Murdoch
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The Melbourne Children's Knowledge Translation and Research Impact Project

DISCUSSION PAPER:
CONSIDERATIONS FOR KNOWLEDGE TRANSLATION AND RESEARCH IMPACT AT MELBOURNE CHILDREN'S

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Preface

This Discussion Paper is one of four publications resulting from The Melbourne Children's Knowledge Translation and Research Impact Project.

The Melbourne Children's Knowledge Translation and Research Impact Project. Final Report: A Framework for Action. Leone, V., Modica, L., & West, S. (2017). The Melbourne Children's Knowledge Translation and Research Impact Framework, and the findings and recommendations in the Final Report are based on an analysis of the Discussion Paper, Environmental Scan and Consultation Report. This data was supplemented and informed by internal and external review throughout the Project. The Framework is applied to selected campus knowledge translation case studies, and key findings and recommendations propose action to enhance knowledge translation and research impact at Melbourne Children's.

The Melbourne Children's Knowledge Translation and Research Impact Project. Consultation Report: Perceptions of Knowledge Translation and Research Impact. Fong, M., Rushton, S., & West, S. (2016). The Consultation Report summarises data collected from:

- external experts via semi-structured interviews based on their expertise in research translation, research impact and knowledge of the policy and funding environments [n=8, approx. 60 minutes each]
- campus leaders via semi-structured interviews [n=14, approx. 40 minutes each]
- campus staff via an online survey [n=109 fully completed]. Survey respondents worked in the following areas of Melbourne Children's:
    - 78 respondents worked in research
    - 33 respondents worked in clinical care
    - 30 respondents worked in education and training
    - 12 respondents worked in other areas including administration, service provision, knowledge translation, evaluation, policy, public affairs and coordination.

The consultations captured a range of perspectives about the prevailing funding environment, knowledge translation, key considerations, and opportunities and challenges for advancing research impact.

The Melbourne Children's Knowledge Translation and Research Impact Project. Discussion Paper: Considerations for Knowledge Translation and Research Impact at Melbourne Children's. Moore, T., Heiden, T., Leone, V., & West, S. (2017). The Discussion Paper identifies evidence and best practice in health and medical research translation. It seeks to align key concepts with the broader vision and strategy of the Melbourne Children's by addressing the following questions:

- How are research translation and knowledge translation defined?
- What are the core concepts of knowledge translation?
- What is the relationship between knowledge translation and research impact?
- Where does research impact fit within the context of Melbourne Children's?
- What impact measurement framework will help us understand and conceptualise knowledge translation and inform our approach to enhancing and measuring research impact?

The Melbourne Children's Knowledge Translation and Research Impact Project. Environmental Scan: Implications of the External Environment for Knowledge Translation and Research Impact at Melbourne Children's. Heiden, T., Leone, V., & West, S. (2017). The Environmental Scan captures the changing landscape of research policy and funding in Australia. It identifies four relevant consultation and review processes, and their potential implications for Melbourne Children's.

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ABBREVIATIONS

ARC	Australian Research Council
CAHS	Canadian Academy of Health Sciences
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CIHR	Canadian Institutes of Health Research
KT	knowledge translation
MCRI	Murdoch Childrens Research Institute
NHMRC	National Health and Medical Research Council
RCH	The Royal Children's Hospital, Melbourne
RCHF	The Royal Children's Hospital Foundation
RI	research impact
UMDP	University of Melbourne Department of Paediatrics
WHO	World Health Organisation.

Background

There is widespread concern about the 'research to practice' gap in the health sector (Albrecht, Archibald, & Snelgrove-Clarke, 2016; Glasgow, Vinson, & Chambers, 2012; Glasziou, Straus, & Brownlee, 2017; Graham, Logan, & Harrison, 2006; Grimshaw, Eccles, & Lavis, 2012; Lang, Wyer, & Haynes 2007; Searles, Doran, & Attia, 2016; Straus, Tetroe & Graham, 2013; Sudsawad, 2007; Szilagyi, 2009; Westfall, Mold, & Fagnan, 2007). One reason for this concern is that the failure to apply up-to-date strategies and treatments results in less than optimal care and greater risk of adverse events (Glasziou et al., 2017; Straus et al., 2011; Ward et al., 2009). Another reason is that any failure to apply research results means that investments in research are being wasted (Straus et al., 2011 Ward, House & Harmer, 2009a).

Bridging the research to policy gap is not an easy matter. As Westfall et al. (2007) note,

> *Inventing a new medicine or treatment is only the starting point for improving the health of an individual patient. The magnitude and nature of the work required to translate findings from human medical research into valid and effective clinical practice… have been underestimated.*
>
> *Myriad detours, speed traps, roadblocks, and potholes limit the movement of treatments from bench to practice. They include the limited external validity of randomized controlled trials, the diverse nature of ambulatory primary care practice, the difference between efficacy and effectiveness, the paucity of successful collaborative efforts between academic researchers and community physicians and patients, and the failure of the academic research enterprise to address needs identified by the community. (Westfall et al., 2007)*

As this suggests, there are a number of reasons for the research-to-practice gap. One is the length of time it takes to produce definitive research results:

> *Despite increasing demands to produce timely and relevant research findings, our traditional research process remains painstakingly slow. Randomized efficacy trials take approximately 5.5 years from the initiation of enrollment to publication, and 7 years or longer after adding the time from grant application submission to enrollment initiation. Extensive follow-up periods for relevant outcomes such as morbidity/mortality as well as delays in participant recruitment and publication can extend this time period to a decade or longer. During this period, scientific and technological advances will occur that may make the eventual findings less relevant or even obsolete. (Riley, Glasgow, Etheredge, & Abernethy, 2013)*

The second contributing factor is how long it takes for research findings to be adopted by practitioners (Glasziou et al., 2017; Neta, Glasgow, & Carpenter, 2015; Riley et al., 2013). One review found that there was an average time of 17 years to move 14 per cent of research into clinical practice (Morris, Wooding, & Grant 2011). Additionally, reviews of research 'wastage' (Chan, Song, & Vickers, 2014) have highlighted the need to make research protocols and full results more widely available.

A third factor contributing to the delay in the uptake of research findings is that most evidence-based interventions are not ready for widespread dissemination, not being sufficiently practice-based or designed to be easily applied at scale in real-world settings (Green, 2006; Kessler & Glasgow, 2011; Riley et al., 2013; Westfall et al., 2007).

How can we close the gap between research and practice? Two complementary ways have been adopted. One is to focus on the gap itself, and seek ways of improving the movement of research evidence into health and medical practice. This has been the approach most commonly adopted over the last decade (Albrecht et al., 2016; Grimshaw et al., 2012; Riley et al., 2013), and there are now a number of competing frameworks, terminologies and strategies for bridging the research to practice gap. These focus on how research knowledge is transferred (or 'translated') and disseminated, the extent of uptake by policy makers and practitioners, and the ultimate impact on the health and wellbeing of the population.

A second way of addressing the research to practice gap is to focus on the research itself, and to suggest that the current research paradigms are part of the problem, as they have not provided the answers needed for more rapid translation and more probable implementation. Those adopting this approach argue that a major shift is needed, involving more practice-based research (Green, 2006, 2008; Westfall, Mold, & Fagnan, 2007) and a greater focus on the needs of practitioners, patients, payers, and policy makers (Kessler & Glasgow, 2011; Riley et al., 2013).

While this second approach undoubtedly needs to be part of the solution, the primary focus of this paper is the first of the two strategies. Specifically, the paper seeks to bring clarity and perspective to the concepts of knowledge translation and research impact, and to identify implications for Melbourne Children's.

Melbourne Children's is the collaboration between The Royal Children's Hospital, Melbourne (RCH), Murdoch Childrens Research Institute (MCRI), the University of Melbourne Department of Paediatrics (UMDP) and The Royal Children's Hospital Foundation (RCHF). Based in Melbourne's Parkville precinct, the campus unites leaders to advance child and adolescent health through the integration of prevention and early intervention, clinical care, research, education and training, and academic leadership.

Aim and scope of this discussion paper

This paper focuses on evidence and best practice in health and medical research translation. Given the broad array and evolving thinking and terminology around these concepts, this paper looks to align the concepts with the broader vision and strategy of the Melbourne Children's by answering these questions:

- How are research translation and knowledge translation defined?
- What are the core concepts of knowledge translation?
- What is the relationship between knowledge translation and research impact?
- Where does research impact fit within the context of Melbourne Children's?
- What impact measurement framework will help us understand and conceptualise knowledge translation and inform our approach to enhancing and measuring research impact?

The paper begins by discussing the concept and intricacies of knowledge translation (KT) and how the process of knowledge translation creates opportunities for research impact. This is followed by a discussion of research impact, considering the types of impact and ways in which research impact may be measured.

The final section of the paper identifies the implications of these findings for Melbourne Children's, and includes research impact frameworks selected for their relevancy and applicability to a health and medical research campus that encapsulates many different disciplines, styles and types of research.

Methodology

A literature search was conducted using PubMed and Google to identify recent reviews and grey literature, written by authorities on the subject and that gave sufficiently detailed information on knowledge translation.

The impact and impact measurement parts of this paper draw upon a series of recent systematic and narrative reviews (Greenhalgh, Raftery, & Hanney, 2016; Guthrie, Wamae, & Diepeveen, 2013; Milat, Bauman, & Redman 2015; Penfield, Baker, & Scoble, 2014). Grey literature and other information from international funders and experts in the field were also consulted.

What is knowledge and how is it known?

Before exploring what knowledge translation involves, we need clarify to what we mean by knowledge: how is knowledge known, who needs it, and whose job is it to transfer or translate it?

There are many definitions or concepts of 'knowledge'. Understandably, the Australian Research Council (2015) focuses on the kind of knowledge generated by research:

> *Research is defined as the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies, inventions and understandings. This could include synthesis and analysis of previous research to the extent that it is new and creative. (ARC, 2015)*

However, research knowledge is only one form of knowledge:

> *For some, knowledge is the evidence created by research; to others knowledge is derived from experience or expertise; to others still, knowledge is habitual, arising from tradition. For some, knowledge is a careful combination of each. (Campbell, 2012)*

Moreover, not all knowledge is equally good or useful (Pawson, Boaz, & Grayson, 2003) and there are contested notions of what constitutes good evidence (Greenhalgh, 2010; Greenhalgh & Wieringa, 2011; Lambert, 2006, 2013; Levitt, 2013; Nutley, Powell, & Davis., 2013; Pawson et al., 2003; Schorr, 2012). This is because knowledge depends upon personal perspectives and personal contexts, and changes as it moves among stakeholders (Campbell, 2012). Values also play a critical role in determining what knowledge or evidence is accepted as valid and how it is used (Elliot & Resnick, 2014; Head, 2016; Moore, 2016; Pelley, 2014). This means that what constitutes evidence cannot be established by purely technical or procedural means.

This is most evident when we consider how knowledge and evidence inform policy development. Waddell et al. (2005) interviewed policy makers regarding their use of evidence in developing policy and found that policy makers needed and used research evidence, but only as one source of information among many competing influences, such as public opinion, institutional constraints and fiscal restraints. Thus, as Head (2016) has observed,

the neutral and objective evidence of scientific knowledge does not, and cannot, drive policy in a democratic political system. Evidence is harnessed to competing arguments about ends and means, and the political decision-making process is inherently marked by conflicts, trade-offs, and compromises. (Head, 2016)

As a result of these debates, there have been moves away from an exclusive reliance on traditional evidence-based practice towards the adoption of a pluralistic notion of evidence encompassing a range of forms of knowledge (Blewett, 2007; Eccles, 2009; Greenhalgh & Wieringa, 2011; Greenhalgh et al., 2016; Lambert, 2013; Pawson et al., 2003).

Pawson and colleagues (2003) identify five forms of knowledge:

- research knowledge – held by researchers
- practice knowledge – held by practitioners
- experiential knowledge – held by parents and communities
- organisational knowledge – held by service system organisers
- policy knowledge – held by policy makers.

None of these forms of knowledge are more important than any of the others, and decision making in real-world settings necessarily involves the blending of several sources of knowledge. Evidence-based practice is properly regarded as a decision-making process that blends knowledge from different sources, rather than relying solely on research knowledge (e.g. deciding which evidence-backed intervention to use). Instead, evidence-based practice[1] involves the blending of research knowledge with the practice knowledge held by practitioners and with the experiential knowledge of parents and communities (Centers for Disease Control and Prevention; Eccles, 2009; Moore, 2016; Puddy & Wilkins, 2011). Certainly, this is how practitioners make decisions. For instance, in working directly with patients, doctors must combine both relevant research evidence and tacit knowledge of the wider clinical and social situation (Greenhalgh & Wieringa, 2011). As a result of this need to blend knowledge and evidence from different sources, medicine is more properly understood not as a science but as a practice '…specifically, an uncertain, paradox-laden, judgement-dependent, science-using, technology-supported practice' (Greenhalgh & Wieringa, 2011).

To make such evidence-informed decisions, policy makers, practitioners and parents need access to the research knowledge developed and held by the research community. However, this knowledge is not easily accessible, for several reasons:

- the knowledge is genuinely complex and difficult for all but the highly trained to understand
- the knowledge is distributed across a steadily expanding range of specialties and sub-specialties, and there is no systematic process for integrating the findings and extracting the key messages
- it is not written in a language or a format that communicates the key messages effectively; academics use concepts and terms that are not readily understood by the general public and are not encouraged to write plainly[2]
- academics are rewarded for publishing in journals that are not available to the general public and are prohibitively expensive (Monbiot, 2011; Soos, 2012)[3]

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1   Moore (2016) suggests using the term evidence-informed decision making when referring to this process of blending knowledge from different sources, reserving the term evidence-base practice for the research knowledge component.

2   According to Lyons (2016), many academics still operate under the flawed logic that good writing must be complex writing. For instance, the UTS Library's Academic Writing Guide (2013) suggests that academic writing should use more complex grammar, vocabulary, and structures, and advises academics that, instead of two short sentences, they should use more complex sentence structures.

3   The high cost of journals is becoming an increasing problems for universities (McGuigan & Russell, 2008) and academics (The Economist, 2012) alike.

Conversely, to contribute to evidence-informed decision making, researchers need access to the knowledge held by policy makers, practitioners and parents. However, this knowledge is not easily accessible to researchers, principally because they rarely engage with these decision makers and therefore do not have a good understanding of the issues they face in promoting children's health and wellbeing. For instance, in seeking to influence policy makers, researchers should seek to learn about the policy process, establish research-policy partnerships to build relationships of trust, and increase personal contact to bridge the culture gap between the research and policy context (Waddell et al., 2005).

Knowledge translation

The process of making research knowledge available to policy makers, practitioners and parents – thereby bridging the research to practice gap – is most commonly known as knowledge translation[4], although it has also been called knowledge transfer and knowledge exchange (Graham et al., 2006) as well as research translation, knowledge mobilisation, and research utilisation (Ward et al., 2009a).

Despite its wide usage, there is no commonly agreed definition of knowledge translation, or common understanding about what it involves (Davidson, 2011; Graham et al., 2006; Shea, 2011). It means different things to different people (Grimshaw et al., 2012), being variously understood as involving dissemination, communication, commercialisation/technology transfer, knowledge management or implementation science (Campbell, 2012; Graham et al., 2006).

The World Health Organisation (WHO) defines knowledge translation as:

> *The synthesis, exchange, and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people's health. (WHO, 2006)*

The Canadian Institutes of Health Research (CIHR) definition of translation is particularly relevant to health and medicine:

> *Knowledge translation is a dynamic and iterative process that includes synthesis, dissemination, exchange, and ethically sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the healthcare system. This process takes place within a complex system of interactions between researchers and knowledge users that may vary in intensity, complexity, and level of engagement depending on the nature of the research and the findings, and the needs of the particular knowledge user. (Graham, 2010)*

Other definitions focus on the application of knowledge by practitioners. Thus, Searles et al. (2016) define research translation as 'a process of knowledge generation and transfer that enables those utilising the developed knowledge to apply it.' They add that, "once generated, knowledge flows can be multidirectional and non-sequential." For the Australian Research Council (2015), knowledge translation or transfer involves 'deliberately embedding knowledge for use in a context beyond the researcher's own sphere.'

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4 As well as being problematic for researchers, the term knowledge translation is confusing for the general public (Davidson, 2011). Greenhalgh and Wieringa (2011) argue that we should broaden the range of metaphors to include other ways of conceptualising the research, policy and practice nexus. Despite these concerns, this paper will continue to use the term knowledge translation.

Despite their differences, these definitions all view knowledge translation as the process of moving knowledge into action through information and evidence exchange between knowledge producers and knowledge users (Graham et al., 2006; Mitton, Adair, McKenzie, Patten, & Perry, 2007). It is the meeting ground between two fundamentally different processes: those of research and those of action (Bennett & Jessani, 2011) with the primary purpose of increasing the chance of research evidence being used in policy and practice, to create impact, and for the identification of relevant research questions (Mitton et al., 2007).

Effective knowledge translation is essential for closing the research-to-practice gap in health research and clinical care and ensuring a more efficient and effective use of research innovations in practice and policy (Barwick, 2016). However, as Straus et al. (2011) point out, we must avoid assuming that all knowledge must be translated into action – there needs to be a mature and valid evidence base before we expend substantial resources on translating and disseminating this evidence. Given the limited resources available, we should work with stakeholders (including patients/public, clinicians, and policy makers) to establish what knowledge translation activities should have priority.

Knowledge translation is both a field of research and a field of practice. Translational research fosters the multidirectional and multidisciplinary integration of basic research, patient-oriented research, and population-based research, with the long-term aim of improving the health of the public (Rubio-Esposito et al., 2010).

Research in knowledge translation includes studies that attempt to quantify and understand the discrepancies between what is known and what is done, as well as those that examine the impact and acceptability of interventions designed to narrow or close these gaps (Lang, Wyer, & Haynes, 2007). However, reviews of the research into the most effective knowledge translation strategies suggest that the overall quality of the research is poor at this stage (Albrecht et al., 2016).

Knowledge translation is also a practice in its own right, with knowledge translation practice an emerging professional discipline (Barwick, 2016; Barwick, Phipps, & Myers, 2014). In recognition of the growing importance of knowledge translation, some universities are beginning to include knowledge translation activities alongside standard scholarship in research and teaching as legitimate academic contributions and as promotion criteria (Barwick, 2016).

Forms of knowledge translation

Early knowledge translation efforts used a push approach, a one-way process in which researchers sought to communicate their research findings and evidence to potential users of research (Lavis, Ross, Mcleod, & Gildiner, 2003). As the process of knowledge translation has developed, other models, such as pull, knowledge exchange, and integrated knowledge translation models have evolved (Lavis, Lomas, Hamid, & Sewankambo, 2006). These more interactive models involve ongoing linkages between researchers and decision makers (Ward, Smith, Foy, House & Hamer, 2010; Ginsburg, Lewis, Zackheim, & Casebeer, 2007; Landry, Amara, & Lamari, 2001). These models reflect the growing evidence that two-way communication, the development of partnerships, and interaction between researchers, decision makers, and other stakeholders leads to more successful translation (Bowen & Martens, 2005; Greenhalgh & Wieringa, 2011; Lavis et al., 2003).

Two broad categories of knowledge translation have been identified (Graham et al., 2006; McGrath et al., 2009; Straus et al., 2013): end-of-grant knowledge translation and integrated knowledge translation.

End-of-grant knowledge translation involves activities initiated by researchers to disseminate research results through the traditional academic methods of conference presentations, peer-reviewed publications, and website postings as well as tailored messages for specific audiences such as workshops for clinicians and policy-oriented briefs for administrators (Graham et al., 2006).

Integrated knowledge translation involves researchers engaging research stakeholders or users of the knowledge generated by the research throughout the research process, including determining the research questions (Bowen & Graham, 2013; Graham et al., 2005; Graham & Tetroe, 2009; Kothari & Wathen, 2013; McGrath et al., 2009; Riley et al., 2013). As defined by McGrath and colleagues (2009),

Integrated knowledge translation is a collaborative, participatory, action-oriented way of conducting research that results in the co-creation of knowledge by researchers and knowledge users. The end result of this collaboration is the integration of research findings into clinical practice in a more structured, efficient, expedient and effective manner. (McGrath et al., 2009)

What distinguishes integrated knowledge translation from other approaches is that it involves stakeholders at the beginning of the project and maintains their engagement throughout. Stakeholders commonly include the public, patients, clinicians or decision makers. Knowledge users may be involved in shaping the research questions, deciding on the methodology, helping with data collection and tools development, interpreting the study findings, crafting the message, disseminating the research results and moving the results into practice. This approach is likely to lead to different research paradigms being adopted, with less reliance on trial-based efficacy studies such as randomised control trials (Kessler & Glasgow, 2011; Riley et al., 2013), and more use of practice-based and pragmatic research models that allow greater flexibility and rapid learning (Glasgow, 2013; Glasgow & Riley, 2013; Green, 2006, 2008; Petticrew, 2013; Scott, 2013; Riley et al., 2013; Westfall et al., 2007).[5]

Enablers of successful knowledge translation

The following factors have been identified as important for successful knowledge translation.

- *Building partnerships, collaborations and relationships.*

  Successful knowledge translation relies upon building partnerships, collaborations and, above all, personal contact between researchers and research-users, usually from the outset (Bennett & Jessani, 2011). This makes knowledge translation an intensely social process (Bowen & Martens, 2005; Bennett & Jessani, 2011; Greenhalgh & Wieringa, 2011; Innavaer et al., 2002): building trust, respect and rapport can be 'more potent than logic and more compelling than evidence' (Bennett & Jessani, 2011). Engagement between researchers and research user groups facilitates an understanding of each other's environments that helps the utilisation process (Bennett & Jessani, 2011; Mitton et al., 2007). Thus, building genuine partnerships is the key to successful knowledge translation (Bennett & Jessani, 2011; Greenhalgh & Wieringa, 2011; Innavaer et al., 2002) and is a strong predictor of successful outcomes (Bowen & Martens, 2005) and greater take-up of research (Phipps, Jensen, & Myers, 2012). However, building such partnerships takes time (Bowen & Martens, 2005), and involves open dialogue, and the development of shared goals (Innavaer et al., 2002; Ginsburg et al., 2007; Dobbins, DeCorby, & Twiddy, 2004).

- *Understanding the service and organisational context.*

  What works in one context may not work in another (Cartwright, 2013; Cartwright & Hardie, 2012) – we cannot assume that what one organisation or jurisdiction was able to implement successfully can be applied with equal success in another organisational or policy setting (Campbell, 2012). Successful knowledge translation therefore requires that the researchers work with the stakeholders to develop a clearer understanding of the context in which the knowledge is aiming to operate (Greenhalgh & Wieringa, 2011; Campbell, 2012).

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5   While integrated knowledge translation has many important benefits for disseminating a broad range of research, it is not appropriate for all types of research; not all health research projects will lend themselves to being able to do effective integrated knowledge translation (i.e. basic science).

- *Tailoring knowledge.*

  Tailoring messages to fit the needs and knowledge base of particular audiences increases the chances of the research evidence being understood and utilised (Campbell, 2012; Mitton et al., 2007; Phipps et al., 2012). Knowledge translation processes and strategies must involve tailoring not only the knowledge but the timing, setting and format of dissemination for each audience (Greenhalgh & Wieringa, 2011; Mitton et al., 2007; Lomas, 1997). van der Heide and colleagues (2016) have developed a tool to enhance transparent and unambiguous communication on scientific evidence by knowledge workers.

- *Building capacity.*

  Explicit efforts to build the capacity of researchers, policy makers and practitioners are needed for successful knowledge translation. Collaborative research depends upon researchers developing teamwork and partnership skills, as well as learning to acknowledge the expertise of non-academic partners (Bowen & Martens, 2005). Through knowledge translation partnerships, researchers can gain a better understanding of the needs and circumstances of policy makers and practitioners, and learn how to align their research to meet these needs more effectively. Similarly, as policy makers become participants in setting the research agenda, or as a consumer of the evidence base, they gain a better understanding of the demands of the research process and are more able to frame realistic research questions (Campbell, 2012).

None of this is easy. According to Shonkoff (2000), bridging the gap between the three distinct cultures of research, policy, and practice[6] presents many challenges:

> *Tensions among researchers, policymakers, and practitioners are inevitable. Science is focused on what we do not know. Social policy and the delivery of health and human services are focused on what we should do. Scientists are interested in questions. Policymakers and practitioners are interested in answers. Scholars embrace complexity. Policymakers demand simplicity. Scientists suggest that we stop and reflect. Service providers are expected to act. Few researchers have the temperamental fortitude for the messy, action-oriented world of social and political activism. It is a rare practitioner who has the patience or the caution of a meticulous scientist. The intersections among these three domains represent a true cross-cultural experience. The capacity to navigate across their borders, to speak and understand their distinctive languages, and to achieve credibility in all three worlds while maintaining a sense of intellectual integrity in each, requires respect for their differences as well as a commitment to their shared mission. (Shonkoff, 2000)*

Shonkoff suggests that competence at the interface of science, policy, and practice requires mastery of three cross-cutting challenges: understanding the rules of evidence, understanding the influence of ideology and values, and understanding the importance of professional respect and security.

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6   There is a fourth 'culture' that needs to be considered in this context – the domain of parenting and child-rearing. One of the aims is to raise public awareness of research evidence and its implications for child rearing, and to shape parental caregiving practice.

The knowledge translation pathway to impact

One way of understanding the overall process of knowledge translation is as a pathway from research to impact. As depicted in Figure 1, this pathway involves a number of distinct phases or steps, forming a cycle.
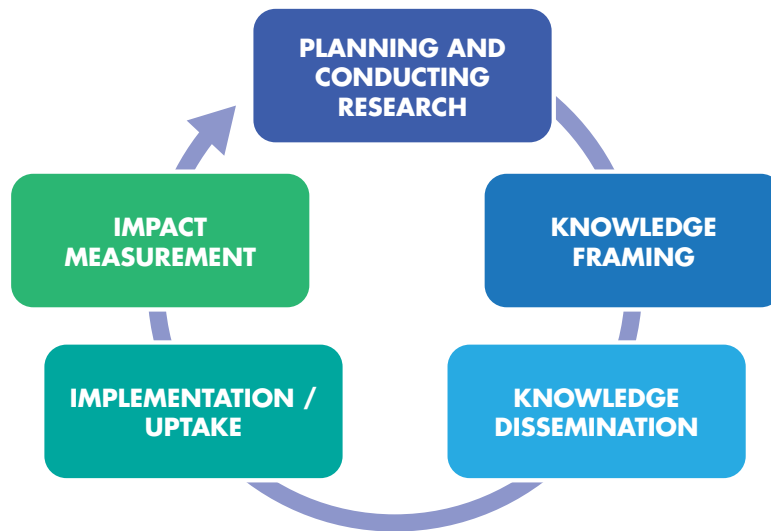

Figure 1: The knowledge translation pathway to impact.

- *Planning and conducting research* – this involves framing of research questions with the 'end in mind', i.e. with a clear idea of how the research will be applied.
- *Knowledge framing* – this involves framing messages from research in various ways for different audiences.
- *Knowledge dissemination* – this involves various strategies for ensuring that the framed messages reach their intended targets.
- *Implementation/uptake* – this involves strategies for promoting the adoption of proven strategies into practice.
- *Impact measurement* – this involves efforts to measure the extent to which the proven interventions were adopted and whether they had the desired impact.

Each of these steps is considered in more detail in the following sections.

Planning and conducting research

Knowledge translation is not something that occurs once research has been completed, but should be an integral part of planning and conducting research. To increase the chances that research results will be useful to and used by practitioners, research should always be framed with the end in mind, that is, with a clear idea of what the outcomes of the research will be and how the research will achieve these outcomes. When the desired outcomes include the adoption of research findings by practitioners or incorporation of findings into policies, then the research plan should specify the steps taken to ensure that this happens.

For example, Searles and colleagues (2016) have developed a research program logic model that identifies (1) the need being addressed by the research program; (2) the research activities being supplied to meet the 'need'; (3) the expected research outputs; (4) the end-users of those research outputs; and (5) the anticipated impact from the use of the research outputs. This model requires the researcher to identify those who will use the research products, which, for basic research might be other basic scientists or pharmaceutical companies interested in progressing the research, and for population health research might be public health authorities (Searles et al., 2016).

Developed by an Australian Research Council (ARC) working group, the Research impact pathway[7] shown in Table 1, is designed to help researchers think about the logic pathway underpinning their research and the expected immediate outcomes and long-term benefits of their research.

Table 1: Research impact pathway (ARC, 2015).

RESEARCH IMPACT PATHWAY				
INPUTS	**ACTIVITIES**	**OUTPUTS**	**OUTCOMES**	**BENEFITS**
• Research Income • Staff • Background IP • Infrastructure • Collections	• Research Work and Training • Workshop and Conference Organising • Facility Use • Membership of Learned Societies and Academies • Community and Stakeholder Engagement	• Publications including E-Publications • Additions to National Collections • New IP: Patents and Inventions • Policy Briefings • Media	• Commercial Products, Licences and Revenue • New Companies – Spin offs, Start Ups or Joint Ventures • Job Creation • Implementation of Programs and Policy • Citations • Integration into Policy	• Economic, Health, Social, Cultural, Environmental, National Security, Quality of Life, Public Policy or Services • Higher Quality Workforce • Job Creation • Risk Reduction in Decision Making

In order to increase the likelihood that the research findings will be relevant to the needs of key stakeholders, policy makers and practitioners, researchers need to engage them in framing research questions. This is the rationale underpinning the integrated knowledge translation approach in which researchers engage research stakeholders or users of the knowledge generated by the research throughout the research process, including determining the research questions (Bowen & Graham, 2013; Graham et al., 2005; Graham & Tetroe, 2009; Kothari & Wathen, 2013; McGrath et al., 2009; Riley et al., 2013). The stakeholders may include the potential users of the research, those funding the research, and the institutions where the research is being conducted (such as Melbourne Children's).

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7 http://www.arc.gov.au/research-impact-principles-and-framework

Knowledge framing

The second phase of the research-to-impact cycle is knowledge framing. To enable research knowledge to be shared, it must first be framed or transformed into a form that enables knowledge users (i.e. policy makers, practitioners and parents) to understand, benefit from and make use of it.

One of the key skills involved in knowledge framing is the ability to write clearly and present ideas in ways that can be readily understood by a wide range of audiences. The psychologist Stephen Pinker – author of a number of influential books that bridge the divide between the academic and lay worlds (Pinker, 1994, 2002, 2007, 2011) – has also written a book on writing (Pinker, 2014) in which he argues that the best single explanation as to why people write bad prose is what he calls the 'Curse of Knowledge' – the difficulty in imagining what it is like for someone else not to know something that you know. Academic writers often use technical terms, abbreviations, and assumptions that their readers have no way of knowing because they haven't had the same training. Pinker argues that most bad prose is not the result of deliberate attempts to dazzle or impress an audience with one's erudition but the result of a failure to get inside the head of the reader. Academics and researchers are not usually trained in writing in ways that communicate effectively with non-researchers, and there is a case to be made for having dedicated writers to support them in this task.

Another of the key skills in knowledge framing is *knowledge synthesis*. This can only be undertaken once a sufficient body of evidence has accumulated.

Various definitions and descriptions of knowledge synthesis have been proposed (Graham, 2012; Graham & Tetroe, 2009; Grimshaw, 2010; Kastner et al., 2012; Whittemore et al., 2014). The Canadian Institutes of Health Research (2008) defines knowledge synthesis as "the contextualization and integration of research findings of individual research studies within the larger body of knowledge on the topic," while according to Kastner, Tricco, and Soobiah, (2012), "a knowledge synthesis attempts to summarise all pertinent studies on a specific question, can improve the understanding of inconsistencies in diverse evidence, and can identify gaps in research evidence to define future research agendas."

There are a number of ways of conducting knowledge syntheses (Dunst, 2016; Grimshaw, 2010; Kastner et al., 2102; Whittemore, Chao, & Jang, 2014), including systematic reviews, realist syntheses, narrative syntheses, meta-analyses, meta-syntheses, and practice guidelines. Guidelines for conducting knowledge syntheses have been developed by Grimshaw (2010), Kastner et al. (2012), and Whittemore et al. (2012).

Another form of knowledge synthesis is books written for the educated lay public that summarise knowledge about particular body of knowledge or research. These may be written by researchers and academics or by science writers. Notable examples of recent key syntheses by researchers and academics include books by Prescott (2015), Dietert (2016), Gopnik (2016), Marmot (2015) and Putnam (2015). Similarly useful books by science writers include those by Collen (2015), Marchant (2016) and Pinker (2015). These books are valuable not only in summarising and synthesising wide areas of research, but also in being written in a way that makes the findings much more accessible to a wider audience.

Dissemination

The third stage of the research-to-impact pathway is dissemination. This may involve the targeted distribution of information and intervention materials to specific audiences (Gagnon, 2011; Neta et al., 2015), or active and planned efforts to persuade target groups to adopt an innovation (Greenhalgh et al., 2004a, 2004b, 2005; Lomas, 1993; Shea, 2011).

There are many ways research findings can be disseminated including:

- grey literature publications – policy briefs, reports, publications for practitioners, working papers, books, articles academic/research websites e.g. The Conversation
- the internet – parenting websites (e.g. Raising Children Network)
- teaching and training
- presentations to government (e.g. at government inquiries)
- conference presentations
- evidence reviews – systematic reviews (Elliott & Resnik, 2014; Grimshaw et al., 2012; Gough et al., 2013; Smith et al., 2011), rapid evidence reviews (Khangura, Konnyu, & Cushman, 2012; Thomas, Newman, & Oliver, 2013), review-based briefings (Chambers & Wilson, 2012), realist systematic reviews (Pearson, Chilton, & Woods, 2012) and meta-narrative reviews (Greenhalgh et al., 2005)
- web-based directories of 'what works' (which have their limitations – see Cohen, 2016)
- strategies for influencing policy (Gluckman, 2014)
- framework analysis (Bales & Kendall-Taylor, 2014; Kendall-Taylor & Lindland, 2013; Lindland, Fond, & Haydon, 2015).

Each of these methods has their strengths and weaknesses. For instance, publishing as grey literature avoids some of the accessibility barriers of the research literature (such as cost) but has its own barriers to access (e.g. it is not organised in a systematic way – McCallum, 2016).

While the field of knowledge translation promotes the uptake of evidence-based practices, the methods used to promote these practices are often not themselves based on robust evidence, and therefore there is little guidance available about which interventions work and under which circumstances (Bhattacharyya, Estey, & Zwarenstein, 2011; Grol & Grimshaw, 2003; Grimshaw & Eccles, 2004). To address this problem, Bhattacharyya et al. (2011) recommend a combined approach whereby service managers routinely incorporate simple evaluation designs into program implementation to increase the impact of their services, while researchers seek to build knowledge of effectiveness of interventions by conducting rigorous evaluations with rich descriptions of context and implementation, exploring reasons for success and failure.

Knowledge translation involves a diverse array of strategies that connect researchers and research users to enhance research utilisation. These include knowledge brokers, networks, and communities of practice.

In the health context, knowledge brokerage is defined as:

> *all the activity that links decision makers with researchers, facilitating their interaction so that they are able to better understand each other's goals and professional cultures, influence each other's work, forge new partnerships, and promote the use of research-based evidence in decision-making. (Lomas, 2007)*

Knowledge brokers help connect researchers and research users for sharing and exchange of knowledge (Bennett & Jessani, 2011; Caswill & Lyall, 2013; Gagnon, 2011; Head, 2010; Knight & Lyall, 2013; Mitton et al., 2007), and facilitate the translation of knowledge to end users (Lomas, 2007; Bennet & Bennet, 2008). Sometimes known as knowledge intermediaries (Meagher & Lyall, 2013), knowledge brokers seek to bring people together and foster relationships through a common understanding of each stakeholder's needs (Mitton et al., 2007).

Knowledge brokers may be individuals, teams, supporting agencies, and resources and supports that make research and decision making more accessible to each other (Grimshaw et al., 2012; Knight & Lyall, 2013: Lomas, 2007)

Three different approaches to brokering have been identified within the literature (Ward et al., 2009b):

- The first relates to the creation, diffusion and use of knowledge and brokering and is seen as a way of facilitating or managing these activities. In this approach brokers act as 'knowledge managers'.
- In the second, brokering focuses on the interface between the "creators" and "users" of knowledge and seeks to foster links between the two. In this approach brokers act as linkage agents.
- The third approach to brokering is designed to enhance access to knowledge by providing training to knowledge users which may lead to positive social outcomes. In this context brokers act as capacity builders (Ward et al., 2009b).

Researchers, think tanks and knowledge translation centres also play an important role in knowledge dissemination (Smith, Kay, & Torres, 2013). Examples include the influential Centre on the Developing Child at Harvard University, as well as RCH/MCRI's own Centre for Community Child Health.

Knowledge translation is necessarily interdisciplinary, requiring the involvement of several disciplines to translate knowledge from one type of research to another (e.g. to move a basic science discovery into clinical practice) (Albrecht et al., 2016; Rubio et al., 2010). To tackle the kind of complex social and health problems increasingly facing society, large interdisciplinary teams are needed, although it can be a challenge having these initiatives recognised and valued by the universities (Bammer, 2006, 2008; Bammer & Smithson, 2008; Baumwol, Mortimer, Huerta, Norman & Buchan, 2011; Norman, Best, & Mortimer, 2011). Collaboration among disciplines through multidisciplinary teams can facilitate the emergence of novel concepts and approaches to addressing important health issues (Rubio et al., 2010).

What is known about the effectiveness of different forms of dissemination? A review of knowledge translation strategies to promote research uptake in health settings found that the overall quality of available research was poor (Albrecht et al., 2016). According to Bhattacharyya et al. (2011), the evidence base for interventions to change clinical practice is modest but growing. They argue that, to increase the use of evidence-based implementation strategies, service managers and researchers should work more closely together. Managers should routinely incorporate simple evaluation designs into program implementation to assess and increase the impact of their services, whereas researchers should focus on creating cumulative knowledge through rigorous designs and rich descriptions of context and implementation to explore reasons for success and failure.

Greenhalgh et al. (2004a, 2004b, 2005) conducted a systematic literature review of the diffusion of service innovations, and identified the conditions that promote the adoption of innovations by individuals, organisations and systems. They recommend a whole-systems approach to implementation research that is theory-driven, process- rather than 'package'-oriented, participatory, collaborative and co-ordinated, multidisciplinary and multi-method, and ecological. They identify two particularly promising approaches to whole-systems research in health service delivery and organisation: participatory action research, and realistic evaluation (and the linked realist synthesis) approach developed by Pawson and colleagues (2013).

Implementation/uptake

The fourth phase of the research-to-impact cycle concerns the implementation or uptake of research findings. Dissemination of research findings, no matter how effective, is no guarantee of implementation or uptake. As a result of effective dissemination strategies, policy makers and practitioners may become more aware of pertinent research evidence but still not integrate them into policies and practices.

Implementation is the use of strategies to adopt and integrate evidence-based health interventions and change practice patterns within specific settings (Neta et al., 2015). The Australian Research Council (2015) defines uptake and adoption as:

> *The application of research outputs by users, resulting in outcomes. This may involve complex processes over time, whereby research outputs (e.g. knowledge, technologies, intellectual property) are adapted, built upon and operationally applied. Evidence of engagement, uptake and adoption, may include licenses, incorporation into policies or standards, use of tools, etc. (ARC, 2015)*

There are two aspects to the process of implementation: deciding what to implement, and then ensuring that the actual implementation is done effectively.

Effective strategies that assist evidence-based decision making for healthcare professionals are crucial to ensuring high-quality patient care and outcomes (Albrecht et al., 2016). However, choosing an effective intervention strategy is not simply a matter of choosing an intervention from a list of 'proven' strategies. Instead, one must take account of other contributing factors, including the outcome that is desired, the circumstances in which the intervention is to be implemented, and the values and preferences of those involved (Moore, 2016).

Effective strategies to ensure more effective use of proven interventions have been the focus of the implementation science approach (Bertram et al., 2014; Durlak, 2016; Fixsen, Blasé, Naoom, Friedman & Wallace, 2005; Pew-MacArthur Results First Initiative, 2016). According to the leading international journal in the field, Implementation Science,

> *Implementation research is the scientific study of methods to promote the systematic uptake of proven clinical treatments, practices, organisational, and management interventions into routine practice, and hence to improve health.[8]*

The assumption behind the implementation agenda is that, to get better results, we need to be much more thorough about ensuring that practitioners are able to deliver evidence-based programs faithfully and consistently. However, while much progress has been made in the implementation science field (Bertram et al., 2014; Durlak, 2016), there are some problems with this strategy (Cartwright, 2013; Greenhalgh et al., 2014; Hammersley, 2013; Moore, 2016). One concern is that the overemphasis on following algorithmic rules in decision-making 'can crowd out the local, individualised, and patient initiated elements of the clinical consultation' (Greenhalgh et al., 2014). Alternative models of evidence-informed decision making that reconcile evidence-based practice and the need to respond to patient values and priorities have been proposed (Armstrong-Petticrew, 2014; Littell & Shlonsky, 2009; Moore, 2016).

Enablers of effective implementation and uptake

Durlak and DuPre (2008) reviewed the research on the influence of implementation on program outcomes and the factors affecting implementation, and compared their results with three other systematic narrative reviews (Greenhalgh et al., 2005; Fixsen et al., 2005; Stith, Pruitt, & Dees, 2006). They found substantial overlap regarding specific factors that affect implementation, with all four reviews agreeing on the importance of 11 factors: funding, a positive work climate, shared decision-making, co-ordination with other agencies, formulation of tasks, leadership, program champions, administrative support, providers' skill proficiency, training, and technical assistance.

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8   http://implementationscience.biomedcentral.com/about

In a subsequent review, Durlak (2016) identified ten important points concerning implementation:

1. Implementation refers to the ways a program is put into practice and delivered to participants.
2. Implementation is a multi-dimensional concept with at least eight related components.
3. Quality implementation is an essential component of effective programs.
4. Monitoring implementation is an essential element of all program evaluations.
5. It is extremely costly to ignore implementation.
6. Adaptations are common and may or may not improve program outcomes.
7. Effective professional development services are essential for quality implementation.
8. Multiple ecological factors affect implementation.
9. There are multiple steps and activities involved in achieving quality implementation.
10. Quality implementation requires collaboration among multiple stakeholders.

To support the effective implementation of evidence-based interventions, a number of core implementation drivers or components have been identified as being needed (Bertram et al., 2014; Fixsen et al., 2005, 2009). There are three types of drivers:

- Competency drivers develop the competence and confidence of practitioners by ensuring appropriate staff selection, training, coaching, and performance assessment.
- Organisation drivers create a more hospitable administrative, funding, policy, and procedure environments to ensure that the competency drivers are accessible and effective as well as to ensure continuous quality monitoring and improvement with attention to population outcomes.
- Leadership drivers address both adaptive and technical challenges, and are needed to establish, support and monitor the competency drivers and the organisation drivers throughout implementation stages (Bertram et al., 2014).

Impact measurement

The fifth phase of the research-to-impact cycle is impact measurement.

Within academia, impact refers to the influence that research has on one's fellow researchers. There are well-established methods of measuring this form of impact including publication in high-impact journals, and citations by other researchers.[9] However, there is increasing recognition that research should also be judged by its effects on the broader society in addition to building the academic knowledge base (Greenhalgh et al., 2016; Penfield et al., 2014). Research impact is now broadly conceptualised as all the diverse ways that research benefits individuals, organisations and nations through increasing effectiveness of public services and policy, improving quality of life and health, or economic benefits (Economic and Social Research Council, 2016).

Recent definitions of research impact capture this shift (Graham, 2012; Greenhalgh et al., 2016; Searles et al., 2016). According to the Australian Research Council (2015), research impact is:

> *the demonstrable contribution that research makes to the economy, society, culture, national security, public policy or services, health, the environment, or quality of life, beyond contributions to academia. (ARC, 2015)*

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9 Although the use of this methodology to evaluate research is credible and acceptable to the research community in some countries (e.g. Australia), it has been met with greater hostility in others (e.g. the UK) (Guthrie et al., 2013).

Research Councils UK distinguishes between academic impact, and economic and societal impact. Academic impact is defined as the "demonstrable contribution that excellent research makes to academic advances, across and within disciplines, including significant advances in understanding, methods, theory and application. Economic and societal impact is "fostering global economic performance, and specifically the economic competitiveness of the UK, increasing the effectiveness of public services and policy, [and] enhancing quality of life, health and creative output" ('Pathways to Impact', 2016).

The Canadian Academy of Health Sciences (Graham, 2009) distinguishes between health, social and economic impacts:

> *'Health impacts' can be defined as changes in the healthy functioning of individuals (physical, psychological, and social aspects of their health), changes to health services, or changes to the broader determinants of health. 'Social impacts' are changes that are broader than simply those to health noted above, and include changes to working systems, ethical understanding of health interventions, or population interactions. 'Economic impacts' can be regarded as the benefits from commercialization, the net monetary value of improved health, and the benefits from performing health research. (Graham, 2009)*

All these definitions focus not only on academic impact, but on broader socio-economic impacts. The UK 2014 Research Excellence Framework has clearly focused their assessments on the individual elements of academic impact and impact beyond academia, a distinction not made so clearly in other countries (Greenhalgh et al., 2016).

Efforts to be more specific about the various forms of impact have been made. Davies and colleagues (2005) outline two categories of impact: instrumental and conceptual. Instrumental impacts show a clear connection between a study and an outcome, for example, changes in clinical practice, policy and behaviour. Conceptual impacts are less tangible, making them difficult to measure and assess, and are associated with increasing knowledge and informing decision making without a direct link. Research can contribute to the "formation of values, the creation of new understandings and possibilities, and to the quality of public and professional discourse and debate" (Davies, Nutley, & Walter, 2005). Capturing these conceptual impacts is methodologically challenging. Add to this the many different types of impact, relative to the different types of research – basic, applied, action, clinical, user-driven, translation, and so on (Kuruvilla, Mays, Pleasant, & Walt, 2006).

Across the literature and more broadly there are six classifications of research impact (Bornmann, 2012; Economic and Social Research Council, 2016):

- Academic – Scientific advances across and within disciplines.
- Capacity Building – Technical skill development.
- Conceptual – Understanding of policy issues, reframing debates.
- Instrumental – Development of policy, practice or service, shaping legislation, behaviour.
- Economic – Economic benefits to individuals, organisations, nations
- Social – Societal changes regarding benefits to individuals, organisations, nations.

Measuring impact

The need to measure the full impact of research is becoming increasingly acknowledged (ARC, 2015; Group of Eight and the Australian Technology Network of Universities, 2012). Traditional academic measures of impact – such as number of papers, impact factors of journals, frequency of citations, and number of research grants – primarily reflect the impact of research on other researchers operating with the academic 'bubble'. These self-referential measures are widely used by research granting bodies and academic institutions, but they do not capture other benefits of research, such as shaping the development of policies, practices and products, as well as broader societal and economic impacts (Barwick, 2014; Milat et al., 2015).[10]

In Australia and internationally, researchers are increasingly expected to be accountable for wider social impacts and produce value for money from their research, and funders are keen to demonstrate the benefits or research spending (ARC & DET, 2016; Greenhalgh et al., 2016; Milat et al., 2015). The ARC (2015) suggests that evidence of research impact could include the extent to which research outcomes have been taken up and used by policy makers, and practitioners, or have led to improvements in services or business. Impact measurement and the returns on investment of research are being used to highlight how funding is being used (Greenhalgh et al., 2016).

Guthrie and colleagues (2013) identified four reasons for research impact measurement:

1. Advocacy – to demonstrate the benefits of supporting research, enhance understanding of research and its processes among policymakers and the public, and to make the case for policy and practice change.
2. Accountability – to show that money has been used efficiently and effectively and hold researchers to account.
3. Analysis – to understand how and why research is effective and how it can be better supported, feeding into research strategy and decision making by providing a stronger evidence base.
4. Allocation – to determine where best to allocate funds in the future, making the best use possible of a limited funding pot.

Similarly, Penfield and colleagues (2014) identified the primary purposes of impact measurement as (1) enablers to monitor and manage the performance of research organisations, (2) accountability of the value of public spending, (3) to inform funding decisions, and (4) to understand the pathways to impact.

However, there is no simple way to measure and compare the less tangible socio-economic (non-academic) impacts from different types and disciplines of research. A number of frameworks have been developed to assist in better capturing and understanding the non-academic impacts of research (ARC & DET, 2016; Greenhalgh et al., 2016; Guthrie et al., 2013; Milat et al., 2015; Penfield et al., 2014).

Impact frameworks vary in their purpose, and it is important to consider who is being informed (Penfield et al., 2014), be it government, funders, or the public. Guthrie and colleagues (2013) provide a useful decision-making tree to help researchers determine what impact measurement tool is best suited to their particular purpose. Details of a range of impact measurement frameworks can be found in the Appendix.

The challenge of impact measurement

Measuring research impact is complex. The impacts of research are not easily quantified, there can be considerable time lags, and impact may be from accumulated knowledge and not a specific research finding (Guthrie et al., 2013).

In endeavouring to assess or evaluate impact, a number of difficulties emerge and these may be specific to certain types of impact (Penfield et al., 2013). Research and reviews of research impact measurement have highlighted several challenges to the measurement of research impact.

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10 Barwick (2014) argues that, from an impact perspective, counting grants and publications is 'true but useless'.

Time lag. The time lag between research and impact varies considerably. Observations of time to impact suggest an average of six years for research evidence to reach reviews, papers, and textbooks, and another nine years for the implementation of evidence into practice (Milat et al., 2015). Morris and colleagues (2011) identified an average of 17 years from research evidence to clinical practice. In an attempt to overcome the difficulties with time lags, research impact assessments have imposed specific timeframes and the flexibility of timeframes where appropriate, this presents its own difficulties of interpretation (Penfield et al., 2014). Importantly, early measurement of impact might create policies that result only in short-term benefits, disregarding potential long-term impacts (Bornmann, 2016). It is recommended that assessment periods allow enough time for impact to manifest, but not so long as to make verification of the impacts difficult for the stakeholders involved (Milat et al., 2015). The point at which assessment takes place will influence the degree and significance of that impact (Penfield et al., 2014).

Measuring social impact. As Bornmann (2016) notes, no standard method—such as bibliometrics—has emerged that can measure the benefit of research to society reliably and with validity. The search is ongoing for an equivalent of citation rates for measuring activities such as contributions to government policies or communication of research outcomes to non-academic audiences. Currently, universities mainly use case studies to determine the value of their research for society, but this methodology has not been standardised (Bornmann, 2016).

Attribution. Impact may occur, not only from targeted research, but serendipitously in the process of developing networks and translating knowledge (Penfield et al., 2014). Experts in impact measurement suggest the use of a theoretical framework to assist in identifying causality, through the mapping of actors, activities, linkages, outputs, and impacts of the research program being assessed (Penfield et al., 2014). The framework should be not linear but recursive, acknowledging the contextual environments that influence and interact with various aspects of the process (Penfield et al., 2014). The ability and ease of attributing impact decreases with time. In contrast, the impact or effect increases over time (Penfield et al., 2014) and as highlighted previously time to impact may be considerable. Over time, the networks involved and other knowledge that is built into the system along with the process of implementation, can create difficulty in attributing the impact to the initial piece of research (Bornmann, 2016; Penfield et al., 2014). Milat and colleagues (2015) suggest that the independent verification of processes along with end-user assessments can improve the attribution of effects.

Gathering evidence. Setting up the initial collection and measurement of impact poses some difficulties, in particular, there may be a lack of evidence. Baseline measures may not have been collected or may no longer be available. Future impact measurements will be able to overcome this by putting the required baseline data collection and research impact planning strategies in place (Milat et al., 2015; Penfield et al., 2014).

Implications

- The ultimate aim of Melbourne Children's research is to contribute to improving the health and wellbeing of children and young people, both within the hospital and in the wider community. Only rarely is research able to do this directly – instead, it contributes by influencing those who are directly responsible for providing the policies, services and environments that shape children's health and wellbeing.

- All research should be able to demonstrate how it contributes to evidence-informed decision making in real-world settings – including clinical practice (e.g. within RCH), community-based practice, policy making, public health messages, and parenting. All research should therefore begin with the end in mind, and have clear pathways for achieving these ends.

- Research should not occur in a separate world, separated from the real-world of policies, services and parenting challenges. To identify research outcomes that will be of value in making evidence-informed decisions in real-world settings, researchers should engage with the end users of their research – co-designing research with policy makers, practitioners and parents.

- Research is not a value-free zone or a purely technical exercise (Blewett, 2007) – personal and communal values and judgements shape the selection of research strategies and goals, and their application of findings into practice. Rather than seeking to eliminate the influence of politics and values, it would be better to acknowledge the role they play and engage with the potential users of research findings in selecting valued goals and designing research to meet these goals.

- Knowledge translation constitutes a research field in its own right, and needs to have dedicated resources and a research program addressing the specific translation needs of Melbourne Children's. There is a need for research into the effectiveness of different knowledge translation and dissemination strategies in reaching different target groups. Guidance on what that research should focus on has been provided by Greenhalgh et al. (2004a, 2004b).

- Knowledge translation is a practice specialty in its own right and needs dedicated resources devoted to the various forms of translation appropriate for the Melbourne Children's. As Head (2016) states, 'Strong arguments have been made for building high-level support networks and specialized bodies to foster research translation.'

Appendix

Research Impact Frameworks

With so many varying frameworks in existence, we narrowed the focus of our review to only peer-reviewed frameworks with strong theoretical underpinnings that had been used specifically within the health research sector.[11]

The Payback Framework

The Payback Framework (Buxton & Hanney, 1996) is a commonly used framework (see Figure A1). Developed in 1996, the framework incorporates both the academic and societal impacts from research and consists of a logic model and five categories. The logic model includes seven stages of research from conceptualisation to impact, and five categories – knowledge (e.g. academic publications), benefits to future research (e.g. training new researchers), benefits to policy (e.g. information base for clinical policies), benefits to health and the health system (including cost savings and greater equity), and broader economic benefits (e.g. commercial spin-outs) (Greenhalgh et al., 2016). This framework encompasses knowledge translation through the two interfaces for interactions between research and potential research users throughout all stages of the research process from creation to dissemination and implementation.
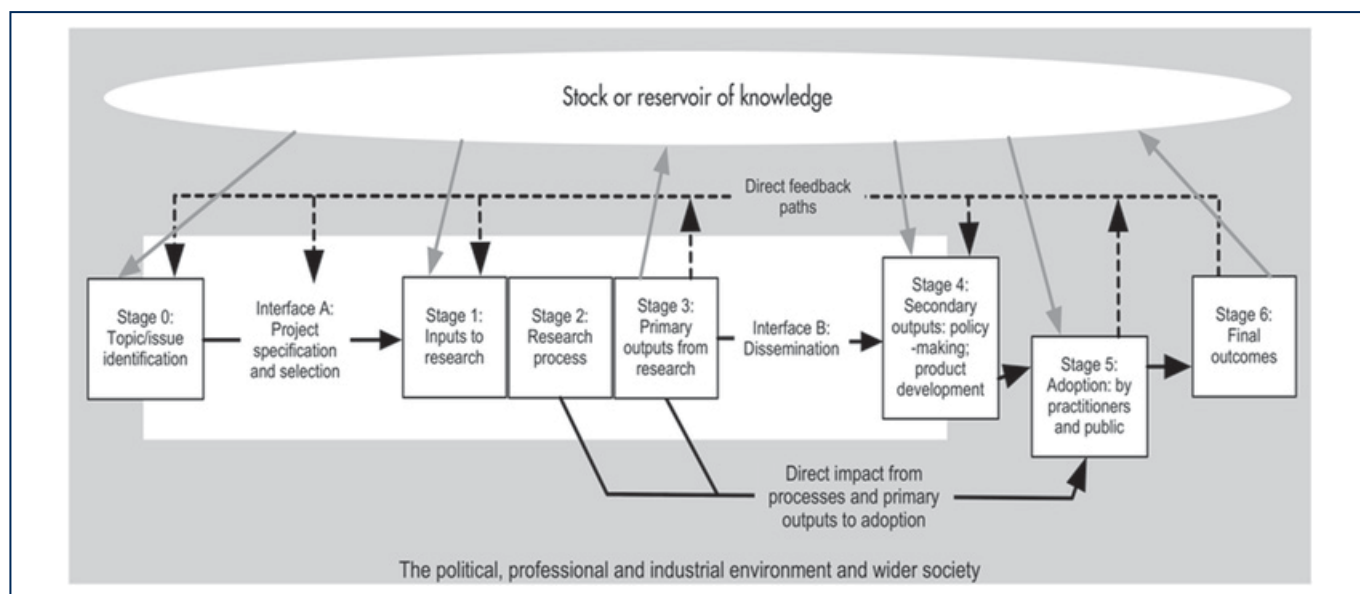

Figure A1: The Payback Framework (Buxton & Hanney, 1996).

The Payback Framework has been used within the health sector internationally. Organisations using the Payback Framework include the Canadian Institutes of Health Research, the Dutch Public Health Authority, the Australian National Health and Medical Research Council (NHMRC), and the Welfare Bureau in Hong Kong (Penfield et al., 2014).

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11 This list draws on a recent narrative review of Greenhalgh and colleagues (2016) that discusses six frameworks that have proven to be robust and useful, based on an as yet unpublished meta-synthesis of the impact framework literature published between 2004 and 2014.

Use of the Payback Framework involves measurement through case studies, researcher interviews, and document analysis, making this a resource and labour-intensive process. There are reports of adapted Payback Framework methodology to reduce the workload of impact assessment, but it is not known how or to what extent such changes would compromise the data.

Research Impact Framework

The Research Impact Framework, another commonly used framework, was developed in the UK by Kuruvilla et al. (2006) and has been validated through the empirical analysis of research projects at the London School of Hygiene & Tropical Medicine (Milat et al., 2015). It was originally developed by and for academics who were interested in measuring and monitoring the impact of their research. This model is a basic impact checklist intended for use by researchers who seek to identify and select impacts from their work without the need for other skills in research impact assessment (Greenhalgh et al., 2016). The checklist is designed to encourage reflection and discussion and includes research-related impacts, policy and practice impacts, service (including health) impacts, and an additional 'societal impact' category with seven sub-categories.

A pilot study of the framework found that participating researchers engaged readily with the Research Impact Framework and were able to use it to identify and reflect on different kinds of impact from their research. This framework is not as thorough as the Payback Framework and is not suited to a formal impact assessment by third parties (Greenhalgh et al., 2016; Milat et al., 2015).

The Canadian Academy of Health Sciences Framework

The Canadian Academy of Health Sciences (CAHS) Framework is a widely used adaptation of the Payback Framework (see Figure A2). Its adaptation is said to have created a 'systems approach'. The development of CAHS Framework was the result of a collaboration of international experts (academics, policy makers, and university heads). The Framework was then endorsed by research funders, policymakers, professional organisations and government across Canada, and refined through public consultation (Milat et al., 2015).

The CAHS Framework involves the assessment of context and the consideration of impacts within five categories:

- Advancing knowledge (measures of research quality, activity, outreach and structure).
- Capacity-building (developing researchers and research infrastructure).
- Informing decision-making (decisions about health and healthcare, including public health and social care, decisions about future research investment, and decisions by public and citizens).
- Health impacts (including health status, determinants of health – including individual risk factors and environmental and social determinants – and health system changes).
- Economic and social benefits (including commercialisation, cultural outcomes, socioeconomic implications and public understanding of science).
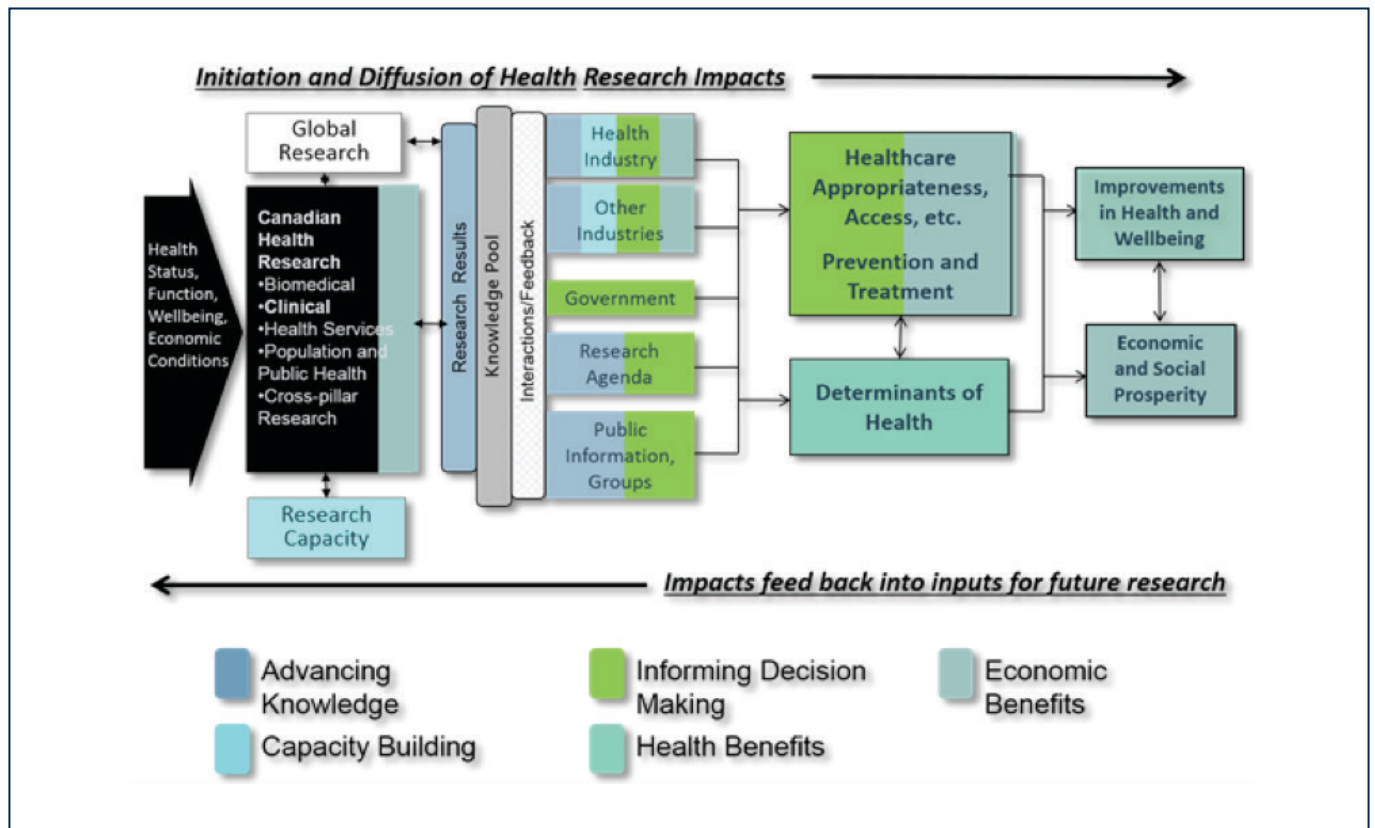
Figure A2: The CAHS Framework – biomedical (2009).

For each category, a menu of metrics and measures (66 in total) is offered, and users are encouraged to draw on these flexibly to suit their circumstances. By choosing appropriate sets of indicators, the CAHS Framework can be used to track impacts within any of the four 'pillars' of health research (basic biomedical, applied clinical, health services and systems, and population health – or within domains that cut across these pillars) and at various levels (individual, institutional, regional, national or international).

UK Research Excellence Framework

The 2014 Research Excellence Framework (REF) – an extensive exercise to assess UK universities' research performance – allocated 20 per cent of the total score to research impact. Each institution submitted an impact template describing its strategy and infrastructure for achieving impact, along with several four-page impact case studies, each of which described a program of research, claimed impacts and supporting evidence. These narratives, which were required to follow a linear and time-bound structure (describing research undertaken between 1993 and 2013, followed by a description of impact occurring between 2008 and 2013) were peer-reviewed by an intersectoral assessment panel representing academia and research users (industry and policy makers).

Other countries are looking to emulate the REF model (Morgan, 2014). An independent evaluation of the REF impact assessment process by RAND Europe (based on focus groups, interviews, survey and documentary analysis) concluded that panel members perceived it as fair and robust and valued the intersectoral discussions, though many felt the somewhat crude scoring system (in which most case studies were awarded 3, 3.5 or 4 points) lacked granularity. The 6679 non-redacted impact case studies submitted to the REF (1594 in medically-related fields) were placed in the public domain (http://results.ref.ac.uk) and provide a unique dataset for further analysis. In its review of the REF, the members of Main Panel A, which covered biomedical and health research, noted that "International MPA [Main Panel A] members cautioned against attempts to 'metricise' the evaluation of the many superb and well-told narrations describing the evolution of basic discovery to health, economic and societal impact".

The CSIRO Impact Framework

CSIRO conducts research aiming to address the scientific problems facing Australian industry and the nation. It has a legislated obligation to encourage and facilitate the application and use of research it conducts. To enable this to occur in a coordinated way, CSIRO developed and implemented an organisation-wide impact framework in 2010 (CSIR0, 2014), see Figure A3. The framework enables consistent planning, monitoring and evaluation of CSIRO's research. It is an 'input to impact' program logic model, based on the hypothesis that: ...creating impact begins with deploying inputs, to conduct research activities and produce outputs, which themselves are translated through short to medium term outcomes into long-term impact. (CSIRO 2014). While the impact framework depicts a linear process, it is operationalised with an understanding that science is serendipitous and agile in execution, with multiple feedback loops, that recognise the importance of engagement at all stages.

The framework is implemented through an impact planning and management pathway where impact statements are produced and aggregated to impact areas. The process is supported by the CSRIO Impact Evaluation Guide which provides impact evaluation principles and information (such as a standardised cost-benefit approach) to ensure comparability of impact evaluation findings and reports across the organisation.
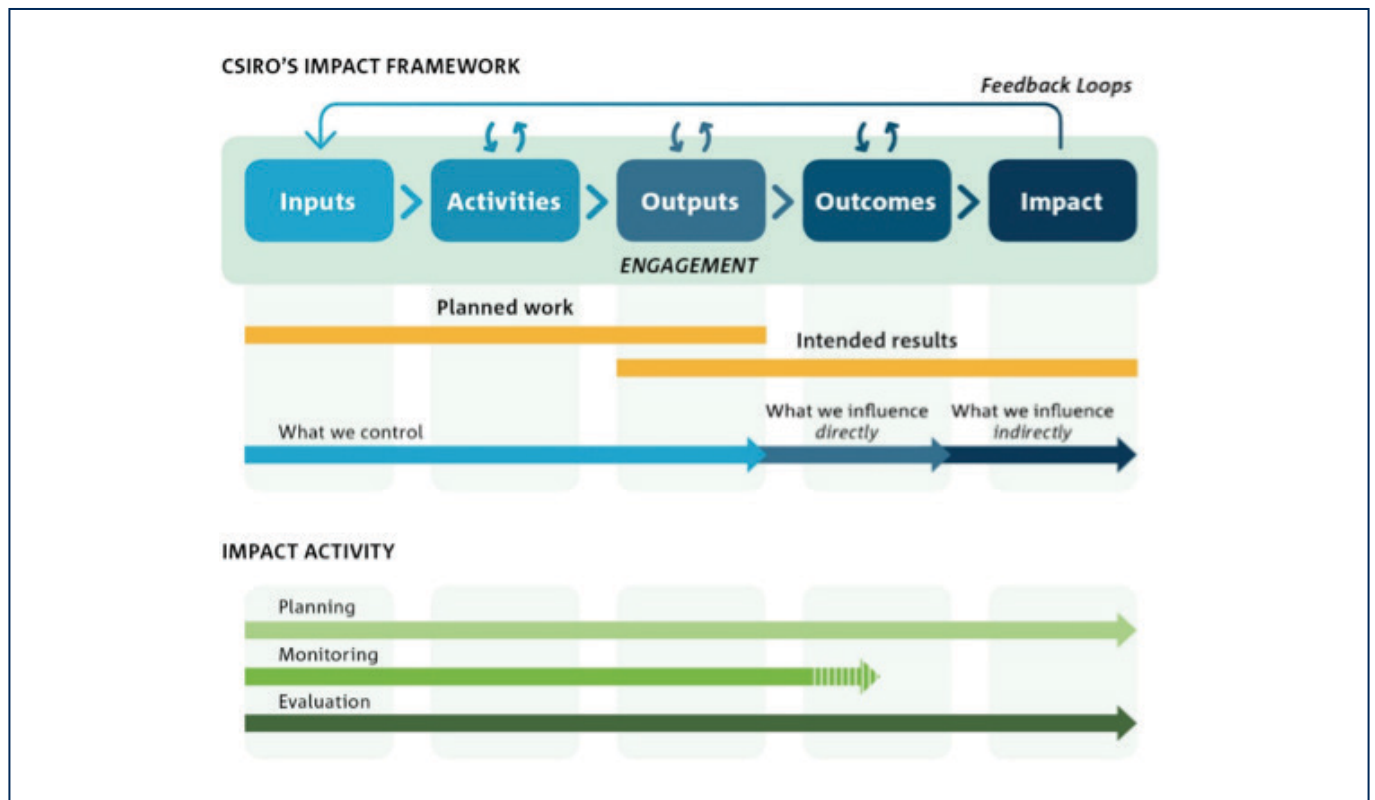

Figure A3: CSIRO's Impact Framework. (CSIRO, 2014).

Alongside the impact framework, the planning and management pathway, and the evaluation guide, CSIRO has also implemented a cultural program to support the organisation's outcome focus, customer service and impact delivery. This includes: strong leadership and accountability; capability building (training, learning and development); a focus on evidence of outcomes at all levels (not just inputs or compliance); outcome setting; review and amendment of staff induction, review, recruitment, promotions and rewards to reinforce and build desired impact behaviour; and individual training in the CSIRO Impact Framework.

The Co-produced Pathway to Impact

The Co-produced Pathway to Impact (Phipps et al., 2016) builds on a logic model that tracks the movement of knowledge by mapping the progress of research to impact through key stages (see Figure A4). The model builds on a logic model to emphasise the role of co-construction and collaboration in delivering research impact. Researchers and academics are not responsible for producing products, policies or delivering services. Subsequently, impact is mediated by others – impact occurs when researchers and/or academics collaborate with those who develop policies and products and deliver services. The model identifies:

- Dissemination: moving knowledge and research out of academic environments into policy and practice settings to allow it to progress towards impact.
- Uptake: knowledge is taken up by an organisation or individual as useful for informing decision making.
- Implementation: an organisation or individual uses the knowledge in the development of products, policies or services.
- Impact: the research-informed products, policies and services have an effect on the end user.

To address the risk of misinterpretation of linear models – that research evidence is simply 'transferred' to the end user, and the failure to recognise the collaboration to bring about impact – the Co-produced Pathway to Impact model retains the progression of a logic model while articulating the role of collaboration throughout the process to create interactive relationships between academic and non-academic partners to enable research to progress to impact. It mirrors the CAHS model, however it embeds collaboration throughout the research to impact process.
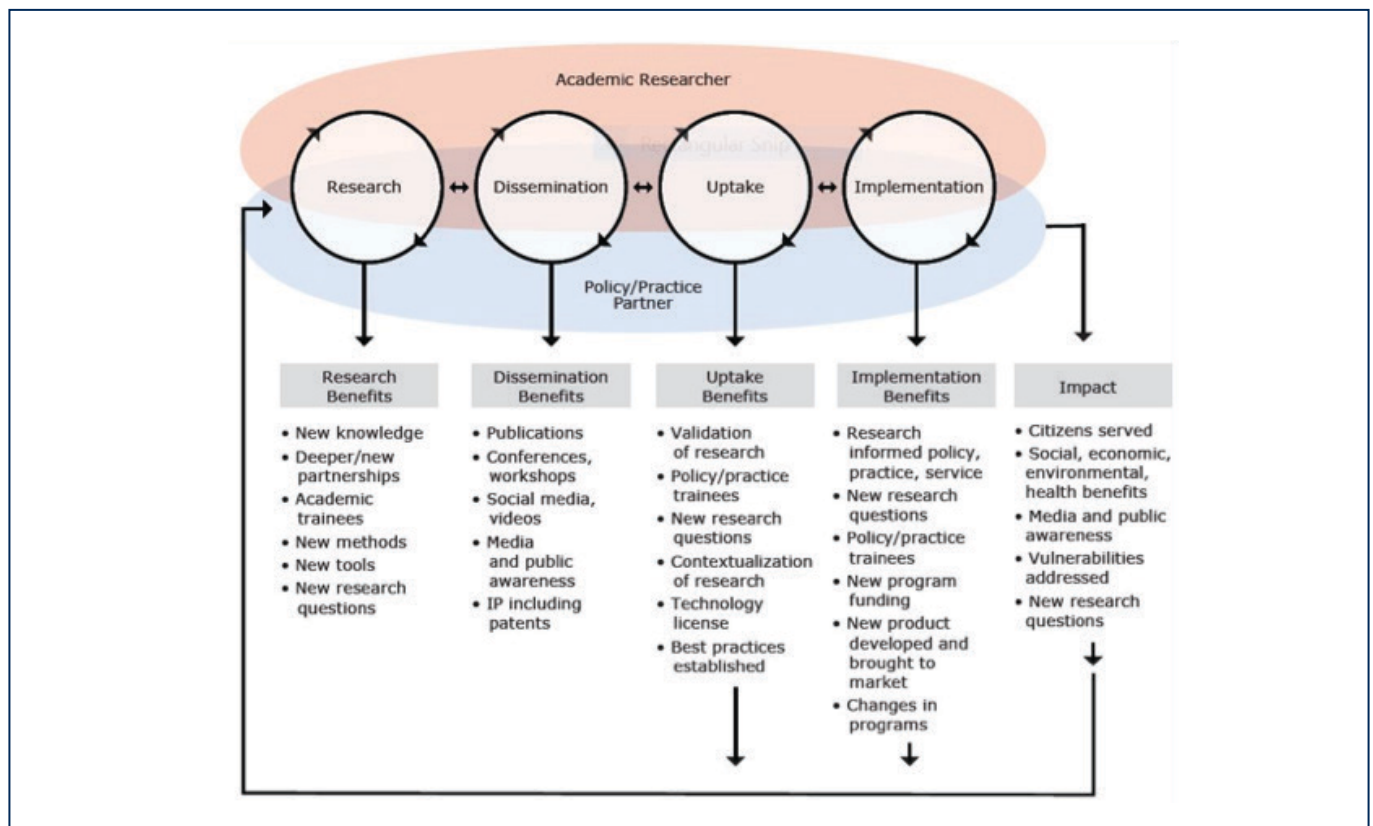

Figure A4: The Co-produced Pathway to Impact (Phipps et al., 2016).

The co-creation at each stage of the pathway accelerates the impact of research by ensuring the readiness of partners to take up findings due to their input into the nature of the research question, methods, context and interpretations, and enhancing their motivation and engagement with the research.

The RQ+ Assessment Framework

Ofir and colleagues (2016) describe a holistic approach and assessment framework for evaluating 'research' – the RQ+ Assessment Framework – that goes beyond the traditional deliberative means (e.g. peer review) and often used analytics (e.g. bibliometrics). They argue that determining the effectiveness of research (in terms of its relevance, use and impact) should not only involve researchers, research managers and funders but multiple stakeholders and potential users. This framework rates research on four dimensions: research integrity (the technical quality, appropriateness and rigor of the design and execution of the research), research legitimacy (the extent to which research results have been produced by a process that took account of the concerns and insights of relevant stakeholders), research importance (the importance and value to key intended users of the knowledge and understanding generated by the research), and positioning for use (the extent to which the research process has been managed, and research products/ outputs prepared in such a way that the probability of use, influence and impact is enhanced).

Research Impact Framework

Cohen, Schroeder and Newson (2015) describe and test a new impact assessment tool to measure the impact that health intervention research has on real-world policy and practice. This expanded impact assessment framework was tested on intervention studies funded over a five year period by Australia's NHMRC to determine if these studies had post-research real-world policy and practice impacts. As shown in Table A1, the framework groups different types of impacts into four levels of impact that might arise from intervention research: scholarly outputs; translational outputs; policy or practice impacts; and long-term population outcomes. Each impact level was populated with sub-categories or indicators to enable assessment of the type of impacts that occur at each level.

Using the framework, Cohen and colleagues found that individual studies did have concrete and measurable real-world impacts, although the magnitude of the impacts varied between studies. They suggest that the framework provides a systematic and multidimensional approach to impact assessment, but note that it is resource intensive and would need refinement if it is to be used on a routine basis.

Table A1: Research impact framework (Cohen et al., 2015).

SCHOLARLY OUTPUTS			
Publication, citations	New research funding, hypotheses or projects	Capacity building	Journal impact factor
TRANSLATIONAL OUTPUTS			
Plain language summaries, media engagement	Formal knowledge exchange processes	Lobbying government ministers or departments	Intervention packaged for implementation
POLICY AND PRACTICE IMPACTS			
Changes to practice	Changes to services	Policy change	Commercialisation
LONG-TERM POPULATION OUTCOMES			
Behaviour change	Health outcomes	Social outcomes	Economic outcomes

Other frameworks include the:

- Social Impact Assessment Methods for research and funding instruments through the study of Productive Interactions (SIAMPI) (Penfield, 2014).
- The Banzi Framework (Milat et al., 2015).
- Case study methodology (Group of Eight and the Australian Technology Network of Universities, 2012).
- The Framework to Assess the Impact from Translational health research (FAIT) (Searles et al., 2016).

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