DESIGNING SMART HEALTH CARE TECHNOLOGY INTO THE HOME OF THE FUTURE

Steve Warren, Ph.D. and Richard L. Craft, M.S.
Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185, Email: swarre@sandia.gov

Abstract
This editorial paper presents a vision for intelligent health care in the home of the future, focusing on technologies with the highest potential payoff given targeted government funding over the next ten years. A secure, plug-and-play information framework provides the starting point for identifying technologies that must be developed before home-based devices can know their context and assimilate information to support care decisions.

Introduction
Whereas traditional health care delivery is episodic and relies primarily on in-person physician visits, future health care delivery will migrate to a proactive, patient-centric model that focuses on lifestyle management and disease prevention [1]. In addition to the need to lower health care expenditures for patients with chronic diseases/conditions, the change in care delivery perspective is being driven by several technology trends [2], including increasingly-capable telemedicine systems (see **Figure 1**), internet access to health information, and the migration to electronic patient records. For this mode of care delivery to be effective, "smart" devices must be developed that are aware of their context and can therefore support care decisions, since care providers are not always immediately accessible in a home environment.

Figure 1. State-of-the-art desktop telemedicine system.

Methods
An architecture has been proposed that defines seven service areas, or functionality sets, within which telemedicine device technologies can be grouped [3]. Addressing these areas one-by-one, the authors (a) identified classes of technology that support smart home care systems and (b) scored these technologies relative to their perceived potential to contribute to contextual decision making.

Results
Classes of technology identified as the primary contributors in the six service areas include the following: **(1) User Interface**: voice, sign language, and gesture recognition; **(2) Medical Devices**: wearable devices with integrated sensors, better battery technology, and sensors that are smart, self-aware, low-power, self-calibrating, non-invasive, and/or lightweight; **(3) Patient Records**: distributed electronic patient record repositories, data mining/search engines, and wearable storage; **(4) Communications**: low-power telemetry and networks that are home-based/wearable; **(5) Processing**: intelligent software agents, automated diagnosis algorithms, knowledge assimilation techniques, artificial intelligence algorithms, neural networks, fuzzy logic, on-chip decision support, trend data analysis tools, and information reduction tools; **(6) Protocols**: evaluation procedures; and **(7) Backplane**: standard device descriptions and resources for establishing context. In addition, two technical areas encapsulate capabilities for stitching these service areas together: **(1) Information Surety**: novel biometrics, owner-aware sensors, and role-based access controls and **(2) Standards**: information architectures, security, plug-and-play hardware, communication, messaging, storage, nomenclature, protocols, diagnostic procedures, and device descriptions.

Conclusions
Realization of smart home care systems will require targeted government funding in nine key technology areas. However, this research and development will not proceed in an optimal way without an ongoing dialogue between the medical and scientific communities that delineates operational requirements for home-based telehealth systems and continues to identify emerging technologies relevant to home care.

Acknowledgements
This work was supported by the Telemedicine and Advanced Technology Research Center, Fort Detrick, Frederick, MD.

References
[1] A. Kinsella. **Home Healthcare: Wired & Ready for Telemedicine ... The Second Generation**, Sunriver, OR, Information for Tomorrow, ©1998, ISBN 0-9657-674-7-7.
[2] **Strategies for the Future: The Role of Technology in Reducing Health Care Costs**, Sandia National Laboratories, ©1996, SAND 60-2469, November 1996.
[3] S. Warren, R. L. Craft, R. C. Parks, L. K. Gallagher, R. J. Garcia, and D. R. Funkhouser. "A Proposed Information Architecture for TeleHealth System Interoperability," Paper for *Toward An Electronic Patient Record '99 (TEPR '99)*, Orlando, FL, May 1-6, 1999.

DISCLAIMER