International Perspectives on Social Policy, Administration, and Practice

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Knowledge, Innovation, and Impact

A Guide for the Engaged Health Researcher

AGEWELL

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AGE-WELL NCE Inc. (www.agewell-nce.ca) is Canada's Technology and Aging Network. The pan-Canadian network brings together researchers, older adults, caregivers, partner organizations, and future leaders to accelerate the delivery of technology-based solutions that make a meaningful difference in the lives of Canadians. AGE-WELL researchers are producing technologies, services, policies, and practices that improve quality of life for older adults and caregivers and generate social and economic benefits for Canada. AGE-WELL is funded through the Government of Canada's Networks of Centres of Excellence (NCE) program.

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Sixsmith, Sixsmith, Mihailidis, Fang - Knowledge, Innovation, and Impact: A Guide for the Engaged Health Researcher

This book provides researchers with a straightforward and accessible guide for carrying out research that will help them to generate good science with real-world impact. All too often researchers excel at research design, data collection and analysis, but lack the knowledge and ability to commercialize or mobilize the outcomes of their research. Moreover, there is a lack of training and educational resources suitable to support researchers to navigate large, complex research teams composed of the wide range of disciplines and experience that are becoming typical. To improve the process of research into real-world impact, the book draws on the editors' experience of leading the AGE-WELL Network of Centres of Excellence and offers practical advice in three areas central to AGE-WELL (Aging Gracefully across Environments using Technology to Support Wellness, Engagement and Long Life): transdisciplinary team working; co-creation approaches and methods; and, commercialization and knowledge mobilization. The format of the book is straightforward and emphasizes the practicalities of how to undertake the kinds of activities that researchers need to engage in if they are serious about achieving impact. There are concise chapters on key practical topics; worked examples; case studies; and associated learning activities. Written in plain language, this valuable resource will help guide researchers through the process of research-driven innovation.

Contents

Abbreviations

3D	Three dimensional
AGE-WELL	Aging Gracefully across Environments using Technology to Support Wellness and Long Life
AGE-WELL NCE	Aging gracefully across environments using technology to support wellness, engagement and long life Network of centres of excellence
AI	Appreciative inquiry
AI	Artificial intelligence
ANOVA	Analysis of variance
APPTA	Advancing policies and practices in technology and aging
ART	Antiretroviral therapy
AT	Assistive technology
CABHI	Centre for Aging and Brain Health Innovation
CAD	Computer-aided design
CAM	Computer-aided manufacturing
CARE	Case reports
C-ASAP	Community area silver alert program
CBPR	Community-based participatory research
CCBRT	Community Based Rehabilitation in Tanzania
CEAL	Challenging Environment Assessment Labs
CHEERS	Consolidated Health Economic Evaluation Reporting Standards
CIHI	Canadian Institute of Health Information
CIHR	Canadian Institutes of Health Research
CIPO	Canadian Intellectual Property Office
CLRI	Ontario Centres for Learning, Research and Innovation in Long-term Care
CMA	Canadian Medical Association
CONSORT	Consolidated Standards for the Reporting of Trials
COREQ	Consolidated criteria for reporting qualitative research
CoRSU	Comprehensive Rehabilitation Services Uganda

CRPD	United Nations' Convention on the Rights of Persons with Disabilities
CSA	Canadian Standards Association
CSPO	Cambodian School of Prosthetics and Orthotics
CTEF (Simon Fraser University)	Community Trust Endowment Fund
EMRs	Electronic medical records
EQUATOR	Enhancing the QUAlity and Transparency Of health Research
ERB	Ethical review boards
FNIGC	First Nations Information Governance Centre
GBP	British Pound Sterling
GDPR	General data protection regulations
HIV	Human immunodeficiency virus
HTA	Health Technology Assessment
ICTs	Information and communication technologies
IDRC	International Development Research Centre
IECs	Independent ethics committees
iKT	Integrated Knowledge Translation
IP	Intellectual property
IRBs	Institutional review boards
KITE	Knowledge, Innovation, Talent, Everywhere
KM	Knowledge mobilization
LBGTQ+	Lesbian, gay, bisexual, transgender, queer, and questioning
LIFE	Learning information for future empowerment
LMICs	Lower and middle income countries
LTBI	Latent tuberculosis infection
LTC	Long-term care
MAREP	Murray Alzheimer Research and Education Program
MHAC	Mental Health Awareness Club
mHealth	Mobile health
MHNA	Mental health needs assessment
MMA	Maximum achievable angle
MNDA	mutual nondisclosure agreement
MRI	Magnetic resonance imaging
MSFHR (I2C)	Michael Smith Foundation for Health Research (British Columbia)–Innovation to Commercialization program
NANA	Novel Assessment of Nutrition and Ageing
NASA	National Aeronautics and Space Administration
NASSS	Nonadoption, abandonment, scale-up, spread, and sustainability framework
NDA	Non-disclosure agreement

NIDILRR	National Institute on Disability, Independent Living, and Rehabilitation Research
NIDILRR	National Institute on Disability, Independent Living, and Rehabilitation Research
NPL	Natural language processing
NRC-IRAP	National Research Council Industrial Research Assistance Program
NSERC	National Sciences and Engineering Research Council of Canada
OARC	Ontario Association of Residents' Councils
OCAP	Ownership, Control, Access, and Possession
P&O	Prosthetics and orthotics
PCHT	Point of Care Healthcare Technologies project
PCT	Patent Cooperation Treaty
PIP	Product Innovation Pathway
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
PRISMA-P	Preferred reporting items for systematic review and meta-analysis protocols
QMU	Queen Margaret University
R&D	Research and development
RCTs	Randomized clinical trials
REBs	Research ethics boards
ROI	Return on investment
RQ+	Research Quality Plus
SA	Shareholders' agreement
SAFER	Shelter aid for elderly residents
SFU	Simon Fraser University
SH	Shareholders
SMART	Specific; measurable; attainable; relevant; timebound
SMS	Short message service
SPIRIT	Standard protocol items: recommendations for interventional trials
SQUIRE	Standards for QUality Improvement Reporting Excellence
SRQR	Standards for Reporting Qualitative Research
SSHRC	Social Sciences and Humanities Research Council of Canada
STAR	Science and Technology for Ageing Research (STAR) Institute (at Simon Fraser University)
STARD	Standards for Reporting Diagnostic accuracy studies
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TATCOT	Tanzania Training Centre for Orthopaedic Technologists
TCPS2	Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans
TDW	Transdisciplinary working
ToR	Terms of reference
TRIPOD	Transparent reporting of a multivariable prediction model for individual prognosis or diagnosis
TRI-UHN	Toronto Rehabilitation Institute-University Health Network

TRI-UHN	Toronto Rehabilitation Institute-University Health Network
TRL	Technology Readiness Level
UHN	University Health Network
UK	United Kingdom
UML	Unified Modelling Language
UNBC	University of Northern British Columbia
USPTO	US Patent and Trademark Office
UW	University of Waterloo
UX	User experience
WHO	World Health Organization
WIPO	World IP Organization

Part I
Thinking About Impact

Chapter 1
Introduction: The Engaged Health Researcher—Why and How to Use This Book

Andrew Sixsmith, Judith Sixsmith, Alex Mihailidis, and Mei Lan Fang

Turning Ideas into Impact

The world of research has changed. The idea of an academic working alone in his or her ivory tower, isolated from the distractions of the outside world, is becoming a thing of the past. More and more, researchers are working in teams in large collaborative projects, where the funders have high expectations that the research will deliver tangible social and economic benefits. While impact is a worthwhile objective, achieving it in practice is a complex process, and many researchers are unprepared for the challenge of turning their ideas into real-world products, policies, practices, and services. How do you work effectively in a large team? How do you involve stakeholders and end users in your research? How do you *do* commercialization and knowledge mobilization? How do you manage relationships and expectations effectively with a range of different, nonacademic stakeholders? How do you reconcile these additional actions with your academic goals and activities? Researchers are increasingly expected to do more than traditional research tasks, but in our experience there has been limited practical support. The aim of this book is quite straightforward—to bring together current knowledge and experience to provide researchers with an accessible guide to how to carry out translational, *engaged* health research that will help to turn ideas, knowledge, and technologies

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into actions and outcomes that can have positive real-world impact on societies and economies.

Overview of the Book

The book is divided into four parts, starting by looking at the underlying ideas around engaged health research and then moving on to practical *how-to* chapters that constitute the main part of the book.

Part I: Thinking About Impact

This part introduces and discusses the underlying ideas and principles behind engaged health research—the why, what, and how of research-driven innovation. A major theme in this book is to plant the seed for us to start thinking about knowledge mobilization, innovation, and impact as being part of all stages of the research, even at the initial conceptual stages. The problem is how do we most effectively build these new activities into our research? For example, how do we work together with a diversity of external stakeholders to jointly conceptualize the problem area of our research? How should we co-design the project and what methods do we need to employ in knowledge mobilization or commercialization? How do we determine the expertise needed in the project? What do we mean by innovation and impact? How do we work toward impact as the goal? What are the barriers and opportunities? This part introduces the three ideas that we feel are crucial to an integrated, more holistic approach to knowledge mobilization: transdisciplinary working, co-production research, and effective outreach. Part I sets the scene for the rest of the book. The following three parts provide the practical *how-to* guides on key topics relating to the three pillars of engaged research.

Part II: Working Collaboratively

This part is about working collaboratively on the complex problems that exist within the health field. It is also about rethinking these problems and creating disruptive ideas and solutions. As well as breaking down the disciplinary silos that exist in academia, it requires researchers to work with stakeholders and communities in a meaningful way, as equal partners in the innovation process. The principle is fine, and there are many good articles that introduce the ideas behind transdisciplinarity and other forms of collaborative working, but what is less available are resources on how to do this effectively in practice. This part covers topics such as establishing the expertise base needed in the project; building authentic and meaningful

partnerships; putting in place partnership mechanisms that support strong and enjoyable teamwork, introducing positive frameworks to support the integration of ideas across disciplines and sectors; working in ways which are inclusive of hard to reach or seldom heard groups; and minimizing the negative aspects of power relations within research. Issues of education and training are also covered, ensuring that the necessary social and teamworking skills are in place, thereby building capacity for future collaborative research. However, capacity building for the future is only part of the story for developing collaboratives frames for research. Developing a flourishing, person-oriented, and vibrant research culture is also necessary, a culture that is open to self-reflection and critical appraisal and most importantly is respectful of researchers and the participants in research.

Part III: Designing Together

This part focuses on research methods and is about involving stakeholders and end users as co-producers and co-creators of solutions. Researchers often have specialist knowledge and skills, for example, in the engineering or computer science fields, but if this expertise is to be applied successfully, solutions need to be grounded in the everyday knowledge and expertise of the person, the participant, the patient, or the customer. The key is to avoid the technology-driven approach by involving users at all stages from concept, through development and into real-world evaluation and implementation. This part covers topics such as how to conduct a robust and rigorous review of existing knowledge; co-create health innovations together with their intended recipients; meaningfully engage stakeholders throughout the entire research process; facilitate the development and maintenance of valuable relations between knowledge creators and knowledge users during the prototyping stage; and conduct ethical research, particularly when working with vulnerable groups. Aligned with the key messages and goals of this book, the topics addressed in this part enable to us to better identify, understand, and respond to the needs, aspirations, and everyday lives of those we aim to serve and co-produce practical solutions through health research innovation that can ultimately be turned into real-world products and services.

Part IV: Creating Research Products

This part focuses on the very practical aspects of turning ideas, prototypes, and new practices into real-world products and services. Typically, these have been seen as activities that come after the research phase, or "end of project knowledge translation." This is the researcher's get-out-of-jail card that allows him or her to quietly forget about impact and move on to their next project. We argue that these activities need to be brought forward into all stages of the research. For instance, thinking

about commercialization or deployment right from the start will help to avoid building solutions that will inevitably fail. Visualizing what the final product might look like, who the customer is, and how much the product might cost are things that can be easily done, but have a big pay-off later on. This part covers topics such as how to effectively communicate with a wide audience, including other researchers, stakeholders, and partners; informing policy and influencing policy makers through research findings and appropriate methodologies, including how best to navigate the policy and health system landscapes; and, finally, topics around commercialization and knowledge mobilization, including important issues like dealing with intellectual property and integrated approaches to knowledge translation. All of these topics are meant to help researchers to work more closely with their teams, stakeholders, and partners in order to develop more effective solutions that will eventually be embedded in real-world contexts.

Each part has a brief introduction that gives the reader an overview about the ideas, themes, and connections they will find in the part and particular things that they might want to look out for.

How-to Chapters

The format of these how-to chapters is very simple and focuses on key topics, written in plain language that will help researchers through the process of research-driven innovation. The how-to chapters should help readers to visualize the kinds of non-core activities they need to engage in in order to ensure they progress toward innovation and impact. Each how-to chapter will address a key pillar in the translational research process. Each has a similar easy-to-follow format that will include the following sections:

The Challenge

Each how-to chapter addresses a specific topic or component in the translational research process: the issue, opportunity, or problem.

Key Ideas

The how-to chapters are short and to the point, and each provides an overview of 5–6 practical ideas relating to their particular challenge. It is helping the reader to start to answer the question: How do I go about X?

- What is the idea?

- What to do practical in terms of activities and outputs.
- May include a "box"—a very short case study or example to illustrate the idea.

Product Innovation Pathway (PIP) Model

This is an innovation in this book (more about this in Chap. 3). We want to help researchers to think about innovation at different stages of their project and not just something that is tacked on at the end. For example, researchers could be "doing commercialization" right at the start by carrying out an environmental scan of their market sector. However, commercialization activities further down the innovation pipeline will be very different. We have adapted and simplified the well-known TRL (technology readiness level) innovation scale into our own PIP model to make it more appropriate to the wide range of research projects. The model has five *stages*: innovative ideas; planning; development; testing; and outcomes. Every how-to chapter provides some pointers to the kinds of activities a researcher might have to engage in at various points in the PIP. These are guides and not blueprints, as every research project is likely to have its own objectives and dynamics that make it unique.

Finding Support

The book can only be an introduction to the complex world of translational research. It is important to provide readers with ideas for next steps and sources of further information: What should I do next? Who can I connect with to get help and support? Key resources, references and links to further reading.

Case Studies

Each of the how-to sections contains case studies that complement the how-to chapters in the book and will provide concrete examples to help the reader to visualize a key idea or approach in a very practical way: "…this is how we did it, and it worked really well…." The case studies will:

- Demonstrate how this example contributed to a successful translational research project.
- Provide examples of technologies and services at different stages of maturity.
- Illustrate major global health and healthcare challenges in the twenty-first century.

Learning Activities

As with case studies, the how-to chapters are supplemented by learning activities to reinforce learning about practical steps in a successful translational research project and relevant to a key health and healthcare challenge. The learning activities identify a key challenge and set out a particular problem, activity, and learning outcomes, as well as learning resources and any supporting materials needed in the activity.

The authors and editors of this book hope you find this book a helpful guide as we found it a rewarding experience putting it together with you in mind.

Chapter 2
Thinking Innovatively About Innovation Research

Andrew Sixsmith, Alex Mihailidis, Mei Lan Fang, and Judith Sixsmith

The Challenge: Innovation Is Complex

The title of this chapter highlights *innovation research*, rather than *innovation and research*. This is for two reasons. Firstly, we argue that research for its own sake is important, but having some kind of real-world benefit may also be an important objective. Improving our understanding of the way the world works is the goal of science, and using research knowledge to improve the lives and health of people is fundamental to the medical and health fields. However, turning research ideas into new products and services is often difficult. Excellent research may result in weak returns in terms of new enterprises, real-world products, and social and economic impact (Sixsmith, Mihailidis, & Simeonov, 2017).

Secondly, we suggest that "research" and "innovation" actually go hand in hand and we need to be smarter about the way we think about how they are connected. Sixsmith et al. (2017) argue that there may be an overly simplistic view of the innovation process in the research world. A recent report on fundamental science in Canada suggests that innovation is often seen as a straightforward linear process

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where "investments in basic and applied research should somehow cascade quickly into more goods and services along with healthier and happier populations" (Naylor Report, 2017, p. 63). However, innovation is a complex and often unpredictable process that doesn't lend itself to easy translation from research to real work applications. It is not just about developing new products or technologies because it is about thinking and doing things in new ways and implementing them as real-world solutions that will make a difference to individuals, society, and the economy. This is inevitably a messy process, where compartmentalizing the innovation process into discrete tasks and phases, such as basic research, solution development, and knowledge translation, is a flawed approach. Another flawed idea is that research results will naturally flow into implementation and adoption. The implication is that researchers need to be prepared to work in an iterative way, where the "flow" of the different parts of a project is interconnected and iterative, not necessarily in a linear direction.

The aim of this book is to shift our academic thought process toward thinking more actively about the innovation process within research contexts and to provide some practical approaches and tools that we hope will help people who work in the research community to take their ideas from "the lab into the real-world" or, more accurately, bring the world of research and the world of innovation closer together.

What Do We Mean by Innovation?

In getting to grips with the notion of innovation and impact, it is important to start defining some terms, for example, what do we mean when we talk about *innovation*? While there is no well-accepted definition, it could be said that innovation is about doing something in a new way that will have a positive benefit. Innovation might involve some kind of "invention," such as developing a new technology, but there are a few things to remember here. First, the invention itself is not the innovation because an innovation has to be implemented and used by people, businesses, etc. Second, innovation is not just about technology—it could be a process, service, policy, or a new business model. Third, innovation is a process and can look very different, depending on the context:

- Designing a new component in an existing product, system, or service may not require a huge investment or change. This *incremental innovation* is about small improvements that will make something more efficient, add value, reduce costs, etc. It might make an existing product more competitive or extend its shelf life in the market. Another approach is to apply expertise or solutions from one market or sector to another. While these may not look exciting, they typically account for most of the innovations that occur in business and services and can result in huge added value. They are also low risk, as they will be implemented and adopted within existing business processes. In the health sector, this could be a change to the way a service or procedure is organized and delivered that improves outcomes or reduces costs, but doesn't significantly impact on the organization as a whole. Even in areas such as pharmaceuticals, this low-key approach can be

seen as crucial to innovation and contribute to the development of "blockbuster" drugs (Wertheimer & Santella, 2005, p. 4).

- *Radical innovation* is about creating new industries or markets and typically comes from an entirely new technology, service, or procedure. Obvious examples here are the telephone and the internal combustion engine that gave rise to the telecommunications and automotive industries in the twentieth century. The most radical innovation here was not necessarily the telephones and cars themselves but the communications networks and mass production that turned luxury products into mass-market products. Examples from the health sector include the improved sanitation and building of fever hospitals in the early twentieth century to control the spread of infectious diseases. These fever hospitals were in turn rendered redundant with the widespread introduction of vaccines and antibiotics in the mid-twentieth century. Taken together these radical innovations saw the eradication of many of the killer infectious diseases that were common throughout history.
- *Disruptive innovation* is about a new technology or process that significantly changes an existing market or process. These disruptive innovations often come from entrepreneurs or small businesses, rather than large businesses or established organizations (where existing investments and processes can produce inertia). Disruption is about effect and impact, such as creating a new market or changing the way people or an organization does something. An example of a disruptive innovation in the health sector is the implementation of laws banning smoking in public spaces and the positive impact that this has had on health outcomes and attitudes to smoking (Frazer et al., 2016).

Innovation as a Process

Innovation can also be a process that turns ideas into various tangible outputs that are then implemented and used. This concept is captured in the idea of the technology readiness level (TRL). The TRL defines the process of innovation as a series of stages of maturity from concept to implementation. We will talk about this further in Chap. 3 when we introduce the *Product Innovation Pathway* model that is used to organize many of the ideas and methods discussed in this book.

In any research project that aims to create a *product*, it is useful to think of *levels*: ideas-planning-development-testing-implementation. These levels have different requirements and dynamics. For example, *ideas* might be about defining a problem, establishing market need, or coming up with a range of potential solutions, while *testing* might require a trial of a new device or intervention. But importantly, this should be seen as an iterative process, where a project progresses in small, related actions similar to a learning process. Indeed, outcomes from one part of a project might require the research team to revisit previous actions. However, some of the things that we often see as part of a discrete phase of working might be a useful part of other phases of a project, e.g., thinking about markets and the implementation process could be something that is addressed even at early stages of a project.

Where Does Research Fit in the Innovation Process?

If we want research to result in innovation, then the research itself must be innovative in the way it is conducted. This is one of the key messages when we discuss the idea of integrated knowledge mobilization and transdisciplinarity in later chapters. We often think of researchers in the health sector as people who inhabit laboratories, focused on developing new drugs or technologies that might someday be used by patients and the public. But health research covers a very wide set of activities and disciplines, ranging from basic science through to more applied sciences (e.g., computing science and engineering), social sciences, policy, business, and the humanities. In the health sector, all these can be part of innovation in many different ways and at different points in the process, for example:

- Understanding the problems and needs of people and patients.
- Requirements analysis and modelling.
- Visualizing and developing solutions and prototypes.
- Designing and developing new solutions.
- Organizing trials and evaluating outcomes.
- Providing evidence of best practice or outcomes.
- Evaluating long-term impact.
- Understanding barriers to adoption.
- Developing delivery models.
- Understanding the business environment.
- Communicating results of research.
- Developing models of clinical practice.
- Translating research knowledge into practical services.

Looking at these, we can immediately see an issue—researchers will be required to work outside of their typical disciplinary boundaries. They may also often require working with professional or experiential stakeholders within research projects themselves. For example, a project to develop some kind of assistive technology may require different research and sectoral expertise, such as a psychologist and an occupational therapist working with engineers. Crossing disciplinary and professional sector boundaries to working together collaboratively is a key part of this book.

Failure to Launch

Herzlinger (2006) points out that government investment in health-related research and development is second only to defense spending in the United States, while private sector R&D spending is probably in the tens of billions of dollars. Despite all of the investment, hard work, and the need for new solutions, too many of these efforts fail to launch. This gap between R&D and real-world deployment has been labeled the “valley of death” (Hudson & Khazragui, 2013). A quick Google search

of the expression "innovation valley of death" offers numerous possible reasons, including:

- Disjoint between academic processes and entrepreneurial processes.
- Failure to network outside the academic "comfort zone".
- Insufficient early-stage attention to the likely needs and decisions at a later stage.
- High cash demands versus low ability to raise it.
- Not enough emphasis on management, teams, and products.
- Assumption that pilots will naturally scale up to mainstream.

We often see impact case studies used to demonstrate where research has resulted in successful implementation and adoption of a new technology or process. These success stories are fine but are probably vastly outnumbered by unsuccessful ones that we tend to hear less about. Even where research leads to successful implementation, there is around a 17-year gap between getting research funding and when the results are put into practice in a real-world setting (Morris, Wooding, & Grant, 2011).

Box 2.1 A Personal Story

This is a fictionalized account but is typical of many projects that begin with good intentions but ultimately fail to deliver. The aim of the project was to develop a smart assistive environment to support people with cognitive impairments. The project was an international consortium of commercial, academic, and nonprofit partners and combined very significant public and private sector funding. Despite the investment, talent and hard work, a huge amount of research, and tech development, the project did not result in a product that could be eventually taken to market. Here are just some of the possible reasons:

- The initial project plan focused almost exclusively on technical aspects and technology development. Conversely, minimal resources and time had been earmarked for human aspects such as understanding user needs, working with them to develop prototypes, and then demonstrating and evaluating the solutions.
- The different aspects of the project were highly task-oriented and compartmentalized, making it difficult to communicate ideas and requirements between different teams.
- Motivations within the project varied greatly between different actors, often making it difficult to work in a cohesive way.
- Lack of knowledge around intellectual property and protection caused disagreement across partners on who owns what.
- The engineers and developers were too ambitious and unable to deliver key components, which undermined the viability of the overall system.
- The lack of a strong business case in the thinking around the system development.
- One of the major commercial partners pulled out due to changing priorities at management level.
- There were many different types of ethical challenges that created barriers for appropriate commercialization.