviewed, but not funded.

Non-VA Approvals (n = 4; total 2007 funding received = $700,455)

Title: A joint DoD-VA hearing loss prevention program (HLPP)

Principal Investigators: Stephen Fausti, PhD; Marjorie Leek, PhD

Funding Agency: DoD-VA Joint Incentive Funding 2007 Funding Received: $560,898

Timeframe: 10/01/07 – 09/30/09

Objectives: The major, long-term goals of this project are to prevent hearing loss in soldiers and veterans, consequently reducing the cost of conditions related to such loss. This program focuses upon education and behavior change as the keys to minimizing further hearing loss. The project seeks to create a multimedia Hearing Loss Prevention Program that can be delivered in a hearing conservation program site or a primary care or other medical setting. For this initial stage of our project, we are targeting soldiers in the hearing conservations programs at Ft. Lewis WA and Ft. Bragg NC, as well as veterans who come to the Portland VAMC for health care. Targeting these individuals extends and supplements existing DoD hearing conservation services, and will reach veterans who may not yet be enrolled in hearing health care services at the VA.

Plan: To address these problems and to reinforce and extend the hearing conservation services offered to active duty soldiers, we propose to create Hearing Conservation Units (HCUs) to be placed, initially, in three locations: one at Ft. Lewis, WA; one at Ft. Bragg, NC; and one at the Portland VAMC. The HCUs will include sound-treated hearing conservation "kiosks" that will be lightweight sound-treated booths in which the hearing health care program can be presented by computer. The HCUs will include computer-presented, interactive modules or programs that provide hands-on education and training about hearing loss and tinnitus, allow self-monitoring of hearing sensitivity through a screening program, provide individualized instruction and evaluation for the use of hearing protective devices (HPDs) and test for proper HPD use by the individual user. A scientifically-accurate simulation of different configurations and severity of hearing loss and tinnitus using realistic soundscapes such as battle sounds or social interactions will provide an entertaining, but sobering, demonstration of the value of preserving hearing. Also included will be a module that provides information concerning audiological services available in the military and VA health care systems, and how those services may be accessed. A discussion of procedures for a seamless transition into the VA system will be presented, including the process of establishing a service connection for auditory disabilities.

Methods: There are three components to the proposal: one is the modification and further development of education and training modules for preventing hearing loss and tinnitus to make them specifically appropriate for these populations; second is the programming and integration of the computer modules and the user interface; and third is the construction of the kiosk-sound booths for the delivery of the program. In theory, each of these components is independent, but in practice, they require one another to deliver the program at the optimum level. At the end of the first six months, the computers will be installed at Madigan/Ft. Lewis, Ft. Bragg, and the Portland VAMC. A half-time audiologist will be hired at each site to monitor use, contact local commanders and other personnel who might be interested in the benefits of the HCUs, develop brochures and fliers to encourage use and announce availability of the systems, and answer questions from HCU users.

Findings to Date: Personnel have been recruited to staff this project, and the several stages of development are currently underway, including development of training software, and modules for fitting hearing protection and for simulating hearing loss.

Title: Hearing therapies for the future

Principal Investigators: Gabrielle Saunders, PhD; Dawn Konrad Martin, PhD

Funding Agency: NIH-NIDCD 2007 Funding Received: $20,800 (direct); $0 (indirect); $8,000 (RR&D); $10,975 (registration); $11,000 (industry sponsors)

Timeline: 09/01/07 – 08/31/08

Objective: This proposal requests funding for a conference titled 'Hearing Therapies for the Future' to be held September 26th - 28th 2007 in Portland, Oregon. This will be the third in a series of biennial conferences hosted by the National Center of Rehabilitative Auditory Research (NCRAR). The conference objective is to expand understanding and facilitate effective treatment of noise induced hearing loss (NIHL). To this end, conference sessions will combine varied formats to stimulate learning, discussion and information dissemination among leading scientists in the field of prevention, treatment and rehabilitation of NIHL, and audiologists who will gain knowledge that is directly applicable to their clinical practice. NIHL is a preventable cause of hearing loss that affects Americans of all ages. Exposure to noise is to blame for the hearing loss of about 10 million of the 28 million Americans with hearing impairment. The risk of NIHL among our nation's younger generations is increasing which is especially troubling in view of evidence that early exposure to noise increases the incidence and progression of age-related hearing loss. Thus, this conference has potential to benefit all Americans. More specifically, the conference will address current understanding of NIHL from cellular, molecular, and clinical perspectives. There will be a keynote address given by a hearing impaired individual who is a well-known scientist in the fields of auditory neuroscience and cochlear physiology. He will present an informal overview of research needs from the perspective of an educated consumer. There will be four main conference sessions. At each session, two or three renowned researchers in the field of NIHL will each give 30-45 minute invited presentations. Following the presentations there will be roundtable discussion panels among researchers, experienced clinical audiologists and invited lay persons with hearing impairment. Finally there will be a poster session for posters presented by scholarship winners and by individuals whose submitted posters meet the peer review criteria for acceptance.

Plan and Methods: The target audience is clinical audiologists, however in past years researchers, medical personnel and students have also attended the NCRAR conferences. Up to 8 scholarships will be awarded to practicing clinicians that will cover the cost of conference attendance. The meeting will be publicized via e-mailing lists from national and local organizations and through audiology training programs. Conference proceedings will be published in the journal 'Seminars in Hearing'. The NCRAR hosted highly successful conferences in 2003 and 2005 using the same format and locations as this proposed meeting. Audience ratings from those meetings show that over 80% of participants found the content, format, speakers and location to be extremely favorable.

Findings to Date: The conference took place on September 26th - 28th 2007 as planned, and over 150 individuals attended from VA, various universities and private industry. Remaining grant monies are being used to disseminate conference DVD recordings, and the conference proceedings are to be published in a forthcoming special issue of the peer-review journal *Seminars in Hearing*.

Title: Pre-doctoral summer training program in auditory research

Principal Investigator: Marjorie Leek, PhD

Funding Agency: NIH-NIDCD 2007 Funding Received: $23,872 (direct); $1,910 (indirect)

Timeframe: 05/01/07 – 04/30/12

Objectives: To provide a three-month summer research experience for up to four students per year.

Plan: Students will be enrolled in an accredited university program leading to the Doctor of Audiology (AuD) degree. The will spend the summer working at the NCRAR with one or two research mentors on research projects of mutual interest. They also will participate in research discussions among the staff of the NCRAR, and will have formal and informal instruction in scientific ethics.

Methods: Recruiting letters will be sent to all AuD program directors in the country, describing this program and asking their help in identifying potential trainees. Recruiting will also take place at national professional conferences and by word of mouth. Students will make application for the program by filling out a brief form, writing a two-page description of what they hope to gain from the program, and providing letters of reference from their program directors. Those selected each year will receive a monthly stipend paid for by the award, financial assistance from the NCRAR to help with their travel to and from Portland, and travel assistance to attend the following year's meeting of the American Auditory Society (AAS). As part of their application, they will indicate one or two NCRAR staff members with whom they wish to work. It is expected that each student will be involved in a research project, either one currently ongoing or a small new one.

Findings to Date: This program began during the summer of 2007, when four students were brought to the NCRAR from Utah, Arizona, Washington, and Kansas. They worked enthusiastically on their research projects, and will present research posters at the AAS meeting in March 2008.

Title: The ability to make multiple auditory judgments about non-speech stimuli

Principal Investigator: Frederick Gallun, PhD

Funding Agency: NIH-NIDCD 2007 Funding Received: $50,000 (direct); $13,000 (indirect)

Timeframe: 03/01/07 – 01/31/10

Objectives: Listeners in constantly changing noisy environments often experience more difficulties than when the same noise level is present but the environment is not changing so rapidly. This is a particular problem for those with even mild hearing loss (McCoy et al., 2005). Improving understanding of the processes by which a rapidly changing auditory environment is analyzed by listeners with impaired hearing will lead to improved creation of appropriate therapies and devices to reduce the difficulties such listeners experience.

Plan: 60 listeners, equally divided among normally-hearing and hearing-impaired and younger and older listeners will make judgments about brief (50 ms) changes in the amplitude (increase vs. decrease), frequency (higher vs. lower) and/or perceived location (left vs. right) of easily distinguished narrowband noise bursts.

Methods: Noise bursts will be centered on three frequencies: 758 Hz, 2013 Hz and 5085 Hz). Judgments will be made sequentially or simultaneously as well as within or across frequency regions. In the first set of experiments, listeners will detect changes in the amplitude of one of the noise bursts; in the second they will detect changes in location; in the third they will detect both. Across conditions, the number of bursts will be varied as well as uncertainty about which noise burst will change. It is hypothesized that primary limitations in making multiple judgments involve 1) short-term memory processes and 2) sharing resources within and between auditory processing mechanisms. The influence of aging is expected to be profound and an equally substantial effect of hearing loss is anticipated.

Findings to Date: Preliminary results from the first experiment suggest that listeners are more likely to attend to the first and third bursts when only three are presented, but that attention is distributed more broadly across time as the number of bursts is increased. At the current time, sixteen listeners have been enrolled, limiting the scope of the findings and the conclusions that can be drawn regarding age and hearing impairment.

Ongoing non-VA (n = 7; total 2007 funding received = $1,033,076)

Title: Auditory modeling of suprathreshold distortion in persons with impaired hearing

Principal Investigator: Brian Walden, PhD

Co-Principal Investigators: Marjorie Leek, PhD; Kenneth Grant, PhD; W. Van Summers, PhD (multi-site study between Walter Reed Army Medical Center and the NCRAR)

Funding Agency: The Oticon Foundation 2007 Funding Received: $138,320

Timeframe: 02/01/06 – 01/31/09

Objectives: Current hearing aids generally do an excellent job of compensating for the loss of sensitivity resulting from hearing impairment, but they are quite limited in their ability to address suprathreshold forms of distortion. Greater use of amplification by persons with impaired hearing may depend upon the development of signal processing algorithms that restore more normal suprathreshold auditory function. The research proposed in this application is intended as a precursor to the development of effective "reverse engineering" approaches to restoring more normal suprathreshold auditory function in persons with impaired hearing; that is, signal processing strategies that alter incoming auditory signals in such a way that, after processing by the impaired auditory system, more normal neural input to the brain is achieved.

Plan: Although conceptually familiar to hearing aid software engineers, preprocessing of the incoming auditory input to compensate for distortions imposed by the impaired auditory system has not been practical because of an inability to describe patient-specific distortions in a way that is amenable to familiar signal-processing approaches. This research seeks to take advantage of recent computer-based auditory processing models that provide visual and mathematical representations of auditory input at various stages of neural processing. Several measurements of auditory function will be taken on a small set of subjects in order to completely characterize their individual auditory systems.

Methods: Psychoacoustic (behavioral) tests will be carried out by listeners with various types and configurations of hearing loss. In all experiments, listeners will be asked to listen over earphones to specially constructed sounds and indicate their ability to detect, discriminate, or identify them by touching designated areas on a touch-screen monitor or by pushing buttons on a response box. The sounds to be tested will vary depending on the exact experimental question that is being asked. As information becomes available about individual subjects, auditory models will be modified to attempt to predict the performance of that subject on evaluation studies of speech perception under noise and reverberation.

Findings to Date: Sixteen subjects have enrolled in this study at the Portland site, and fifteen at Walter Reed Army Medical Center. Measures have been made to establish auditory filter bandwidths, estimates of compression in forward masking, speech recognition in steady state and fluctuating background noise, and amplitude modulation detection. These studies have indicated broader auditory bandwidth, greater linearity in cochlear processing and a lack of normal release from masking of speech in hearing impaired subjects. Modeling efforts are underway at Walter Reed, and testing continues at both sites.

Title: Development and evaluation of an outcome measure for tinnitus

Principal Investigator: Mary Meikle, PhD

Co-Principal Investigator: James Henry, PhD

Co-Investigators: William Martin, PhD; Craig Newman, PhD; Sharon Sandridge, PhD; Harvey Abrams, PhD; Paula Myers, PhD

Funding Agency: Tinnitus Research Consortium 2007 Funding Received: $49,994

Timeframe: 07/01/06 – 06/30/07 (no cost extension through 03/31/08)

Objectives: A new outcomes instrument for measurement of the severity and negative impact of tinnitus will be developed in a multi-site study conducted by the Oregon Health & Science University in conjunction with three other clinical sites located in Ohio, Florida and Oregon, respectively.

Plan: An Outcomes Working Group (consisting of the eight co-investigators, assisted by outcomes consultants with psychometric and biostatistical expertise and an Advisory Panel of tinnitus experts) will be set up to develop the self-report questionnaire. It will be designed for use in (1) assessing the severity and negative impact of tinnitus in affected individuals, and (2) use in evaluating treatment-related changes in tinnitus. Responses from 1200-1500 tinnitus patients (with tinnitus ranging in severity from mild to severe) will be studied at the various sites over the 3-year period.

Methods: Using a systematic development protocol, a prototype questionnaire will be developed during the first 6 months of Year 1. The prototype questionnaire will then be administered to all subjects at intake and to those requesting treatment (approximately half of the group) at 3, 6, and 9 months following the initiation of their treatment. The resulting data will be entered into a database for statistical evaluation. A variety of statistical techniques, including correlational and other factor-analytic techniques will be used to evaluate psychometric characteristics of the instrument (validity, reliability) and its responsiveness to change will be evaluated using a hierarchical linear model to test whether treated subjects show significant tinnitus improvement compared to wait-listed controls. Based on preliminary findings with the first prototype, in Years 2-3 a second prototype questionnaire will be developed and evaluated at the various sites, using similar statistical procedures. It is anticipated that the final product, the "Tinnitus Functional Index" or TFI, will exhibit desirable psychometric characteristics that are well-adapted to its various intended uses.

Findings to Date: Testing and evaluation of the Phase 2 prototype was completed in December 2007. A total of 347 subjects were evaluated using Phase 2 questionnaires. The resulting data are currently undergoing detailed analysis. Preliminary results indicate that Prototype 2 functions very well in regard to scaling the severity and negative impact of tinnitus. Follow-up questionnaires were obtained from 147 of the subjects at 3 months, 85 subjects at 6 months, and 27 subjects at 9 months. The follow-up data indicate that Prototype 2 has excellent sensitivity to treatment-related change, thus satisfying our overall objective of developing a tinnitus questionnaire with enhanced sensitivity to treatment effects.

Title: Hearing loss and the perception of complex sounds

Principal Investigator: Marjorie Leek, PhD

Funded Agency: NIH-NIDCD 2007 Funding Received: $150,998 (direct); $39,259 (indirect)

Timeframe: 09/01/03 – 08/31/08

Objectives: Auditory speech recognition by individuals with hearing loss requires recovery of the intended message from a distorted internal representation of the input stimulus. This research is focused on the preservation of temporal precision in auditory processing by hearing-impaired listeners, and how these measures relate to pitch perception. The preservation of precise temporal firing patterns in the auditory nervous system is necessary for the clear perception of pitch that supports recognition of speech sounds as well as for the ability of normal-hearing people to extract the speech signal from a noisy background. An understanding of the interaction of factors such as impaired spectral and temporal processing with the acoustics of speech and music is critical to the potential ability to tailor programmable hearing aids to individual patients' hearing losses.

Plan: Each experiment in this grant involves prospective data collection from two groups of up to six subjects. The experimental group will be people with sensorineural hearing loss and a control group will consist of subjects with normal hearing. The listeners will be asked to discriminate among sounds that vary along acoustic dimensions known to be important to auditory processing of speech and other sounds: the frequency spectrum, the temporal waveform envelope, and the temporal fine structure in the waveform. Experiments are also proposed that will estimate the amount of temporal "jitter" imposed by a damaged auditory system in the preservation of accurate neural temporal information across different frequency ranges.

Methods: Listeners will be asked to listen over earphones to specially constructed sounds and indicate their ability to discriminate them by touching designated areas on a touch-screen monitor or by pushing buttons on a response box. The sounds to be tested will vary depending on the exact experimental question that is being asked. For each set of sounds, a mean discrimination threshold and variability will be determined. In a second type of task, listeners will be asked to match the pitches of two types of complex sounds. For this task, the listener will hear two sounds alternating, and will be able to control the pitch of one of them until he/she estimates that they match. The frequency relationships of the matched sounds will be compared to findings in normal-hearing listeners, and the variability of the matches will indicate the stability and strength of the perceived pitch.

Findings to Date: One study on this grant shows that people with hearing loss have difficulty discriminating complex sounds that differ only in their temporal periodicity. This study is meant to determine temporal processing ability in hearing impaired listeners, and the effects of limiting sounds to higher frequencies. Another study nearing completion shows that both normal-hearing and hearing impaired subjects can benefit from having clear spectral plus phase cues in identifying vowels. That is, enhancement of speech understanding occurs by providing these two kinds of acoustic features to cue a speech sound. In general, this grant and other work shows that impairments related to temporal processing help to explain some of the speech understanding difficulties experienced by people with hearing loss.

Title: Identification of ambiguous vowel stimuli in noise by hearing-impaired listeners

Principle Investigator: Michelle Molis, PhD

Funding Agency: OSHU Medical Research Foundation 2007 Funding Received: $15,000

Timeframe: 12/01/06 – 11/30/08

Objectives: Hearing impairment frequently results in reduced frequency selectivity in the auditory periphery. Additionally, there is a loss of perceptual sensitivity which requires that inputs be presented at increased levels to ensure audibility—a step that may further decrease frequency selectivity. The result is a smoothed internal representation lacking unambiguous spectral prominences corresponding to formant frequencies. The introduction of a competing background noise further exacerbates this situation. Since, optimal vowel exemplars are rarely produced by speakers in real world situations; there is extensive overlap between category tokens. This stimulus ambiguity makes understanding speech in everyday listening situations an even greater challenge for individuals with hearing loss. An evaluation of vowel identification with ambiguous stimuli in the presence of competing noise will provide a more realistic evaluation of listeners' capabilities than is commonly provided in a laboratory setting. This study will compare patterns of vowel identification in noise between and among hearing-impaired and normal hearing listeners.

Plan: Two groups of listeners will participate in this investigation: a normal hearing group and a hearing-impaired group. The identification patterns for three different subsets of synthesized vowel stimuli will be collected.

Methods: Vowel stimuli will be drawn from semi-regularly sampled stimulus spaces varying either in first and second formant frequencies or second and third formant frequencies. These vowel sounds will be presented to subjects over earphones along with speech-shaped background noise at several signal-to-noise ratios. On each trial, listeners will be asked to assign stimuli to one of three vowel categories by pressing buttons on a labeled response panel. This task will produce response frequency profiles for each of the possible response categories.

Findings to Date: It is expected that the responses of the hearing-impaired listeners will be more variable than the responses of the normal hearing listeners at all signal-to-noise ratios. Furthermore, it is expected that this variability will be even greater for the stimuli that vary in second and third formant frequencies. Response patterns will likely relate to degree of hearing loss and impairment of peripheral frequency selectivity.

Title: Otitis media impact on the inner ear

Principal Investigator: Dennis Trune, PhD

Funding Agency: NIH-NIDCD 2007 Funding Received: $121,375 (direct); $66,543 (indirect)

Timeframe: 07/01/06 – 06/30/08

Objectives: The goal of this research is to identify how inflammatory processes in the middle ear cause cochlear dysfunction. The PI, in collaboration with colleagues, has recently developed an acute otitis media mouse model, as well as described chronic otitis media in the C3H/HeJ mouse that has a defect in its toll like receptor 4 (TLR4). Furthermore, these collaborations have led to the development of new methods to characterize both middle ear and inner ear cytokine expression, NF-kB-mediated inflammatory processes, nitric oxide-mediated cochlear damage, and quantitative immune cell pathology. The proposed studies will capitalize on both these acute and chronic middle ear disease mouse models to establish the correlative middle ear and inner ear immune mediated processes. This will describe for the first time the molecular immune mechanisms by which otitis media can directly cause inner ear pathology. Therefore, this research has the potential to significantly advance our understanding of inner ear inflammatory processes elicited by both acute and chronic otitis media and lay the groundwork for development of new procedures for the detection and therapy of such hearing loss.

Plan: The specific aims of this proposal are:

Aim 1: To characterize the inner ear inflammatory processes in acute otitis media. This will clarify immune-mediated processes in the cochlea elicited by short-term middle ear infections.

Aim 2: To characterize the inner ear inflammatory processes in chronic otitis media. This will clarify inner ear immune-mediated processes that can result from chronic middle ear infections.

Methods: The proposed studies will utilize BALB/c mice inoculated in the middle ear with heat-killed *Haemophilous influenza* or *Streptococcus pneumoniae* (acute otitis media) and C3H/HeJ mice defective for TLR4 (chronic otitis media) to characterize inner ear pathology, physiology, cytokine gene expression, cytokine levels, NF-kB activated inflammatory processes, and reactive oxygen species. Inner ear pathology will be measured with auditory brainstem response audiometry, the endocochlear potential, light and electron microscopy, and immunohistochemistry of inflammatory mediators. Cochlear immune-mediated processes will be assessed by measurement of inflammatory cytokines, cytokine gene expression, and ELISA of transcription factors, vascular related factors, and reactive oxygen species.

Findings to Date: The inner ear tissues will express cytokine RNA in response to both acute and chronic otitis media. Studies with PCR and ELISA show cytokine gene expression in the inner ear parallels expression in the middle ear, now providing a basis for sensorineural hearing loss in acute and chronic otitis media.

Title: Steroid responsive mechanisms in the ear

Principal Investigator: Dennis Trune, PhD

Co-Investigator: Steven Hefeneider, PhD

Funding Agency: NIH-NIDCD 2007 Funding Received: $253,516 (direct); $136,898 (indirect)

Timeframe: 09/01/05 – 08/31/08

Objectives: Although glucocorticoids, such as prednisone, have been employed for decades for control of hearing loss, little is known of the cellular mechanisms of the ear that are under their control. A better understanding of these steroid responsive mechanisms is critical for our design of appropriate therapy. Therefore, the long term goal of this research is to characterize the steroid driven cellular mechanisms of the ear. Preliminary studies have shown hearing loss in the MRL/MpJ-Faslpr autoimmune mouse responds to treatment with both the glucocorticoid prednisolone and the mineralocorticoid aldosterone. It is hypothesized that two steroid-responsive mechanisms exist in the ear: a *direct* sodium and potassium transport (homeostatic) gene expression mediated by the mineralocorticoid receptor, and an *indirect* inflammatory gene suppression mechanism mediated by the glucocorticoid receptor.

Plan: The planned studies will characterize these steroid-driven cellular and molecular processes with steroid treatments that will functionally isolate the receptors and measure changes in the cochlear homeostatic and inflammatory gene expression they control. The *specific aims* to investigate these steroid mechanisms of the ear are:

Aim 1: Determine the dose-dependent control of inner ear ion homeostatic and inflammatory gene expression by the mineralocorticoid aldosterone and the glucocorticoid prednisolone;

Aim 2: Determine the most effective control of both inner ear ion homeostatic and inflammatory gene expression processes by combination doses of the two steroids;

Aim 3: Determine which cochlear cellular and molecular functions are mediated by each steroid receptor;

Aim 4: Determine if effective inner ear homeostatic and anti-inflammatory gene expression can be induced by middle ear steroid delivery.

Methods: In all studies, assessment will be made of steroid effects on inner ear structure (light and electron microscopy), function (ABR, EP), cochlear specific antibodies (ELISA), and cochlear gene products (ELISA, cytokine RNA expression, and quantitative RT-PCR). The results from these studies will provide significant new findings regarding the cellular and molecular mechanisms of the ear that are under the control of steroids. This study also will lay important groundwork for the development of alternative steroid therapies that may be more effective than those currently employed for clinical hearing loss.

Findings to Date: Treatment of mice with both glucocorticoids and mineralocorticoids show the same ion homeostatic functions are upregulated (sodium channel and Na+-K+-ATPase) by glucocorticoids. This provides the first evidence that immunesuppressive steroids also increase ion homeostasis in the ear, which may serve as the steroid driven process that helps restore hearing loss. Gene expression studies also show that the cytokine profile in the inner ear is different depending on whether we give steroid systemically or deliver them intratympanically. This suggests that the current practice of intratympanic drug delivery may help in some cases of hearing loss that is not responsive to oral drugs.

Title: Temporal resolution of cochlear and auditory nerve responses in older adults

Principal Investigator: Dawn Konrad-Martin, PhD

Funding Agency: NIH-NIDCD 2007 Funding Received: $48,550 (direct); $12,623 (indirect)

Timeframe: 04/01/06 – 03/31/09

Objectives: Older adults have greater difficulty understanding speech compared with younger adults, even when hearing sensitivity is similar between the two groups, possibly due to impaired perception of time-varying speech cues. The decline in temporal resolution that accompanies aging is due to an unknown mixture of peripheral (cochlear and auditory nerve), central auditory, and cognitive processing deficits. Objectives of this work are to determine: (1) whether auditory nerve synchrony is reduced and recovery from prior stimulation is prolonged in older ears; (2) the extent that age-related changes in cochlear function can account for changes in the amplitude and timing of auditory nerve responses, and; (3) whether age-related changes in cochlear mechanical and auditory nerve responses alter the perception of temporal speech cues by older listeners.

Plan: Groups of older and young adults with normal or impaired hearing will serve as subjects. Neural responsiveness is explored in each of the 4 groups by comparing unmasked to forward-masked compound action potentials (CAPs). Measures of temporal resolution based upon CAP data are obtained using a forward-masking paradigm. The contribution of the cochlear-driven otoacoustic emission (OAE) measurements is compared to the neural-driven CAP to determine if changes in cochlear mechanics influence changes in neural responsiveness. Finally, results of speech recognition tests for stimuli that vary in their voice onset time are compared to cochlear and neural responses in order to make inferences about the relationship between speech recognition performance and peripheral auditory system function. Results will determine the extent to which poor temporal resolution and specific physiological changes within the auditory periphery account for age-related deficits in the processing of temporal aspects of speech.

Methods: Four groups totaling 120 subjects will participate in this study (2 groups of 40 elderly individuals and 2 groups of 40 young subjects). Elderly subjects are $\geq$ 63 years with normal hearing or cochlear hearing loss (high frequency pure-tone-average [HFPTA] = 30-50 dB HL). Young subjects are 18 to 35 years old with normal hearing or with noise-induced hearing loss (HFPTA = 30-50 dB HL). Procedures include pure-tone audiometric assessment of conventional and ultra-high frequencies, physiological assessment (tympanometry, measures of temporal resolution based upon CAPs obtained using a forward-masking paradigm, estimates of cochlear mechanical compression and travel time from OAEs); and assessment of listeners' performance on voice onset time (VOT) identification and discrimination tasks.

Findings to Date: Partial OAE data to assess cochlear function have been collected in 34 subjects (18 young normal-hearing subjects, 7 older normal-hearing subjects and 9 older hearing-impaired subjects). Preliminary OAE data in normal subjects resemble direct measures of cochlear nonlinearity in lower mammals. CAP data have been collected in 3 young subjects. Based on these pilot data, we have devised an alternative protocol for eliciting CAP forward-masking curve functions that employs a rising-frequency chirp designed to compensate for cochlear travel-time differences across frequency (Fobel and Dau, 2004), thereby maximizing neural synchrony.

IV. CAPACITY BUILDING

The NCRAR is contributing to the VA's standing as a leading clinical research institution through the recruitment, mentoring and training of the next generation of clinicians and clinical researchers. NCRAR's dedicated 21,000 square foot Center of Excellence facility serves as a unique capacity building advantage for attracting investigators at all career levels, from junior investigators who are mentored to senior investigators with established research programs, all of whom bring new perspectives and stimulating ideas to generate hypothesis-driven rehabilitation research. The facility is generously furnished with 9 dedicated auditory research sound attenuation rooms, an anechoic chamber, and the latest clinical and research instrumentation as shared resources. NCRAR's facility provides optimally functional space, and the center's multidisciplinary staffing creates a unique mentoring and training advantage that would be difficult, if not impossible, to find elsewhere. During 2007, the NCRAR provided mentoring and training to the following individuals:

Associate Investigator Awardees

- Frederick Gallun, PhD (M. Leek, Mentor).
- Michelle Molis, PhD (M. Leek, Mentor).

Career Development Awardees

- M. Samantha Lewis, PhD, RCD (G. Saunders, Mentor).
- Dawn Konrad-Martin, PhD, ARCD (M. Leek; S. Fausti, Mentors).
- Frederick Gallun, PhD, CDA-2 (M. Leek; S. Fausti, Mentors).

Nurse Research Associates

- Deborah Brown (G. Saunders, Consultant & Informal Mentor).
- Jenny Lawson (G. Saunders, Consultant & Informal Mentor).
- Diana Pope (S. Fausti; F. Gallun, Mentors).
- Kimberly Thompson (G. Saunders, Consultant & Informal Mentor).

Rehabilitation Research Disability Supplement Awardee

- Mitchel Turbin, PhD (S. Fausti; J. Henry; K. James, Mentors).

Research Career Scientist Awardee

- James Henry, PhD (S. Fausti; M. Leek, Mentors).

Senior Research Career Scientist Awardee

- Marjorie Leek, PhD.

Visiting Research Scientist

- Pamela Souza, PhD (from the University of Washington, Seattle, WA).
- Christopher Stecker, PhD (from the University of Washington, Seattle, WA).
- Kelly Tremblay, PhD (from the University of Washington, Seattle, WA).

Post-doctoral Research Associates

- Marilyn Dille, PhD, Research Associate (D. Konrad-Martin; S. Fausti, Mentors).
- Caroline Kendall, PhD, CDA-1 Applicant (J. Henry, Secondary Mentor).
- Sarah Melamed, PhD, CDA-1 Applicant (M. Leek, E. Gallun, M. Molis, Mentors).

Pre-doctoral Students

- Anna Diedesch, AuD Candidate, Wichita State University, Wichita, KS (M. Leek; M. Molis, Mentors).
- Eric Hoover, AuD Candidate, University of Washington, Seattle, WA (F. Gallun, Mentor)
- Justin Howell, AuD Candidate, Utah State University, Logan, UT (G. Saunders; M. Samantha Lewis, Mentors)
- Peter Jacobs, MSEE, PhD Candidate, Oregon Graduate Institute, School of Science & Engineering, Oregon Health & Science University, Portland, OR (S. Fausti; E. Wan; D. Erdogmus; M. Leek, Mentors).
- Akiko Kusumoto, PhD Candidate, Oregon Graduate Institute, School of Science & Engineering, Oregon Health & Science University, Portland, OR (M. Leek).
- Kristin Vasil, PhD Candidate, University of Connecticut, Storrs, CT (M. Samantha Lewis, Mentor).
- Kelly Watts, AuD Candidate, Arizona State University, Tempe, AZ (D. Lilly; M. Samantha Lewis, Mentors)

Master's Graduate Students

- Kimberly Owens, MPH, Portland State University, Portland, OR (M. Leek, Mentor).
- Kelly Reavis, MS, MPH Candidate, Oregon Health & Science University, Portland, OR (D. Konrad-Martin; D. Austin; F. Gallun, Mentors).

Undergraduate Students

- Andrew McGuiness, Pre-medical Student Intern, Pacific Lutheran University, Tacoma, WA (M. Samantha Lewis, Mentor).
- Josh Triska, Electrical & Computer Engineering Student Intern, University of Portland, Portland, OR (P. Jacobs, Mentor).

Student Temporary Employee Program Students

- Xavier Reynolds, Research Student Intern (M. Samantha Lewis, Mentor).

NCRAR Staff

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- Bonnie Becker, *Special Assistant*, 100% Salaried VA.
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- Stephen Fausti, PhD, *Director*, 100% Salaried VA.
- Patrick Helt, MA, *Deputy Director/Admin & Technical Support*, 100% Salaried VA.
- Patricia Saub, *Budget Analyst*, 100% Salaried VA.
- Dennis Smith, MD, *Admin Advisor*, 0% Salaried VA-WOC (Independent Contractor).

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- Aynun Naher, *Research Assistant*, 69% Salaried VA.
- Keri O'Connell, AuD, *Research Audiologist*, 100% Salaried VA.
- Kimberly Owens, MPH, *Research Assistant*, 50% Salaried VA.

- Kelly Reavis, MS, MPH Candidate, *Research Audiologist*, 40% Salaried VA.
- Gabrielle Saunders, PhD, *Investigator*, 100% Salaried VA.
- ShienPei Silverman, MA, *Research Assistant*, 0% Salaried VA-WOC (NIH-funded).
- Dennis Trune, PhD, *Investigator*, 0% Salaried VA-WOC (IPA).
- Patrick Tsukuda, MA, *Research Assistant*, 100% Salaried VA.
- Mitchel Turbin, PhD, *Investigator*, 100% Salaried VA.
- Debbie Wilmington, PhD, *Investigator*, 63% Salaried VA.
- Tara Zaugg, AuD, *Research Audiologist*, 100% Salaried VA.

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- Craig Dennis, *Technical Application Coordinator*, 75% Salaried VA.
- Roger Ellingson, MSCSE, *Hardware/Software Engineer*, 0% Salaried VA-WOC (IPA).
- Joseph Istvan, PhD, *Biostatistician*, 0% Salaried VA-WOC (Independent Contractor).
- Peter Jacobs, MSEE, PhD Candidate, *Biomedical Engineer*, 63% Salaried VA.
- Kenneth James, PhD, *Biostatistician*, 0% Salaried VA-WOC (IPA).
- David Phillips, PhD, *Biostatistician*, 0% Salaried VA-WOC (Independent Contractor).
- Josh Triska, *Electrical & Computer Engineering Student Intern*, 100% Salaried VA.

Education and Information Dissemination Division

- Gabrielle Saunders, PhD, *Deputy Director/Education & Outreach*, 100% Salaried VA.
- Carolyn Landsverk, MS, *Education Program Specialist*, 100% Salaried VA.

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- Leonard P. Rybak, MD, PhD, Professor, Department of Surgery, Division of Otolaryngology, Southern Illinois University, School of Medicine, Member.

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- John W. Kendall, MD, Academic Affiliation Liaison, VISN 20, Professor, Department of Medicine and Dean Emeritus, Division of Endocrinology, Diabetes and Clinical Nutrition, Oregon Health & Science University, Member.
- Mark A. Richardson, MD, MScB, MBA, Dean, School of Medicine, Oregon Health & Science University, Member.
- James A. Tuchschmidt, MD, MM, Director, Portland VAMC, Member.

V. INFORMATION DISSEMINATION

The NCRAR serves as a national resource for hearing impaired veterans, their families, the community at large, and rehabilitation research and health care professionals. NCRAR rehabilitation researchers actively influence their fields by contributing to the integration of evidence-based research findings into clinical practice throughout the VA health care delivery system and the nation. In so doing, the NCRAR and its staff serve as VA ambassadors within their institutions and their professional organizations, effectively advancing the VA and the RR&D Service in the professional community and national consciousness. During 2007, the NCRAR effectively disseminated the following information:

Publications in the Journal of Rehabilitation Research and Development (JRR&D, n = 2)

Henry JA, Loovis C, Montero M, Kaelin C, Anselmi KA, Coombs R, Hensley J, James K. Randomized clinical trial: Group counseling based on Tinnitus Retraining Therapy. *J Rehabil Res Dev* 44(1):21-32, 2007.

Lew HL, Guillory SB, Jerger JF, Henry JA. Auditory dysfunction in traumatic brain injury and blast related injury. *J Rehabil Res Dev* 44(7):921-928, 2007.

Publications in Press, Under Review, or in Preparation for the JRR&D (n = 3)

Henry JA, Rheinsburg B, Owens KK, Ellingson RM. Tinnitus malingering. *J Rehabil Res Dev* (In preparation).

Henry JA, Rheinsburg B, Ellingson RM. Computer-automated tinnitus assessment: noise-band matching, maskability and residual inhibition. *J Rehabil Res Dev* (In preparation).

Lilly DJ, Hutter MM, Lewis MS, Levitt H, Kusumoto A, Fausti SA. Development of a sound-field system and materials for the measurement of speech intelligibility in multi-talker babble. *J Rehabil Res Dev* (In preparation).

Publications in Other Scientifically Peer-Reviewed Journals and Books (n = 19)

Best V, Gallun FJ, Carlile S, Shinn-Cunningham BG. Binaural interference and auditory grouping. *J Acoust Soc of Am* 121(2):1070-1076, 2007.

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Kim HH, Addison J, Suh E, Trune DR, Richter C-P. Otoprotective effects of dexamethasone in the management of pneumococcal meningitis: an animal study. Triologic Thesis, *Laryngoscope*, 117:1209-1215, 2007.

Lauer AM, Dooling R, Leek ML, Poling K. Detection and discrimination of simple and complex sounds by hearing-impaired Belgian Waterslager canaries. *J Acoust Soc Am* 122:3615-3627. 2007.

Levitt H. Historically, the paths of hearing aids and telephones have often intertwined. *The Hearing Journal* 60(11):20-24, 2007.

Meikle MB, Stewart BJ, Griest SE, Martin WH, Henry JA, Abrams HB, McArdle R, Newman CW, Sandridge SA. Assessment of tinnitus: Measurement of treatment outcomes. In: *Tinnitus: Pathophysiology and Treatment.* Ed. B Langguth, G Hajak, T Kleinjung, A Cacace, A Møller. *Progress in Brain Research* 166:511-521, 2007.

Saunders GH, Forsline A, Jacobs PG. Attitudes toward Loss of Hearing Questionnaire (ALHQ). A comparison of electronic and paper formats. *J Amer Acad Aud* 18(1):66-77, 2007.

Summers V, Makashay M, Leek ML, Molis MR. Effects of masker phase on tone detection as a measure of cochlear compression in normal-hearing and hearing-impaired listeners. *J Acoust Soc Am* 121:3197, 2007.

Trune DR, Kempton B, Harrison AR, Wobig JL. Glucocorticoid impact on cochlear function and systemic side effects in autoimmune C3.MRL-Faslpr and normal C3H/HeJ mice. *Hear Res*, 226:209-217, 2007.

Tufts JB, Molis MR. Perception of roughness by listeners with sensorineural hearing loss. *J Acoust Soc Am* 121(4):EL161-167, 2007.

Publications in Press, Under Review, or in Preparation for Other Scientific Peer-Reviewed Journals and Books (n = 26)

Dille MF, Konrad-Martin D, Henry JA, Phillips DS, Helt WJ, Gordon JS, Reavis KM, Bratt GW, Fausti SA. Rates of tinnitus expected from chemotherapeutic agents and ototoxic antibiotics: Results of a large prospective study. *J Amer Acad Aud* (In preparation).

Fausti SA, Wilmington DJ, Gallun FJ, Myers PJ, Henry JA. Auditory dysfunction associated with traumatic brain injury. Paper to be presented at the 2008 State of the Art Conference for Research to Improve the Lives of Veterans: Approaches to traumatic brain injury screening, treatment, management, and rehabilitation, and subsequently to be published in a special issue of a scientifically peer-reviewed journal yet to be named. (Under review).

Folmer RL. Hearing loss prevention practices should be taught in schools. *Semin Hear* (In press).

Gallun FJ, Durlach NI, Colburn HS, Shinn-Cunningham BG, Best V, Ihlefeld A, Mason CR, Kidd G. Jr. Binaural release from masking for a tone in noise and in multitone maskers. *J Acoust Soc Am* (Under review).

Gallun FJ, Souza P. Exploring the role of the modulation spectrum in phoneme recognition. *Ear Hear* (Under review).

Griest SE. Evaluation of a hearing-loss prevention program. *Semin Hear* (In press).

Henry JA. An independent review of Neuromonics Tinnitus Treatment. *Ear Hear* (In preparation).

Henry JA, Zaugg TL, Owens KK, Kaelin C., Schechter MA, Stewart BJ. Tinnitus-impact screening interview: Development and clinical application. *Am J Audiol* (Under review).

Konrad-Martin D, Dille MF, James K, Gordon JS, Reavis KM, Bratt GW, Fausti SA. Evaluation of audiometric threshold shift definitions for ototoxicity monitoring. *Ear Hear* (In preparation).

Konrad-Martin D, Jacobs P, Molis M, Gallun E, Leek M. Suppression of stimulus-frequency otoacoustic emissions: Effects of age and hearing loss. *J Acoust Soc Am* (In preparation).

Lauer AM, Molis MR, Leek MR. Discrimination of temporal fine structure by normal-hearing and hearing-impaired listeners. *J Acoust Soc Am* (In review).

Leek MR, Lentz JJ. Spread of masking by harmonic complexes in normal-hearing and hearing-impaired listeners. *J Acoust Soc Am* (In preparation).

Leek MR, Molis MR, Kubli LR, Tufts JB. Enjoyment of music by elderly hearing-impaired listeners. *J Amer Acad Aud* (In press).

Molis MR, Leek MR. Identification of ambiguous vowel stimuli by hearing-impaired listeners. *J Acoust Soc Am* (In preparation).

Molis MR, Leek MR. Synthetic vowel categorization by hearing-impaired listeners. *J Acoust Soc Am* (In preparation).

Myers PJ, Wilmington DJ, Gallun FJ, Henry JA. Hearing impairment and traumatic brain injury among soldiers: Special considerations for the audiologist. *Semin Hear* (In preparation).

Reavis KM, Phillips DS, Fausti SA, Gordon JS, Helt WJ, Wilmington DJ, Bratt GW, Konrad-Martin D. Factors affecting sensitivity of distortion-product otoacoustic emissions to ototoxic hearing loss. *Ear Hear* (In revision).

Saunders GH, Lewis MS. Sound localization, aging and hearing impairment. *International Journal of Audiology* (In revision).

Saunders GH, Griest S. Rationale for and development of a multimedia hearing loss prevention program for adults. *J Acad Rehabil Aud* (In preparation).

Summers V, Makashay M, Grassi E, Grant K, Bernstein J, Walden B, Leek ML, Molis MR. Toward an individual-specific model of impaired speech intelligibility. Chapter submitted to Dau et al. Auditory Signal Processing in Hearing-Impaired Listeners (In press).

Turbin M, Istvan J, Storzbach D. Partial hearing loss: Implications for psychological assessment, treatment, and research. *Professional Psychology: Research and Practice* (In preparation).

Van Tasell DJ, Levitt H, Gatehouse S. The international perspective. *International Journal of Audiology* (In press).

Wilmington DJ, Lewis MS, Myers PJ, Gallun FJ, Fausti SA. Hearing impairment in soldiers: Special consideration for amputees. In: *Care of the Combat Amputee*. B. Pasquina, R. Cooper, Eds. Borden Institute Textbooks of Military Medicine (In press).

Non-peer Reviewed Publications (n = 11)

Gallun FJ, Leek MR, Fausti SA. Auditory function and blast trauma. *NCRAR Newsletter* 7(4):1-3, 2007.

Henry JA. Roadmap to a cure: Measuring tinnitus perception. *Tinnitus Today* 32(2):8-21, 2007.

Henry JA, Myers PJ. Tinnitus rehabilitation through education. *NCRAR Newsletter* 7(2):1-3, 2007.

Henry JA, Schechter MA, Zaugg TL, Dennis KC. Lesson 8: Tinnitus. In *Veterans Health Initiative* (online VA Audiology tutorial) (In press).

Levitt H. A historical perspective on digital hearing aids: How digital technology has changed modern hearing aids. *Trends in Amplification* 11(1):7-24, 2007.

Levitt H. Digital hearing aids: From wheelbarrows to ear inserts. *ASHA Leader* December 2007.

Lewis MS, Wilmington DJ, Hutter MM, Lilly DJ, Bourdette DN, Fausti SA. Auditory function in individuals with Multiple Sclerosis. *MS Focus* (In press).

Lewis MS, Hutter MM, Oliver SR, Lisowski M. Tools to help with hearing. *Patient education materials*, Education Division, Portland VA Medical Center, 2007.

Saunders GH, Echt KV. An overview of dual sensory impairment in older adults: Perspectives for Rehabilitation. *Trends in Amplification* 11(4):243-258, 2007.

Simon HJ, Levitt H. Effect of dual sensory loss on auditory localization: Implications for intervention. *Trends in Amplification* 11(4):259-272, 2007.

Wilmington DJ, Konrad-Martin D, Gordon JS, Helt WJ, Fausti SA. Ototoxicity: Diagnosis and treatment. *NCRAR Newsletter* 7(3):1-3, July 2007.

Presentations at Scientific and Professional Conferences, Meetings, and Symposia (n = 58)

Best V, Gallun FJ, Carlile S, Shinn-Cunningham BG. Binaural interference and auditory grouping. Poster presented at the Association for Research in Otolaryngology's 30th Annual Midwinter Meeting in Denver, CO, February 2007.

Best V, Stupin L, Gallun FJ, Carlile S, Shinn-Cunningham BG. Sequential grouping influences binaural interference. Poster presented at the Association for Research in Otolaryngology's 30th Annual Midwinter Meeting in Denver, CO, February 2007.

Dent M, McClaine E, Shinn-Cunningham BG, Best V, Ozmeral E, Narayan R, Gallun FJ, Sen K. Spatial unmasking of birdsong by Budgerigars and Zebra Finches. Poster presented at the Association for Research in Otolaryngology's 30th Annual Midwinter Meeting in Denver, CO, February 12007.

Diedesch AC, Hoover EC, Watts KLV, Howell JY. Perspectives of four Au.D. students on the 2007 NIH Summer Traineeship Program at NCRAR. Poster presentation at the Biennial NCRAR International Conference: Hearing Therapies for the Future. Portland, OR, September 2007.

Fausti SA. Hearing impairment among soldiers. Presentation given at the Rehabilitation of the Combat Amputee Consensus Conference as part of a symposium to identify key areas of needed future research which will be published in a textbook of military medicine titled, *Combat Care of the Amputee,* Center for the Intrepid, Brooke Army Medical Center, San Antonio, TX, September 2007.

Fausti SA, Gallun FJ, Leek MR. VA service and compensation costs: Supporting "Readiness For Life". Invited lecture to 46th Annual Navy Occupational and Preventive Medicine Conference, Hampton, VA, March 2007.

Fausti SA, Saunders GH. National Center for Rehabilitative Auditory Research (NCRAR) and VA Audiology: Communication, Collaboration, Mentoring and Education. Paper presented at the 7th Annual Meeting of the Association of VA Audiologists, Denver, CO, April 2007.

Forsline A, Saunders GH. The Performance-Perceptual Test (PPT) as a counseling tool – An Update. Poster presented at the American Academy of Audiology Annual Convention, Denver, CO, April 2007.

Gallun FJ. Communication in complex environments: On the role of binaural release from informational masking. University of Washington, SPHSC Colloquium, Seattle, WA, March 2007.

Gallun FJ, Fausti SA, Leek M. Current directions in research at the NCRAR. Invited presentation to DoD Auditory Research Working Group, Groton, CT, August 2007.

Gallun FJ. Hearing loss and informational masking. Presentation at the Aging and Speech Conference, Indiana University, Bloomington, IN, October 2007.

Gallun FJ. On the limits of selective and divided auditory attention. Presentation at the 13th Annual Meeting of the Cognitive Science Association for Interdisciplinary Learning (CSAIL), Hood River, OR, August 2007.

Gallun FJ, Durlach NI, Colburn HS, Shinn-Cunningham BG, Best V, Ihlefeld A, Mason CR, Kidd G Jr. Binaural release from masking for a tone in noise and in multitone maskers. Poster presented at the Association for Research in Otolaryngology 30th Annual Midwinter Meeting in Denver, CO, February 2007.

Gallun FJ, Leek ML. Effects of blast trauma on the auditory system. Presentation to DoD Tri-Service Hearing Conservation Working Group meeting, Portland, OR, April 2007.

Gordon JS, Konrad-Martin D, Reavis KM, Wilmington D, Bratt G, Fausti SA. Comparing audiometric threshold shift definitions for ototoxicity detection. Talk presented at the Convention of the American Speech-Language-Hearing Association in Boston, MA, November 2007.

Hefeneider S, Trune D, MacArthur C, McCoy S. Characterization of a novel peptide that inhibits TLR-signaling and limits bacterial-induced inflammation. 8th World Congress on Inflammation, Copenhagen, Denmark, June 2007.

Henry JA. Best practices for TBI patients: Tinnitus. Invited presentation at the Association of Military Surgeons United States (AMSUS) 113th Annual Meeting, pre-conference workshop, Battlefield Injuries & Illnesses of the OIF/OEF Warrior, Salt Lake City, UT, November 2007.

Henry JA. Crash course in tinnitus management. Invited half-day training workshop presented at the Wisconsin Speech-Language Pathology and Audiology Professional Association 2007 Convention, Middleton, WI, February 2007.

Henry JA. Treating tinnitus: What do Audiologists need to know? Invited presentation at the Washington Society of Audiology Fall Meeting, Tukwila, WA, September 2007.

Henry JA. Using sound to manage your tinnitus. Invited presentation at special event sponsored by the American Tinnitus Association, Dallas, TX, October 2007.

Henry JA, Schechter MA, Myers PJ, Zaugg TL, Kaelin C, Owens K. Tinnitus research and education activities at the NCRAR. Poster presented at the 7th Annual Meeting of the Association of VA Audiologists, Denver, CO, April 2007.

Jacobs PG, Wan EA, Konrad-Martin D, Kagen D, Fausti SA. Correlating forward-masked SFOAE with blood glucose in diabetic subjects. Poster presented at the American Auditory Society Annual Meeting, Scottsdale, AZ, March 2007.

Konrad-Martin D, Phillips DS, Reavis KM, Gordon JS, Helt WJ, Bratt GW, Fausti SA. Evaluation of audiometric threshold shift definitions for ototoxicity monitoring. Poster presented at the American Auditory Society in Scottsdale, AZ, March 2007.

Konrad-Martin D, Reavis KM, Gordon JS, Helt WJ, Fausti SA. Relationship between ototoxic induced behavioral threshold changes and DPOAE changes. Podium presentation at the American Speech-Language and Hearing Association, Boston, MA, November 2007.

Leek ML. Audibility of envelope and fine structure. Invited presentation at Symposium on The Role of Temporal Fine Structure in Auditory Processing, Parmly Sensory Sciences Institute, Loyola University Chicago, IL, May 2007.

Leek ML, Saunders GH, Gallun FJ, Fausti SA. A unique approach to hearing loss prevention: Joint project between the VA and DoD. Presented to DoD Hearing Conservation Working Group meeting, Portland, OR, April 2007.

Lew HL, Guillory SB, Jerger JF, Henry JA. Tinnitus and hearing loss in traumatic brain injury and blast related injury. Poster presentation at the Biennial NCRAR International Conference: Hearing Therapies for the Future. Portland, OR, September 2007.

Lewis MS. Sensory aids 2007: What is hot and what is not. Discussion group topic facilitated at AudiologyNOW!, Annual Meeting of the American Academy of Audiology, Denver, CO, April 2007.

Lewis MS, Hutter M, Lilly DJ, Bourdette D, Fitzpatrick M, Fausti SA. Some effects of multiple sclerosis on the dichotic digits test. Poster presented at the American Auditory Society Annual Meeting, Scottsdale, AZ, March 2007.

Lilly DJ. Addressing selected aspects of hearing impairment with modern digital hearing aids. Invited presentation at special event sponsored by the American Tinnitus Association, Dallas, TX, October 2007.

Lilly DJ. The aging auditory system. Invited presentation to the 35th Annual Tri-State Hearing Convention, Seattle, WA, February 2007.

MacArthur CJ, Kempton B, DeGagne JM, Pillers DM, Trune DR. Bacteriology of chronic otitis media in C3H/HeJ mice. Association for Research in Otolaryngology 30th Midwinter Meeting, Denver, CO, February 2007.

MacArthur CJ, Kempton B, Trune DR. Glucocorticoid and mineralocorticoid suppression of acute otitis media in the mouse. 9th International Symposium on Recent Advances in Otitis Media, St. Petersburg Beach, FL, June 2007.

MacArthur CJ, Kempton B, Trune DR. Impact of various therapeutic steroids on C3H/HeJ mouse chronic otitis media. 9th International Symposium on Recent Advances in Otitis Media, St. Petersburg Beach, FL, June 2007.

Martin WH, Meinke DK, Madison TK, Griest SE, Howarth L, Sobel J. Dangerous Decibels: NIHL prevention for kids of all ages Part I. Abstracts of the AudiologyNOW! Annual Meeting of the American Academy of Audiology. Abs. SM301, p. 65, April, 2007.

Martin WH, Meinke DK, Madison TK, Griest SE, Howarth L, Sobel J. Dangerous Decibels: NIHL prevention for kids of all ages Part II. Abstracts of the AudiologyNOW! Annual Meeting of the American Academy of Audiology. Abs. SM302, p. 67, April, 2007.

McCoy S, Trune D, MacArthur C, Hefeneider S. A novel peptide inhibitor of middle ear inflammation in experimental otitis media. 9th International Symposium on Recent Advances in Otitis Media, St. Petersburg Beach, FL, June 2007.

Meikle MB, Henry JA, Griest SE, Stewart BJ. Perceptual components of tinnitus severity. Poster presented at the Association for Research in Otolaryngology 30th Annual Midwinter Meeting in Denver, CO. Abstr:156, February, 2007.

Melamed S, Chambers R, Allen J. Potential objective measures of tinnitus. Poster presented at the American Auditory Society Annual Meeting, Scottsdale, AZ, March 2007.

Nuttall AL, Omelchenko I, Trune DR, Pang J, Pillers D-AM, Shi X. Nitrite influence on cochlear cytokine expression and injury in the ear following noise exposure. 8th World Congress for Microcirculation, Milwaukee, WI, August 2007.

Nuttall AL, Omelchenko I, Trune DR, Pang J, Pillers D-AM, Shi X. Cochlear cytokine expression in the ear following noise exposure: the influence of nitrite treatment. Neuroscience Meeting, San Diego, CA, November 2007.

Pillers D-AM, Malmin B, den Dunnen JT, Trune DR, Pang J. Upregulation of retinal dystrophin Dp260 transcription by methylprednisolone is mediated by glucocorticoid receptor. Association for Research in Vision & Ophthalmology Annual Meeting, Fort Lauderdale, FL, May 2007.

Pillers DM, Kempton B, Malmin B, Trune DR. Abnormal cochlear dystrophin proteins in muscular dystrophy mice. Do they explain the cognitive defects seen in human duchenne muscular dystrophy? Association for Research in Otolaryngology 30th Midwinter Meeting, Denver, CO, 2007.

Pillers DM, Pang J, Trune DR, Shi X, Nuttall AF. Impact of noise exposure on inflammatory gene expression in the guinea pig and mouse cochleas. Association for Research in Otolaryngology 30th Midwinter Meeting, Denver, CO, February 2007.

Pillers DM, Pang J, Trune DR, Shi X, Nuttall AF. Impact of noise exposure on inflammatory gene expression in the guinea pig and mouse cochleas: Strategies for advancing brain barriers translational research, Thirteenth Annual Blood-Brain Barrier Consortium Meeting, Stevenson, WA, March 2007.

Saunders GH. Research overview. Invited presentation to students and faculty at San Diego State University, San Diego, CA, May 2007.

Saunders GH, Griest S. A multimedia hearing loss prevention program for adults. Paper presented at the Institute of the Academy of Rehabilitative Audiology, St. Louis, MO, October 2007.

Shi X, Trune DR, Nuttall AF. Characterization of cochlear pericytes and effects of loud sound on the expression of contractile proteins in guinea pig lateral wall. Association for Research in Otolaryngology 30th Midwinter Meeting, Denver, CO, February 2007.

Shi X, Trune DR, Nuttall AF. Characterization of cochlear pericytes and effects of loud sound on the expression of contractile proteins in guinea pig lateral wall: Strategies for advancing brain barriers translational research, Thirteenth Annual Blood-Brain Barrier Consortium Meeting, Stevenson, WA, March 2007.

Summers V, Makashay M, Grassi E, Grant K, Bernstein J, Walden B, Leek ML, Molis MR. Toward an individual-specific model of impaired speech intelligibility, presented at International Symposium on Audiological and Auditory Research, Helsinger, Denmark, August 2007.

Summers V, Makashay M, Leek ML, Molis MR. Effects of masker phase on tone detection as a measure of cochlear compression in normal-hearing and hearing-impaired listeners. Poster presented at 153rd meeting of the Acoustical Society of America, Salt Lake City, UT, June 2007.

Trune DR, Kempton B, DeGagne JM, Ghaheri B, Pillers DM, MacArthur CJ. Tissue remodeling cytokines in the middle and inner ear during acute and chronic otitis media. Association for Research in Otolaryngology 30th Midwinter Meeting, Denver, CO, February 2007.

Trune DR, Kempton B, DeGagne JM, Ren T. Breakdown of blood-labyrinth barrier by systemic autoimmune disease: Strategies for advancing brain barriers translational research, Thirteenth Annual Blood-Brain Barrier Consortium Meeting, Stevenson, WA, March 2007.

Trune DR, Kempton B. Mineralocorticoid treatment partially compensates for strial dysfunction in $Kit^{W}/Kit^{W\text{-}v}$ mutant mice. Association for Research in Otolaryngology 30th Midwinter Meeting, Denver, CO, February 2007.

Turbin M. Counseling hard of hearing adults: Issues, skills and resources. Seminar at the National Summer Institute in Rehabilitation Counseling for Deaf and Hard of Hearing Adults, Western Oregon University, Monmouth, OR, June 2007.

Turbin M, Abrams H, English K. Patient-centered audiology: Communication skills for communication sciences professionals. Poster presentation at the Biennial NCRAR International Conference: Hearing Therapies for the Future, Portland, OR, September 2007.

Zaugg TL. Update on research at the NCRAR. Invited podium presentation at the Veterans of Foreign Wars Conference, Kansas City, MO, August 2007.

Zaugg TL, Henry JA, Schechter MA, Myers PJ. Tinnitus and U.S. military veterans. Invited presentation presented to the DoD Hearing Conservation Working Group, NCRAR, Portland, OR, April 2007.

VI. PROFESSIONAL EDUCATION AND COMMUNITY OUTREACH

One of the NCRAR's primary objectives is to sponsor, support and actively participate in professional education and community outreach activities that encourage collaboration among clinicians and researchers in order to translate auditory research and development findings into

evidence-based practice to optimize auditory rehabilitation outcomes, and that inform the community about hearing loss prevention, hearing conservation, and available treatment options for hearing loss and tinnitus. The following activities are representative of the NCRAR's contributions to professional education and community outreach:

NCRAR Biennial International Conference

The NCRAR hosted its third biennial international conference entitled, 'Hearing Therapies for the Future' at the World Trade Center, Portland, OR, September 27–28th, 2007, which was attended by one hundred sixty-five individuals from 30 states, the UK, New Zealand and Germany. Peter Steyger, PhD, Associate Professor, Oregon Hearing Research Center, Oregon Health & Science University, and Col. David Chandler, PhD, Chief Consultant for Rehabilitation Services, Veterans Health Administration gave keynote addresses. On September 26th, the NCRAR also hosted seventy five people who attended a one-day pre-conference workshop entitled, 'Best Practices in Hearing Loss Prevention' at the VA Medical Center, Portland, OR.

Instructional Courses

While serving as the Associate Coordinator for ASHA's Special Interest Division 6: Hearing and Hearing Disorders: Research and Diagnostics, Dr. Konrad-Martin was involved with the planning and offering of an Instructional Course at the ASHA Convention in Boston, MA entitled, "Air Bone Gaps Due to Inner Ear Lesions". This cutting-edge research was presented by field leaders Chris Halpin, Saumil Merchant, and John Rosowski.

As an Individual Member Delegate for the National Hearing Conservation Association, Susan Griest was involved with the planning and offering of five (5) Instructional Courses entitled, "Tinnitus, the other consequence of noise." This was an occupational hearing conservation certification course presented at the Hearing and Speech Institute, Portland, OR in January, March, May, August, and November 2007.

NCRAR Clinical Research Seminar Series (open to clinicians, staff and researchers)

January 2007

Kelly Tremblay, PhD, Associate Professor, University of Washington, Seattle, WA. Hearing aids and the brain: What's the connection? January 19, 2007.

February 2007

Akiko Kusumoto, PhD Candidate, Center for Spoken Language Understanding, Oregon Graduate Institute School of Science & Engineering, Oregon Health & Science University, Portland, OR. Hybridizing conversational and clear speech to determine the degree of contribution of acoustic features to intelligibility. February 9, 2007.

Pamela Souza, PhD, Associate Professor, University of Washington, Seattle, WA. It's all in your ears: But is it the hearing aid or the hearing loss? February 16, 2007.

Mary Cord, AuD, Research Associate, Army Audiology & Speech Center, Walter Reed Army Medical Center, Washington, DC. Field evaluation of an asymmetric directional microphone fitting. February 26, 2007.

March 2007

Marilyn Dille, PhD, Audiologist, Virginia Mason Medical Center, Seattle, WA. The effects of intensity and attention on the P3 response. March 2, 2007.

William Martin, PhD, Professor, Oregon Health & Science University. Something fun from the realm of computational physics: Intracranial inhomogeneities as generators of far-field evoked potentials. AKA: When it comes to scalp-recorded potentials, what makes a bump? March 16, 2007.

Jeffrey Lichtenhan, PhD, Post-doctoral Fellow, University of Kansas Medical Center, Kansas City, KS. A discourse on the translation of a post-stimulus time histogram and single fiber action potential estimation technique developed in gerbil to human utility. March 30, 2007.

April 2007

Paula Myers, PhD, Chief, Audiology Section, James A. Haley VA Medical Center, Tampa, FL. Audiology and polytrauma at the VA. April 13, 2007.

May 2007

George Frye, MSEE, President, Frye Electronics Inc., Tigard, OR. Acoustic reflections: measurement and control. May 11, 2007.

Harvey Dillon, PhD, Director, National Acoustics Laboratory, Sydney, Australia. A potpourri of recent research at NAL. May 18, 2007.

June 2007

William Noble, PhD, Professor, University of New England, Armidale, New South Wales, Australia. Benefits of one versus two cochlear implants. June 13, 2007.

William Noble, PhD, Professor, University of New England, Armidale, New South Wales, Australia. Physiology and phenomenology of tinnitus. June 13, 2007.

July 2007

Christopher Stecker, PhD, Assistant Professor, University of Washington, Seattle, WA. Click-train simulation of cochlear implants: Binaural discrimination. July 13, 2007.

August 2007

Theresa Hnath Chisolm, PhD, Professor, University of South Florida, Tampa, FL. Understanding the role of systematic reviews in evidence-based practice. August 17, 2007.

October 2007

Arthur Boothroyd, PhD, Distinguished Professor Emeritus, City University of New York, New York, NY; Scholar in Residence, San Diego State University, San Diego, CA. Modeling the effects of noise in reverberation on phoneme recognition in the reverberant field. October 12, 2007.

November 2007

Beverley Wright, PhD, Associate Professor, Northwestern University, Evanston, IL. Hearing lessons: Perceptual learning on basic auditory skills. November 7, 2007.

December 2007

Brian Gygi, PhD, Research Scientist, VA Northern California Health Care System, Martinez, CA. Effect of auditory context on the identification of environmental sounds. December 14, 2007.

NCRAR Community Lectures (open to veterans and the public)

February 2007

James Henry, PhD. Medical myth or marvel? The effects of medication and alternative therapies on tinnitus. NCRAR Tinnitus Education Group, VA Medical Center, Portland, OR, February 6, 2007.

March 2007

Frederick Gallun, PhD. Exploring the role of modulation sensitivity in speech perception. Center for Spoken Language Understanding, Oregon Graduate Institute, Portland, OR, March 2007.

May 2007

James Henry, PhD. Treatment for tinnitus: What is the 'state of the art'? Invited presentation at the NCRAR Community Lecture, Portland VA Medical Center, May 2007.

Peter Jacobs, PhD Candidate. Noninvasive blood glucose monitoring using otoacoustic emissions. Presentation made to the Department of Computer Science & Electrical Engineering, Oregon Graduate Institute School of Science & Engineering, Oregon Health & Science University, Portland, OR, May 2007.

David Lilly, PhD. Addressing selected aspects of hearing impairment with modern digital hearing aids. Invited presentation for the NCRAR as part of the community outreach program. Portland VA Medical Center, May 2007.

July 2007

James Henry, PhD, Tara Zaugg, AuD, and Martin Schechter, PhD. Managing your tinnitus: What to do and how to do it. (Special Workshop - Part 1) NCRAR Tinnitus Education Group, VA Medical Center, Portland, OR, July 17, 2007.

James Henry, PhD, Tara Zaugg, AuD, and Martin Schechter, PhD. Managing Your Tinnitus: What to Do and How to Do it. (Special Workshop - Part 2) NCRAR Tinnitus Education Group, VA Medical Center, Portland, OR, July 31, 2007.

Gabrielle Saunders, PhD. Auditory rehabilitation: State of the art hearing aids and other factors. Presentation at Grand Rounds, Department of Otolaryngology, Oregon Health & Science University, Portland, OR, July 2007.

September 2007

Mitchel Turbin, PhD. Living well with hearing loss: Beyond hearing aids. NCRAR Community Lecture, VAMC Auditorium, Portland, OR, September 2007.

Tinnitus Education/Support Group Meetings

The NCRAR and Portland VAMC Audiology Clinic worked jointly to provide ongoing educational support group meetings for veterans with tinnitus. Seven meetings were conducted during 2007, and were facilitated by Drs. James Henry, Martin Schechter and Tara Zaugg. The purpose is to provide information that would be helpful to veterans in managing their tinnitus.

Expositions and Conventions

The NCRAR disseminated information on recent publications, upcoming conferences, and technology development to thousands of attendees at two large professional conventions, AudiologyNOW! 2007 – the American Academy of Audiology (AAA) Convention, April 18-21, 2007, in Denver, CO, and the American Speech-Language-Hearing Association (ASHA) Convention, November 15-17, 2007, in Boston, MA. The AudiologyNow! 2007 Convention had over 7,000 attendees, and the ASHA Convention had more than 13,000 attendees.

NCRAR Newsletter

The NCRAR produces and disseminates quarterly newsletters including publishing them

on the NCRAR's website. Each newsletter includes a scientific article written by an NCRAR rehabilitation researcher, as well as an update of NCRAR activities and upcoming events.

NCRAR Website

The NCRAR maintains a useful website (www.ncrar.research.va.gov), which serves as a valuable means of disseminating useful information to veterans, professionals (clinicians and research scientists) and the lay public. The website features a quarterly newsletter, a calendar of events, publications and presentations, staff bios, abstracts of funded research projects, professional links, employment opportunities, and information on NCRAR sponsored conferences and seminars.

Dangerous Decibels Exhibit

The "Dangerous Decibels" exhibit at the Oregon Museum of Science and Industry (OMSI) opened June 4, 2002. This interactive display, designed to educate both children and adults, is a collaborative effort involving the OMSI, Oregon Health & Science University – Oregon Hearing Research Center, American Tinnitus Association, and the NCRAR. The goal of the exhibit is to increase public awareness of noise-induced hearing loss and and tinnitus, and teach strategies to protect against hazardous noise exposure. The exhibit will remain on display at the OMSI until 2010.

Workshops

James Henry, PhD, Tara Zaugg, AuD, Martin Schechter, PhD. Tinnitus management: Clinical guidelines. Invited one-day training workshop for VA audiologists presented by Drs. Henry and Zaugg at the Oklahoma City VA Medical Center, Oklahoma City, OK, October 2007.

James Henry, PhD, Tara Zaugg, AuD, Martin Schechter, PhD. Tinnitus training program. Invited one-day training workshop for VA audiologists presented by Drs. Henry and Zaugg at the New York VA Medical Center, New York, NY, October 2007.

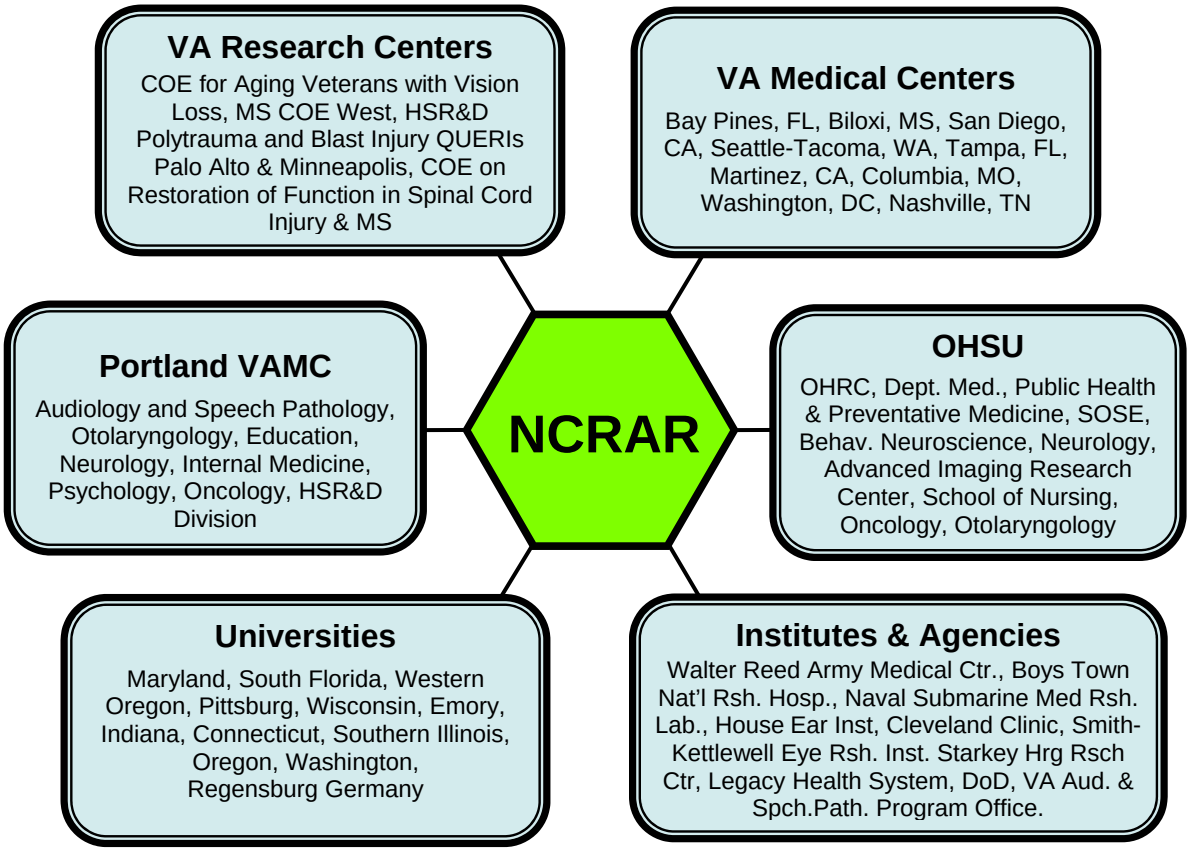
Mitchel Turbin, PhD. The living well with hearing loss workshop. Presentation to veterans, members of the local community, and research participants at the Portland VAMC, Portland OR, July 2007.

Theresa Schulz, PhD, Col. David Chandler, PhD, Kyle Dennis, PhD. Best practices in hearing loss prevention. One-day pre-conference workshop presented by Drs. Schulz, Chandler and Dennis at the Portland VAMC, Portland, OR, September 2007.

VII. RESEARCH COLLABORATIONS

The NCRAR continuously seeks establish and cultivate mutually beneficial collaborative partnerships with clinicians, rehabilitation researchers and educators in other federal agencies and institutions. Through collaborations and internal interactions of investigators, the NCRAR has created a research effort that is greater than the sum of its parts. Our research is multidisciplinary and includes audiology, psychology, neuroscience, neurology, otolaryngology and engineering, with cross-disciplinary resources available to each individual investigator. We are committed to expanding and fostering collaborative working relationships with individuals in the DoD, at other research centers, VA and non-VA medical centers, academic institutions, private industry organizations and non-profit foundations who subscribe to complementary rehabilitation research and development foci. The NCRAR has developed and cultivated active research collaborations with a multitude of agencies, institutions, laboratories and individuals as evidenced by the information that follows.

Collaborating Sites



- VA Centers of Excellence
  - Center for Aging Veterans with Vision Loss, Atlanta VAMC, Decatur, GA (Katharina Echt, PhD – Dual Sensory Impairment Rehabilitation)
  - Center of Excellence on Restoration of Function in Spinal Cord Injury and Multiple Sclerosis, West Haven, CT (Albert Lo, MD, PhD – Neural Plasticity; Stephen Waxman, MD – Neural Plasticity)
  - HSR&D Polytrauma and Blast-related Injuries QUERI, Palo Alto, CA (Henry Lew, MD, PhD – Blast Injury and Polytrauma Rehabilitation)
  - HSR&D Polytrauma and Blast-related Injuries QUERI, Minneapolis, MN (Nina Sayer, PhD, LP – Blast Injury and Polytrauma Rehabilitation)
  - HSR&D MS Center of Excellence – West, Seattle, WA/Portland, OR (Dennis Bourdette, MD – Multiple Sclerosis and Auditory Function)
- VA Medical Centers
  - Bay Pines VA Healthcare System, FL (Theresa Hnath Chisholm, PhD – Amplification, Aural Rehabilitation and Outcomes)
  - Biloxi VAMC, Biloxi, MS (Margaret Peak, PhD – Tinnitus Management)
  - James A. Haley VAMC, Tampa, FL (Paula Myers, PhD –Patient Education Materials and Tinnitus Management)
  - James H. Quillen VAMC, Mountain Home TN (Richard Wilson, PhD – Amplification and Aural Rehabilitation)

- Jesse Brown VAMC, Chicago, IL (Denis Moore, AuD – Tinnitus Management)
- Harry S. Truman Memorial Veterans' Hospital, Columbia, OH (Bonnie Wakefield, PhD, RN – Telemedicine)
- Nashville VAMC, Nashville, TN (Gene Bratt, PhD – Ototoxicity Management)
- Portland VAMC, Portland, OR (Mark Deffebach, MD – Pulmonary Oncology; Martin Schechter, PhD – Tinnitus Management; Daniel Storzbach, PhD – Neuropsychology and TBI)
- San Diego VAMC, San Diego, CA (Allen Ryan, PhD – Biochemical Mechanisms of Ototoxicity and Hair Cell Regeneration)

- Oregon Health & Science University
  - Advanced Imaging Research Center (William Rooney, PhD – Neuro-Imaging)
  - Department of Computer Science & Electrical Engineering, Center for Spoken Language Understanding, Oregon Graduate Institute School of Science & Engineering (Alexander Kain, PhD – Speech Processing Engineering; John-Paul Hosom, PhD – Speech Recognition and Intelligibility; Deniz Erdogmus, PhD – Speech Perception and Signal Processing; Jan van Santen, PhD – Speech Recognition and Synthesis; Eric Wan, PhD – Speech Perception and Signal Processing)
  - Department of Gynecologic Oncology (Tanya Pejovic, MD, PhD – Oncology and Medical Management of Drug Treatments)
  - Department of Neurology (Dennis Bourdette, MD – Neurology and Medical Management of Drug Treatments)
  - Department of Nursing (Barbara Stewart, PhD – Research Design and Methodology, and Statistical Analyses)
  - Oregon Cancer Institute (Grover Bagby, Jr., MD – Ototoxicity Management)
  - Oregon Hearing Research Center Tinnitus Clinic (William Martin, PhD – Noise and Hearing Loss Prevention and Tinnitus Management; Mary Meikle, PhD – Tinnitus Management; Baker Yong-bing Shi, MD, PhD – Pathophysiology, Treatment and Management of Tinnitus)
- University and Hospital Collaborators
  - Australian Catholic University, North Sydney, Australia (Peter Wilson, PhD – Cognitive-Behavioral Therapy for Tinnitus Management)
  - Emory University, Atlanta, GA (Pawel Jastreboff, PhD, ScD, MBA – Tinnitus Retraining Therapy, Katharina Echt, PhD – Dual Sensory Impairment)
  - Legacy Clinical Research and Technology Center, Legacy Health System, Portland, OR (W. Kenneth Ward, MD – Diabetes and Otoacoustic Emissions)
  - McMaster University, Ontario, Canada (Larry Roberts, PhD – Experimental Psychology and Tinnitus Management)
  - Oregon Research Institute, Eugene, OR (Judy Andrews, PhD – Ecological Momentary Assessment Methodology)
  - Southern Illinois University, School of Medicine, Department of Surgery, Division of Otolaryngology (Leonard Rybak, MD, PhD – Ototoxicity and Pharmacological Prevention of Hearing Loss)
  - Stanford University, Palo Alto, CA (Helena Kraemer, PhD – Quantitative Analyses)

- University of Connecticut, Storrs, CT (Frank Musiek, PhD – Central Auditory Processing; Jennifer Tufts, PhD – Speech Perception)
- University of Pittsburgh, PA (Kristina English, PhD – Aural Rehabilitation)
- University of Maryland, College Park, MD (Robert Dooling, PhD – Psychoacoustics; Amanda Lauer, MA – Psychoacoustics)
- University of Oregon, Eugene, OR (Terry Takahashi, PhD – Sound Localization and Central Auditory Processing)
- University of Regensburg, Regensburg, Germany (Otto Gleich, PhD – Auditory Physiology)
- University of South Florida, Tampa Bay, FL (Theresa Chisolm, PhD – Aural Rehabilitation)
- University of Washington, Seattle, WA (Pamela Souza, PhD – Hearing Aids and Speech Perception; Kelly Tremblay, PhD – Electrophysiology and Plasticity of the Central Auditory System; Dennis Turk, PhD – Anesthesiology and Pain Management)

- Institutes and Agencies
  - Advanced Hearing Concepts, Bodega Bay, CA (Harry Levitt, PhD – Psychoacoustics and Research Design Methodology)
  - Army Audiology and Speech Center, Walter Reed Army Medical Center, Washington, DC (Brian Walden, PhD – Amplification and Aural Rehabilitation; Therese Walden, AuD – Amplification and Aural Rehabilitation; Kenneth Grant, PhD – Auditory-Visual Speech Perception; W. Van Summers, PhD – Psychoacoustics and Speech Perception)
  - Cleveland Clinic Foundation, Cleveland, OH (Craig Newman, PhD – Tinnitus Management; Sharon Sandridge, PhD – Electrophysiologic Assessment of Hearing)
  - Department of the Army, Office of the Surgeon General, Fallschurch, VA (LTC Kathy Gates, MS – Noise and Hearing Loss Prevention)
  - Madigan Army Hospital, Ft. Lewis Military Reservation, Tacoma, WA (CPT Elizabeth Cornish – Noise and Hearing Loss Prevention)
  - Oticon Foundation, Copenhagen, Denmark (not-for-profit funding agency)
  - U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, MD (Douglas Ohlin, PhD – Noise and Hearing Loss Prevention)
  - Womack Army Medical Center, Ft. Bragg, NC (LTC Vicki Tuten, AuD – Noise and Hearing Loss Prevention)

VIII. SERVICE TO VA AND PROFESSIONAL ORGANIZATIONS

The NCRAR encourages its staff to remain active within their respective professional organizations and to serve the VA and the community through participation in clinical presentations, community seminars, support groups, grand rounds and other medical practice forums. NCRAR rehabilitation researchers also serve on numerous VA editorial and scientific merit review boards, advisory committees and task forces, as well as a plethora of professional advisory and review committees, editorial review boards, special study sections, and task forces. The following are representative of how the NCRAR staff served the VA and professional organizations during 2007:

- Ad hoc Member, Grant Review Committee, Human Frontier Science Program (F. Gallun).
- Ad hoc Reviewer, *Aging Health* (J. Henry).
- Ad hoc Reviewer, *American Journal of Audiology* (MS. Lewis).
- Ad hoc Reviewer, *Annals of Otology, Rhinology & Laryngology* (J. Henry).
- Ad hoc Reviewers, *Ear and Hearing* (J. Henry; D. Konrad-Martin; M. Molis; G. Saunders).
- Ad hoc Reviewers, *International Journal of Audiology* (J. Henry; G. Saunders).
- Ad hoc Reviewers, *Journal of the Acoustical Society of America* (F. Gallun; D. Konrad-Martin).
- Ad hoc Reviewer, *Journal of the American Academy of Audiology* (M. S. Lewis).
- Ad hoc Reviewers, *Journal of Rehabilitation Research and Development* (M. Samantha Lewis; G. Saunders).
- Ad hoc Reviewers, *Journal of Speech Language and Hearing Research* (J. Henry; G. Saunders).
- Ad hoc Reviewer, *Perception & Psychophysics* (F. Gallun).
- Ad Hoc Reviewer, *Psychological Review* (F. Gallun).
- Alternate Member, Research and Development Committee, Portland VA Medical Center (J. Henry).
- Associate Coordinator, Special Interest Division 6: Hearing and Hearing Disorders: Research and Diagnostics, American Speech-Language-Hearing Association (D. Konrad-Martin).
- Assistant Editor, *Journal of the American Academy of Audiology* (G. Saunders).
- Assistant Editor, Proceedings of Meetings in Acoustics (F. Gallun).
- Associate Editor, *Journal of the American Academy of Audiology* (J. Henry).
- Chair, Academy of Rehabilitative Audiology Institute, Portland, OR (G. Saunders).
- Chair, Principal Investigator Committee, NCRAR (G. Saunders).
- Chair, Space Committee, NCRAR (M. Leek).
- Chair, School of Medicine, Department of Neurology, OHSU (D. Bourdette).
- Co-Director/Associate Director, Department of Veterans Affairs MS Center of Excellence-West (D. Bourdette).
- Conference Chair, NCRAR 2007 Biennial International Conference: Hearing Therapies for the Future, World Trade Center, Portland, OR (G. Saunders).
- Deputy Director, Administration & Technical Support, NCRAR (P. Helt)
- Deputy Director, Education, Training & Outreach, NCRAR (G. Saunders)
- Deputy Director, Research, NCRAR (M. Leek)
- Director, OHSU MS Center of Oregon (D. Bourdette).
- Editor & Producer, NCRAR Newsletter (G. Saunders).
- Evaluation Consultant, Oregon Health & Science University and Body Worlds Evaluation Committee (S. Griest).

- Executive Council, Individual Member Delegate, National Hearing Conservation Association (S. Griest).
- Guest Editor, *Seminars in Hearing* (R. Folmer)
- Invited Reviewer, Health Services Research and Development Merit Review Board (G. Saunders).
- Invited Reviewer, Royal National Institute for the Deaf, Research Grants, London, UK (G. Saunders).
- Member, Advisory Committee, Ninth International Tinnitus Seminar, Goteborg, Sweden (J. Henry).
- Member, Data Safety Monitoring Board (M. Leek).
- Member, DoD Hearing Conservation Workgroup (S. Fausti).
- Member, Editorial Board, *Ear and Hearing* (D. Lilly)
- Member, Editorial Board, *International Journal of Audiology* (D. Lilly)
- Members, Editorial Board, *Journal of the American Academy of Audiology* (M.S. Lewis; D. Lilly).
- Member, Editorial Board, *Journal of Rehabilitation Research and Development* (S. Fausti).
- Member, Editorial Board, *Journal of Speech and Hearing Research* (D. Lilly)
- Member, Editorial Board, *Transactions on Neural Systems & Rehabilitation Engineering* (M. Leek).
- Member, IRB Committee, Portland VAMC (J. Henry).
- Member, Medical Advisory Board of the National Multiple Sclerosis Society (D. Bourdette).
- Member, Planning Committee, Audiology NOW! 2007 Conference of the American Academy of Audiology (M. Samantha Lewis).
- Member, Planning Committee, State of the Art (SOTA) Conference on TBI (S. Fausti).
- Member, Scientific Advisory Committee, American Tinnitus Association (J. Henry).
- Member, Scientific Advisory Council, United Cerebral Palsy Research Foundation (S. Fausti).
- Member, Small Grants (R03) Review Panel, NIH, NIDCD (M. Leek).
- Member, Task Force, National Hearing Conservation Association: Hearing Conservation in the Public Schools (S. Griest).
- Member, VA Audiology and Speech Pathology Program Office, National Research Professional Standards Board (S. Fausti).
- Member, Working Group on Effective Interventions for Infants and Young Children with Hearing Loss, Office on Disabilities at the Department of Health and Human Services (S. Fausti).
- Members, Executive Committee, NCRAR (S. Fausti; D. Smith; G. Saunders; M. Leek; J. Henry; P. Helt; J. Gordon).
- Members, Research & Development Committee, Portland VAMC (G. Saunders; M. Leek).

- Members, Website Steering Committee, NCRAR (G. Saunders, D. Smith; P. Helt; C. Landsverk; A. Forsline; C. Kaelin; P. Jacobs).
- Organizer, NCRAR Clinical Research Seminar Series (G. Saunders).
- Organizer, NCRAR Community Lecture Series including V-Tel broadcasts and DVD distribution (G. Saunders).
- Organizer, NIH AuD Summer Research Training Grant Program Implementation, NCRAR (M. Leek).
- Organizer & Moderator, NCRAR/Portland VAMC Clinical Audiology Program Tinnitus Support Group (J. Henry).
- Organizer & Moderator, Scientific Advisory Board Meeting, Oticon Foundation (M. Leek).
- Panel Member, NIH (NIDCD) R03 Grants (M. Leek).
- President, Academy of Rehabilitative Audiology (G. Saunders).
- Program Chair, Audiology NOW! 2009 Conference of the American Academy of Audiology (M. Samantha Lewis).
- Program Chair, National Hearing Conservation Association 2008 Conference (S. Griest).
- Scientific Program Committee Chair & Moderator, NCRAR 2007 Biennial International Conference: Hearing Therapies for the Future, World Trade Center, Portland, OR (D. Konrad-Martin).
- Special Emphasis Program Manager for People with Disabilities, Equal Employment Opportunities Program, Portland VAMC (M. Turbin).

IX. TRANSLATIONAL RESEARCH ACHIEVEMENTS/IMPACTS

The NCRAR's multidisciplinary staff of clinicians, educators, rehabilitation researchers, and rehabilitation engineers focus their efforts on applied clinical research, auditory rehabilitation, and the development of useful strategies and technologies that are useful in the assessment and treatment of various facets of auditory function and dysfunction. We strive to combine evidence-based research findings with emerging technologies to optimize the effectiveness and efficiency of hearing health care delivery including the use of computer-automation and telemedicine principles. This focus has advanced the discovery of new knowledge about hearing impairments, which is directly influencing the field and contributing toward establishing standards of clinical practice while optimizing the aural rehabilitation of veterans with hearing disabilities. The following are representative of translational research achievements and impacts from the NCRAR:

Analyses of DPOAE: Analyses of distortion-product otoacoustic emissions (DPOAEs) have been completed that support our 2007 goal to develop hearing loss prevention programs and practices. DPOAEs were shown to be a useful screening tool for ototoxicity in adults with pre-exposure hearing loss, but are less sensitive compared with a behavioral test method that targets thresholds near the upper limit of a subject's audible frequency range. Ears successfully monitored for ototoxicity with DPOAEs are those with greater post-exposure hearing changes, better pre-exposure hearing, and baseline DPOAEs that overlap the highest behavioral test frequencies and are present at high f_2's. Results suggest that successful monitoring of ototoxicity with DPOAEs may be predicted clinically by assessing the measurable DPOAE f_2 frequency range and its relation to the highest behavioral test frequencies. Results were presented at the 2007 ASHA

Convention (Konrad-Martin et al., 2007) and are the basis of a manuscript under review for publication in *Ear and Hearing* (Reavis et al, 2008).

AnalyzeOAE Software: NCRAR rehabilitation engineer staff continued the development of a software application called AnalyzeOAE written in Matlab. The program performs signal processing and feature extraction including amplitude, latency, and signal-to-noise (SNR) metrics for analyzing OAE waveforms collected using NCRAR's OAE measurement system. The software has been vital to a number of research projects being conducted at NCRAR (Dr. Konrad-Martin), as well as to the acquisition of pilot data for future studies (Wan/Jacobs). We developed one new useful feature for the AnalyzeOAE Software in 2007. The new feature is a curve-fitting tool that can be used to fit suppressed OAE growth curves to determine auditory compression metrics in test subjects. Dr. Konrad-Martin is currently using this tool in her auditory research studies.

AudioTest Software Suite: NCRAR rehabilitation engineers and researchers continued the development of the AudioTest Software Suite by adding several new useful features, and filed an Invention Disclosure with the VA and OHSU Technology Transfer Offices in August 2007. AudioTest Software Suite is a custom software application developed in Visual C#/C++, and designed to enable researchers to develop their own sound localization and questionnaire tests involving complex calibrated audio stimuli. The first new feature added to AudioTest during 2007 was an AudioTest Otoacoustic Emissions (OAE) Test Module. The AudioTest OAE Test Module is a state-of-the-art OAE test recording platform that provides precision accuracy over audio signals presented to and recorded from within the ear canal during otoacoustic emission testing. The system previously used at the NCRAR was developed by a third-party research group and had only two output channels and one input recording channel. The new AudioTest OAE Test Module has an unlimited number of input/output channels (limited only by the number of sound cards on the computer). Also, the previous OAE test system only provided control over ipsilateral sounds, while the new OAE Test module provides precise control of both ipsilateral and contralateral sound presentations and recordings. The new OAE Test Module will be used extensively by NCRAR investigators studying OAEs, and potentially be made available to other auditory researchers around the country.

The second new feature added in 2007 was a Subjective Calibration routine. The Subjective Calibration feature enables research investigators to calibrate audio signals presented during a psychoacoustic or OAE test that are calibrated to a test subject's individual hearing preferences. For example, two subjects (A and B) would each have a different preference for a "comfortable listening level". The new Subjective Calibration feature provides a means for subjects to select this level and have it present during all subsequent psychoacoustic or OAE tests.

The third new feature developed was a Spectral Calibration feature. This new feature allows a research investigator to calibrate audio signals to 1/3 octave band filtered frequencies. Previously, the AudioTest calibration scheme only enabled broadband calibration. The new calibration method allows research investigators to choose either a broadband calibration method or one of 35 1/3 octave filtered bands. This new feature required programming and serial interface with a B&K 2260 sound level meter.

The fourth new feature added is a method for recording Tympanometry signals from a test subject's ear. A tympanometer is a device that may be used to test middle ear reflexes, and the new feature enables automated control of a GSI Tympstar tympanometer and the exportation of digital waveform data to an Excel spreadsheet, which was previously not possible.

The fifth addition during 2007 involved the expansion and acceleration of our data export feature. Research investigators may export their test results to either a text file or a Microsoft Excel workbook. This year we added a new feature that provides two different formats for exporting the data. Previously, data could only be exported such that each row of exported data represented test data from a given trial. We are now able to export data to Excel worksheets such that each worksheet represents a given trial. This is a more intuitive way for investigators to view their results. Furthermore, export speed was increased by a factor of 2.

The final new addition to the AudioTest Software Suite is a feature that determines the early (word initial) input needed for correct recognition of single words, and for high confidence in the word recognition task. Single words digitized from a prerecorded word list (List 1, Form A of the Northwestern Auditory Test No 6 or NU-6, Auditec of St. Louis) are presented in blocks of 12 to 50 ms increments from the word onset following the "time-gated" word task first reported by Grojan, 1980. A future adaptation of this test will be to present multiple time-gated words in a series in order to increase working memory load. Thus, an identical set of words selected from a standard word recognition list will assess: 1) word recognition performance; 2) perceptual encoding speed; and 3) working memory in patients with diminished speech understanding ability.

Evidence-based Methods of Tinnitus Treatment: Three randomized clinical trials to evaluate methods of tinnitus treatment have been completed. VA audiologists have been trained to conduct the treatment methods being studied in these trials. As a result of receiving the training, these audiologists are able to directly apply their skills to veteran patients. Sites directly affected include the Puget Sound VA Healthcare System, Portland VAMC, Bay Pines VAMC, and San Diego VAMC. A fourth randomized clinical trial is underway at the James A. Haley (Tampa) VAMC. New tinnitus treatment methodology is being evaluated at that site, which directly impacts veterans suffering from tinnitus in that catchment area.

Additionally, two inventions are currently undergoing disclosure through the VA and OHSU. First, an 80-page tinnitus education workbook was completed ("How to Manage Your Tinnitus: A Step-by-Step Workbook"). Second, an 18-module online professional tinnitus training course has been developed. In addition to Dr. Henry, project developers include Paula Myers, PhD, Tara Zaugg, AuD, and Martin Schechter, PhD. Commercial opportunities include audiology clinics and hospitals worldwide.

Evidence-based Practices for Ototoxicity Early Identification and Monitoring: Techniques borrowed from clinical decision theory were used to provide data to support evidence-based practices for ototoxicity monitoring. The ability to detect cisplatin-induced hearing changes using serial audiometric threshold testing near each patient's high frequency hearing limit was evaluated in the context of test-retest variability for a control group of unexposed, hospitalized patients using Receiver-operator characteristic (ROC) curves. Test performance was compared for various definitions for a significant threshold shift (STS), including ASHA-recommended STS definitions. Results indicate that a pure-tone threshold monitoring protocol that uses an individualized, one octave range of frequencies tested in $1/6^{th}$-octave steps is a clinically effective protocol for detecting early ototoxic changes with an acceptable false positive rate. ASHA recommended threshold-shift criteria generally performed well. In general, using smaller frequency step sizes increases false positives only slightly, while increasing sensitivity significantly. Results were presented at the 2007 ASHA Convention (Konrad-Martin et al., 2007) and a manuscripts based on these data is in preparation.

Lipoic Acid Therapy for the Prevention of Cisplatin Ototoxicity: We are optimistic that this interventional study will link the successful use of otoprotectants in animals to the development of clinical protocols in patients receiving ototoxic medications. Currently, the progress of basic science research for prevention of sensorineural hearing loss in animals has exceeded the ability to bring antioxidant supplementation and other preventive regimens into clinical practice. The implementation of a non-prescriptive, safe and inexpensive antioxidant supplement to prevent the progression of cisplatin-induced hearing loss into the frequencies critical for speech communication will improve treatment options for patients and preserve the quality of life following chemotherapy.

Methods and Devices for Non-invasive Analyte Measurement: Patent filed in April 2007, Inventors: Peter Jacobs, MSEE, Dawn Konrad-Martin, PhD, Eric Wan, PhD.

Multimedia program – Hearing Loss Prevention Program (HLPP): A multimedia Hearing Loss Prevention Program has been developed that aims to prevent hearing loss among the veteran population. It aims to educate individuals about hearing loss and noise damage with the goal of changing knowledge, attitudes and intended behaviors towards use of hearing protection in occupational and recreational settings. The target audience is veterans and other older individuals who may not be aware of hearing conservation and who do not necessarily realize the impact that recreational and leisure noise can have upon hearing ability, tinnitus and the resultant quality of life. In particular, we want to inform users of the cumulative nature of noise damage. The program is designed based upon theoretical principles laid out in the Health Belief Model and the Health Promotion Model. The educational section of the program takes less than 20 minutes in order that it is practical for use in a hospital waiting area. The program is modular in design so that users can select components in which they are specifically interested. It is self-administered, low maintenance and does not require upkeep from a professional. The presentation level is adjustable, the content is clearly visible and the reading level of the content is between Grade 5 and 8. The program consists of a looping opening video to attract user's attention, a set of screens to ensure headphones are placed on the correct ears, and that the signals are at a comfortable listening level, six educational modules and a hearing screening module. Module 1 is a video called "How to Protect your Hearing'. It gives an overview of hearing protection and is intended to cover all the basic issues, so that if an individual stops using the program after this first module, he or she would have heard the key facts about hearing protection. Module 2 is called 'Which Protection is right for you?' It consists of interactive computer screens accessed via a touch screen monitor and two short videos. The interactive screens provides information about different types of hearing protectors, and what each type is most suited to. The videos teach the user how to insert/fit the protectors. Module 3, 'When to Protect Your Hearing' is a video that teaches the user about typical sound levels in the environment. Module 4 is named 'How Loud is too Loud?', it is an interactive module in which the user selects specific listening situations, is shown their typical sound levels, safe exposure times, and the appropriate type of hearing protection to use around those sounds. Module 5 is a video titled 'Why Protect your Hearing?' It addresses some of the negative impacts of hearing loss on quality of life and interpersonal interactions. Module 6 is a multifaceted module known as 'What Happens when you Hear?' It provides information about the anatomy and physiology of a healthy, and noise-damaged, auditory system via animated clips developed by ASHA; an interactive section provides an introduction to the physics of sound and it includes a glossary of terms used throughout the program. Finally, in Module 7 users can screen their hearing. The administrator can select the frequencies to be screened, the testing step-size and the testing algorithm.

Formative and summative evaluations o the program will be conducted with funding that is yet to be obtained.

Non-invasive Glucose Monitor Using Otoacoustic Emissions: NCRAR engineering staff continued development of a means to use amplitude and latency measures of ipsilaterally and contralaterally suppressed OAEs to predict blood glucose levels in diabetic patients. A final patent was submitted March 2007. Additional diabetic patient studies were completed September 2006 – February 2007 to verify the functionality of the method. An NIH-R21 proposal was re-submitted in March 2007, and received approval of funding for January 2008 – December 2010. Preliminary results were presented at the American Auditory Society Annual Meeting in Scottsdale, AZ in March 2007 as a part of a mentored student scholarship award program. This work was completed in collaboration with the Department of Computer Science and Electrical Engineering, Oregon Graduate Institute, Oregon Health & Science University.

Ototoxicity Identification (OtoID) Device: NCRAR rehabilitation researchers and engineers have combined pure digital audio technology with pocket PC technology to create a portable, handheld device that enables individualized ototoxicity early identification with a high degree of efficiency, reliability, sensitivity, and specificity (VA asserted ownership rights January 2004). We are currently seeking approval of funding for a continuation proposal that will enable us to enhance and refine the OtoID technology while integrating its component functions into a single, portable system with an optimally automated software program, simplified user interface, and secure data transfer capability.

Performance-Perceptual Test (PPT): The PPT was developed to be a clinical test for comparing actual versus perceived speech perception in noise. To date, data have shown that the difference between perceived and actual ability to understand speech in noise (the PPDIS) is correlated with hearing aid satisfaction. An ongoing study is being conducted to determine whether counseling can bring the PPDIS closer to zero and if so whether this results in better hearing aid outcome. If so, the PPT would prove to be a valuable addition to a clinical counseling tool.

Sound Localization Hardware / Software System: NCRAR engineering staff continued to support and develop better audiometric hardware / software systems within the anechoic chamber for purposes of doing sound localization. This past year, we began a project to develop an inverse filtering algorithm to improve speaker calibration methods in the anechoic chamber. The project involved characterizing the impulse response of a speaker and then applying the inverse of this impulse response to audio presented through the speaker, thereby negating any distortion effects caused by the speaker. Completion of this project is expected in summer of 2008.

X. SUMMARY

The NCRAR is a leader in rehabilitative auditory research and development, having gained national recognition for its advancements in auditory rehabilitation research and development, its contributions to professional education, and its mentoring and training of the next generation of clinicians and auditory rehabilitation researchers. The NCRAR is a comprehensive CoE that includes the infrastructure, resources and multidisciplinary investigative staff to serve as a national resource consistent with VA's Hearing Impairment Rehabilitation priority area. The research and development synergy created by this consortium of broad scope professionals, including both basic and clinical research components, brings diverse perspectives and cutting-edge solutions to common auditory problems. Support of this Center by the VA RR&D Service allows the further development and expansion of the NCRAR's unique research and development contributions to the VA RR&D CoE portfolio, and to the nation, by fostering the integration of research findings into clinical practice. The Center is ideally positioned to expand

its role while maintaining its clear research focus on auditory rehabilitation. The work of the NCRAR and its collaborators to improve treatment options, rehabilitation strategies and hearing loss prevention is essential to optimize hearing health care and quality of life for hearing impaired veterans.