SPECIAL COMMUNICATION

# Workshop on Personal Motion Technologies for Healthy Independent Living: Executive Summary

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ABSTRACT. Rodgers MM, Cohen ZA, Joseph L, Rossi W, for the Workshop on Personal Motion Technologies for Healthy Independent Living Presenters. Workshop on personal motion technologies for healthy independent living: executive summary. Arch Phys Med Rehabil 2012;93:935-9.

The objective of the June 2010 "Workshop on Personal Motions Technologies for Healthy Independent Living" was to discuss personal motion technologies that might enable older adults and individuals with disability to live independently for longer periods. The 60 participants included clinicians, academic researchers, engineers, patient advocates, caregivers, members of the public, and federal representatives. The workshop was divided into 6 sessions that addressed the following: (1) use of technologies in identifying early indicators of disease or adverse events; (2) monitoring daily activities; (3) coping with impairment; (4) managing mild cognitive impairment; (5) rehabilitation and exercise in the home; and (6) caregiver support. Presentations and discussion focused on clinical needs, the health impact of addressing those needs, state-of-the-art technologies, and challenges to adoption of those technologies. Conclusions included the following: (1) Involvement of end-users in research and development will increase the likelihood that technologies will be adopted. (2) Integration of differing types of technology into a system that includes clinical measures is required for independent living. (3) Seniors are willing to sacrifice some privacy for an effective technology that keeps them in their homes as long as they control who receives their data. (4) Multilevel and multiscale models are needed to understand motion in the context of the environment and to design effective systems.

**Key Words:** Caregivers; Independent Living; Motion; Rehabilitation; Remote Sensing Technology; Technology.



AS INDIVIDUALS AGE, their physical and cognitive capacity is often diminished, hindering their ability to live independently and often necessitating moves to assisted living facilities or skilled nursing homes. At present, there are no good methods for monitoring and identifying problems for these individuals other than personal or caregiver reports. The hope is that collaboration between the engineering and clinical worlds could yield new approaches to allow older adults and individuals with disability to live independently for a longer period. There is also a role for behavioral science in identifying how these approaches can be used most effectively and easily in a targeted population, thus increasing their chances of adoption. The National Institute on Aging (NIA) and the National Institute of Biomedical Imaging and Bioengineering (NIBIB) have long been interested in these types of collaborations.

On June 23–24, 2010, the NIA and NIBIB held a workshop to discuss technologies that might enable older adults to live independently longer. The workshop brought together 60 clinicians, academic researchers, engineers, patient advocates, caregivers, members of the public, National Institutes of Health (NIH) staff, and representatives from the Centers for Medicare and Medicaid Services (CMS), the Food and Drug Administration (FDA), the National Science Foundation (NSF), and the

**List of Abbreviations**

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| CMS | Centers for Medicare and Medicaid Services |
| FDA | Food and Drug Administration |
| MCI | mild cognitive impairment |
| NIA | National Institute on Aging |
| NIBIB | National Institute of Biomedical Imaging and Bioengineering |
| NIDRR | National Institute of Disability and Rehabilitation Research |
| NIH | National Institutes of Health |
| NSF | National Science Foundation |
| VA | United States Department of Veterans Affairs |

From the National Institute of Biomedical Imaging and Bioengineering, Bethesda, MD (Rodgers, Cohen); and the National Institute on Aging, Bethesda, MD (Joseph, Rossi).

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The views expressed in this document reflect both individual and collective opinions of the workshop participants and not necessarily those of the National Institutes of Health, or the U.S. Department of Health and Human Services.

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The Workshop on Personal Motion Technologies for Healthy Independent Living Presenters include the following: Majd Alwan, PhD, LeadingAge Center for Aging Services Technologies; Ruzena Bajcsy, PhD, University of California, Berkeley; Paolo Bonato, PhD, Harvard Medical School and Harvard-MIT Division of Health Sciences and Technology; Kathy Brill, MEd, MPS, National Advisory Board on Improving Health Care Services for Seniors and People with Disabilities; Nancy Cullen, MBA, Alzheimer's Association; Desmond Fitzgerald, MD, University College Dublin; Thomas Gill, MD, Yale University; Gregory J. Hanson, MD, Mayo Clinic; Emil Jovanov, PhD, University of Alabama in Huntsville; Jeffrey Kaye, MD, Oregon Health and Science University; Tonya Miller, PT, DPT, COS-C, Celtic Healthcare; Jim Osborn, MS, Carnegie Mellon University; Terrance O'Shea, PhD, Intel Corp; Kenneth Ottenbacher, PhD, OTR, University of Texas Medical Branch, Galveston; Chris Otto, MS, Halo Monitoring, Inc; Joseph Paradiso, PhD, Massachusetts Institute of Technology; Misha Pavel, PhD, National Science Foundation; Jon Pynoos, PhD, University of Southern California; Marilyn J. Rantz, PhD, RN, University of Missouri; Joan C. Rogers, PhD, University of Pittsburgh; Maureen Schmitter-Edgecombe, PhD, Washington State University; Richard Schulz, PhD, University of Pittsburgh; Marjorie Skubic, PhD, University of Missouri, Columbia; George A. Taler, MD, Washington Hospital Center; Bo Xie, PhD, University of Maryland.

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United States Department of Veterans Affairs (VA). The workshop was videocast live to 80 viewers on June 23 and 40 viewers on June 24. (The videocast is archived at http://videocast.nih.gov/Summary.asp?File=15989 [day 1] and http://videocast.nih.gov/Summary.asp?File=15992 [day 2], and includes a link to the NIBIB website with the final agenda, list of participants, and speaker biosketches: http://www.nibib.nih.gov/NewsEvents/SympReports/2010June22.).

Workshop participants discussed the potential use of technology for the early identification of disease, monitoring daily activities, coping with physical impairment, managing mild cognitive impairment (MCI), promoting rehabilitation and exercise, and providing caregiver support. In each of the 6 workshop sessions, participants heard presentations and discussed clinical needs, the health impact of addressing these needs, state-of-the-art technologies, and challenges and barriers to adopting these technologies. The workshop concluded with a general discussion and recommendations.

Several themes emerged from discussions throughout the workshop:

1. Enhancing adoption with an eye toward the end-user
   - Users should be involved in research and development to increase the likelihood that technologies will be adopted.
   - Implementation and adoption of a technology will be easier if clinicians, patients, and families understand the technology's clinical value.
   - Accessibility and usability by persons with disabilities should be considered as essential as efficacy and safety.
2. Characteristics of independent living technology systems
   - Independent living technology systems may often require a number of technologic approaches.
   - Privacy is a key concern, but seniors are willing to sacrifice some privacy for an effective technology that keeps them in their homes. However, they do want control over who receives their data.
   - Clinicians should encourage more physical activity, rather than exercise, because many people are active without participating in formal exercise programs.
3. Needed research
   - Developers and clinicians should work together to identify which data are needed and to develop the simplest solutions possible.
   - Funding agencies and the public should understand that technologies will undergo several iterations between laboratory development and implementation in the community.
   - Multilevel and multiscale models that can account for changes in the environment are needed to interpret the raw data, to understand the context of motion and to design effective systems.
   - More work is needed to detect falls and to understand the risk and causes of falls.
   - Knowledge must be derived from the data generated by personal motion technologies.
   - More real-world testing is needed.
   - To maximize its efficacy, movement monitoring and intervention technology must adapt to the individual.

## OVERVIEW: PERSONAL MOTION AND ACTIVITY TECHNOLOGIES IN HEALTHY INDEPENDENT LIVING

The U.S. population is aging and will have chronic illnesses that require an increasing level of health care resources. In addition, the nation is facing shortages in primary care providers and nurses, and both professional and informal caregivers are limited in their ability to fully address the needs of aging individuals. Clinical practice is moving away from traditional silo- and procedure-based reactive health care toward proactive care that is centered on the person, the home, and the community. This shift has been codified in recent congressional legislation and in a digital health revolution that includes electronic medical records, telemedicine, information-based comparative effectiveness studies, patient-centered medical homes, and accountable care organizations. Effective health care intervention requires the ability to identify changes in an individual's wellness. Traditionally, this has involved inferences based on functional and physical assessments performed at the convenience of the clinician or investigator that depend heavily on recall or brief snapshots and are assumed to represent typical function. In addition, variability between tests and between observers is high. Thus, with traditional methods, relevant information is lacking or inaccurate, and the resulting assessments of change are imprecise. Personal motion and activity technologies could provide constant data that allow clinicians to see variability and trends or trajectories, rather than individual data values, and to understand how traditional measures are affected by daily activities. These technologies might capture rare, irregular, or evanescent events; activities that are difficult for patients to report; and syndromes that evolve slowly over time with poorly marked onset or transitions. Data collected through these technologies, combined with symptoms reported by the patient, could increase the likelihood of early detection and intervention.

Future development should involve continuous improvement in framing basic and clinical questions and solutions, improvement of technology, careful consideration of scalability, evaluation of the ecologic validity of simulation scenarios, and rapid expansion of the evidence base. A wide array of existing technologic platforms, including actigraphy devices, cell phone–based prompters or tracking, and activity, physiologic, and localization sensors, are available, and efforts are underway to apply them more widely in the community.

Workshop participants were asked to consider several points:

- The range and resolution of the data collected should be tailored to the particular need.
- Basic development, prototyping, and demonstrations must be balanced with practical near- and long-term clinical needs and outcomes.
- Real-world applications do not usually conform to theory, and thus iterative modeling may be required.
- One technology does not fit all. The right tool must be matched with the appropriate task.
- The efficacy and effectiveness of technologies should not be overstated without sufficient evidence.
- Technology developers should aim to publish in clinical journals to foster awareness and subsequent communication and collaboration between the communities.

## SESSION 1: DETECTING PERSONAL MOTIONS AND BEHAVIORS AS EARLY INDICATORS OF DISEASE OR ADVERSE EVENT ONSET

Advances in research and technology are providing the potential to identify what changes in motion patterns indicate the start of disease and detect injury. In this session, clinical needs related to early disease or adverse event detection were addressed. Technologic advances that might address these needs were then presented. Related issues and challenges are summarized in the following discussion points.