

# Eldercare Technology for Clinical Practitioners

# AGING MEDICINE

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# Eldercare Technology for Clinical Practitioners

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# Preface

*Background:* The majority of our increasing elder adult population requires some degree of formal and/or informal care because of loss of function as a result of failing health. According to the Centers for Disease Control (CDC), nearly three-quarters of elder adults suffer from one or more chronic diseases. Examples include arthritis, hypertension, and diabetes, to name a few. The cost and burden of caring for elder adults is steadily increasing.

Changes in the Medicare system led to a shift in the responsibility for care from institutions (nursing homes, etc.) to the community (individuals and families). The role of informal caregivers in providing care to the elder adult population has greatly increased in the past two decades. Consequently, informal caregivers have come to be viewed as an unpaid extension of professional caregivers, providing most of the care to elder adults requiring long-term care. In fact, national databases derived from different sources have provided unequivocal evidence that family and friends are the sole care providers for about three-quarters of all community-dwelling elder adults. Informal caregivers have experienced increased physical burdens and emotional strains because of this shift in long-term elder care responsibilities. Furthermore, healthcare providers are faced with a shrinking professional caregiving work force at the same time.

On the contrary, the proportion of the world's population of individuals over the age of 60 years is expected to double by 2030 to 20%. In the USA, the number of elder adults is expected to grow to 108 million over the next 15 years, which represents 45% of the adult population. Elder adults currently account for 60% of the overall healthcare spending in the USA. Appropriate management of chronic disease in older adults can reduce the US health care bill by up to 50%. Furthermore, 92% of these elder adults live alone in their own apartments, homes, independent living facilities, or assisted living facilities, including about 50% of those 75 years and older. Such statistics demonstrate an urgent need for innovative telehealth/telecare tools that enable elder adults to live independently and maximize caregivers' efficacy by providing timely health information and delivering more effective care. This change in the demographics and its potential economic impact on industrialized nations has prompted active research in automated systems for functional and health status monitoring and assistance, enabled by recent technological advancement.

In the meantime, advances in sensor, communication, and information technologies have created opportunities to develop novel tools enabling remote management and monitoring of chronic diseases, emergency conditions, and the delivery of health care. In-home health assessment and monitoring has the added benefit of measuring individualized health status and reporting it to the primary care provider and caregivers alike, allowing timelier and targeted preventive interventions. Health monitoring in home environments can be accomplished by a) ambulatory monitors that utilize wearable sensors and devices to record physiological signals; b) sensors embedded in the home environment and furnishings to unobtrusively collect behavioral and physiological data; or c) a combination of the two.

*Aim and scope:* This book addresses technologies targeted at the assessment, early detection, and the mitigation of common geriatric conditions including decline in functional abilities, gait, mobility, sleep disturbance, vision impairment, hearing loss, falls, and cognitive decline. This book not only describes the state of both embedded and wearable technologies, including technologies under research and on the brink of translation into products, but also focuses on research showing the potential utility of these technologies in the field.

Chapter 1 presents an introduction and reviews the statistics that make a compelling case for development and utilization of technologies for the geriatric care. Chapter 2 presents a comprehensive review of functional assessment instruments and promising technologies used in functional assessment of elders. Chapter 3 covers mobility and gait assessment technologies, whereas Chapter 4 reviews mobility aid technologies for the elderly. In Chapter 5, we review sleep disorders in older age and sleep assessment technologies, with emphasis on in-home assessment technologies. Chapter 6 presents a comprehensive review of age-related changes in vision and corrective technologies, whereas Chapter 7 addresses the management of hearing loss in older age. Chapter 8 is dedicated to falls, fall detection, and fall prevention technologies. Finally, Chapter 9 addresses emerging computer-based cognitive assessment technologies.

We believe, and hope, that this work will fill a gap in the knowledge and will be invaluable to Eldercare practitioners, as well as medical student studying Geriatrics and interested in gerotechnology, social studies, students studying gerontology and interested in gerontechnology, and nursing students interested in Geriatric Nursing, in addition to engineering students interested in Eldercare Technologies, and researchers from a broad spectrum of disciplines, particularly those interested in field experience and the end-user's perspective. This volume comes at a time when interest in Eldercare Technology and the need for effective and appropriate technologies especially are peaking.

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# List of Acronyms and Abbreviations

AASM	American Academy of Sleep Medicine
ABR	Auditory brainstem response
AD	Alzheimer’s disease
ADLs	Activities of daily living
AGC	Automatic gain control
AI	Apnea index
ALD	Assistive listening devices
ALS	Assistive listening systems
AMD	Age-related macular degeneration
ARES	Apnea Risk Evaluation System
ASDA	American Sleep Disorders Association
AVC	Automatic volume control
BCG	Ballistocardiogram
BPPV	Benign paroxysmal positional vertigo
BOS	Bed Occupancy Sensors
BTE	Behind-the-ear
BTS	Bioptic telescopic spectacle
CBS	Charles Bonnet Syndrome
CCTV	Closed circuit televisions
CDC	Centers for Disease Control
CES-D	Center for Epidemiologic Studies Depression
CIC	Completely-in-the-canal
CLVT	Certified low vision therapist
CNA	Certified nursing assistant
CPAP	Constant Positive Airway Pressure
CRT	Cathode ray tube
CSF	Contrast sensitivity function
CSOA	Communication Self-Assessment Scales for Older Adults
DAQ	Data acquisition
DYS	Familial Torsion Dystonia
ECG	Electrocardiogram
EDS	excessive daytime sleepiness
EEG	Electroencephalogram
EGM	Electromyography

EMG	Electromyogram
ENG	Electronystagmography
ETDRS	Early Treatment of Diabetic Retinopathy Study
EV	Eccentric viewing
FDA	Food and Drug Administration
FEM	Finite element model
FFT	Fast Fourier transform
FM	Frequency modulated radio frequencies
FRA	Fall Risk Assessment
FRT	Functional Reach Test
FSQ	Functional Status Questionnaire
GRF	Ground reaction force
HAT	Hearing Assistance Technology
HATNAP	Hearing Assistive Technology Needs Assessment Profile
HF	High frequency
HI	Hypopnea index
HLAA	Hearing Loss Association of America
HRVI	Heart rate variation index
IADL	Instrumental activities of daily living
IL	Induction loops
ILSA	Independent Lifestyle Assistant
IR	Infrared light
ISI	Intermittent snoring index
IT	Information technology
ITC	In-the-canal
ITE	In-the-ear
JND	Just-noticeable difference
LED	Light emitting diodes
LPL	Lipoprotein lipase
LVR	Low vision rehabilitation
MARC	Medical Automation Research Center
MCI	Mild cognitive impairment
MET	Metabolic Equivalent Test
MMSE	Mini-Mental State Examination
MSLT	Multiple sleep latency test
MU	University of Missouri
NAPS	Non-invasive Analysis of Physiological Signals
NIH	National Institutes of Health
NEPA	Non-exercise physical activity
NSF	National Sleep Foundation
OAE	Otoacoustic emissions testing
OSAHS	Obstructive sleep apnea-hypopnea syndrome
OSA	Obstructive sleep apnea
ODI	Oxygen desaturation index
PAPAW	Push-rim activated power assist wheelchair

PFQ	Physical Functioning Questionnaire
PLMS	
PPT	Physical Performance Test
PM	POLY-MESAM
PSG	Polysomnography
RERA	Respiratory effort-related arousal
ROC	Right outer canthus
REM	Rapid eye movement
RSVP	Rapid serial visual presentation
SCSB	Static Charge Sensitive Bed
SDB	Sleep disordered breathing
SHHS	Sleep Health Heart Study
SIMBAD	Smart Inactivity Monitor Using Array Based Detectors
SL	Sleep latency
SPMSQ	Short Portable Mental Status Questionnaire
SPPB	Short Physical Performance Battery test
TIB	Time in bed
TMJ	Temporomandibular joint
TRT	Tinnitus retraining therapy
TST	Total sleep time
TUG	Timed Up and Go
UARS	Upper airway resistance syndrome
ULF	Ultra Low Frequency
VMS	Video magnifier systems
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index