

material. The written description of the interventions had 715 words. Our diagram (fig 3) shows immediately the cumulative nature of the experimental interventions.

Although each intervention is complex, the comparison between successive interventions is relatively simple, each differing from the last by a single component. The year long interval between the control intervention and trial outcome also stands out, in contrast to the six month interval in the experimental arms.

Advantages of using graphs

Graphical depiction of an entire intervention allows its structure to be quickly understood. With the experimental and control interventions placed side by side on the diagram, differences between them—such as in the time elapsing between their delivery and the trial outcome—become obvious.

We believe that the discipline of constructing a diagram will help at the design stage of a trial. By focusing attention on the components of the intervention, it prompts researchers to think through the structure, timing, and contents of each component in detail and to describe the components adequately.

The exercise should help to ensure that the control intervention has been adequately considered and described and that the difference between the experimental arm and the control arm is appropriate for measuring the effect of the intervention.

For the reader of the trial a graph will allow the details of an intervention to be quickly and easily grasped. Aspects that may be missed in a long verbal description stand out clearly, thus the differences between experimental and control interventions become obvious.

The CONSORT trial flowchart has improved transparency and accurate reporting of the num-

By focusing attention on the components of the intervention, it prompts researchers to think

SUMMARY POINTS

Complex interventions often require long explanations that are difficult to follow

Graphical representation could clarify descriptions

The graph would prompt researchers to focus on the structure and timing and ensure appropriate comparisons

Readers would be able to see the differences between comparison groups immediately

bers of participants at different stages of a study. We suggest that our proposed graphical method would similarly increase the clarity of reporting of complex intervention trials.

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The in-between world of knowledge brokering

For research findings to effectively influence health services' delivery of care needs an intermediary, says **Jonathan Lomas**

The ultimate aim of people engaged in health research is to get the health service's workforce, its employers, and its suppliers to have knowledge of facts (as represented by research results) and to use these facts in their practices, policies, and products. How well organised is research to achieve this aim? And how receptive and oriented are health services to this aim? The answers seem to be "not well organised" and "not very receptive." The interpersonal connections needed to bridge this know-do gap are not yet in place.¹ An emerging role therefore exists for knowledge brokers, supported by knowledge brokering resources and agencies, to fill the gap.

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Disconnection between research and health services worlds

The old adage "form follows function" is poorly reflected in the production and use of health research. The research world favours grant acquisition and academic publication over knowledge synthesis and engagement with the health service.² Researcher to researcher communication about the next study ("more research is needed") is well organised and all too common^{3,4}; researcher to practitioner dialogue about implementing findings ("actionable messages") is poorly organised and all too rare.⁵

Structures and incentives in the health system do not

Box 1 | In the nirvana that is a research based health service...**Universities would reward**

- Inclusion of decision makers in research processes
- Creation of centres that connect researchers directly with health service clinicians, managers, and policy makers
- Synthesis of interdisciplinary bodies of knowledge into key actionable messages relevant to pressing service questions
- Dissemination of brief, plain language research summaries through face to face exchanges between the doers and users of research

The health service would reward

- Active involvement of its clinicians, managers, and policy makers in research relevant to pressing health service questions
- Support for operational research and development on its own activities
- Change management driven by research based evidence
- Inclusion of researchers in decision making processes

fare much better. The governance, organisation, and delivery of services reward consensus more than use of research; coordination with stakeholders generally trumps collaboration with researchers; and strategic positioning triumphs over decision making informed by research.⁶ Indeed, research is often seen as the opposite of action, not the antidote for ignorance.

Exceptions to these generalisations exist—the rise of research based guidance organisations such as the National Institute for Health and Clinical Excellence in the United Kingdom, the development of data driven practice organisations such as the Veterans Administration Health System in the United States, or the creation of centralised knowledge transfer and brokerage for the Scottish Executive's health department.⁷ But the general picture is one of poorly connected worlds lacking knowledge of (and often respect for) each other. The inner workings, implicit rules, cultures, and realities that dominate the day to day lives of people working in the health system and those doing research on that system remain, for the most part, mysteries to people on the other side.

Research and decision making as processes, not products and events

Fundamental to this disconnection is a misapprehension by each side of what the other is doing. Researchers tend to see decision making as an event—they deliver their edicts to the impenetrable cardinals' retreat and await the puff of smoke that signals “decision,” while grumbling about irrationality within the conclave. Decision makers—the patients, the care providers, the managers, and the policy makers—tend to see research as a product they can purchase from the local knowledge store, but too often it is the wrong size, needs some assembly, is on back order, and comes from last year's fashion line.

Neither side seems to recognise that the other is managing a complex process rather than presiding

The mere knowledge of a fact is pale; but when you come to realize a fact, it takes on color. It is all the difference of hearing of a man being stabbed to the heart, and seeing it done

Mark Twain, A Connecticut Yankee in King Arthur's Court, 1889

over an event or manufacturing a product. In the case of decision making, multiple interacting processes are used to build consensus around a course of action. In the case of research, accumulating sequential processes reveal the “facts of the matter” through often haphazard cycles of discovery and validation.⁶ When these are disconnected processes, the facts tend to play second fiddle to the values that underpin consensus. If they can be connected, however, the facts can actually help to create the consensus.⁸ Hence one path to more research informed decision making is to focus on better linkage and exchange between the processes that create the facts (research) and the ones that incorporate the values (decision making) (box 1).⁹

Innvaer and colleagues' systematic review of efforts to link research and policy better arrived at this same conclusion: “personal two-way communication between researchers and decision-makers should be used to facilitate the use of research. This can reduce mutual mistrust and promote a better understanding of policy-making by researchers and research by policy-makers.”¹⁰

Research to action: knowledge brokering as a social solution

This linkage and exchange model of connecting research to action moves us away from the predominant view of evidence informed decision making as a technical exercise that places products into events—the implicit premise of, for instance, the clinical guidelines or performance indicators industries. Rather, it characterises the task of better informing decisions with research as being as much social as technical.

Gabbay and le May recently illustrated this in their ethnographic “mindlines” study of how clinical guidelines were translated into practice through social interaction and interpersonal networks in two general practice groups in England.¹¹ Similarly, in their extensive systematic review of the innovation diffusion literatures, Greenhalgh and colleagues concluded that “knowledge depends for its circulation on interpersonal networks, and will only diffuse if these social features are taken into account and barriers overcome.”¹² This is a lesson learnt long ago by the pharmaceutical industry, with its use of local opinion leaders to influence patterns of drug prescribing.

This social focus points to human interaction as the engine that drives research into practice. It implies the need for both human intermediaries between the

Box 2 | Attributes and skills of a knowledge broker^{7 13}

- Entrepreneurial (networking, problem solving, innovating)
- Trusted and credible
- Clear communicator
- Understands the cultures of both the research and decision making environments
- Able to find and assess relevant research in a variety of formats
- Facilitates, mediates, and negotiates
- Understands the principles of adult learning

Box 3 | Illustrative activities of a knowledge brokering agency: the Canadian Health Services Research Foundation

Setting the research agenda

- Triennial consultations with the health service on priority themes: Listening for Direction¹⁷
- Research funding restricted to priority themes
- Each research project required to have 50% funding from an organisation in the health service

Facilitating applied research

- Masters, PhD, and postdoctoral researcher training awards all require a placement in the health service
- Each research project required to include decision makers in the health service as co-investigators
- Decision support research syntheses are co-produced by researchers and people who can implement the results

Disseminating research

- Production of plain language research summaries on pressing service questions: Evidence Boost and Mythbusters
- Support of virtual knowledge networks of researchers and decision makers in the priority theme areas
- Organising regular face to face exchanges on questions/problems and research results in priority theme areas

Getting research used

- Funding and evaluating selected knowledge brokers; providing support and resources to other brokers
- Providing regional workshops to the health service on tools and techniques for research use
- Elite fellowships for decision makers in research use: executive training for research application (EXTRA)

(See www.chsrf.ca for further details)

worlds of research and action (knowledge brokers; box 2) and supporting infrastructure (knowledge brokering agencies and resources).

Knowledge brokering is not a new concept. For instance, in the late 1800s the German dominance of the synthetic dye industry was explained by “an informal network of ties that connected players in industry and academia . . . the academic-industrial knowledge network.”¹⁴ In 1906 the University of Wisconsin created its extension division to support agricultural liaison officers linking local farmers and university researchers, as they still do today.¹⁵

More than 20 years ago technology transfer officers were created in universities to speed research discoveries into patents and production, and organisational behaviourists were calling for “the development of hybrid researcher-practitioner roles (rather than the reliance on external ‘scientists’) . . . [and] mechanisms to promote active boundary spanning, dialogue and joint learning.”¹⁶ Thus were born “clinical epidemiologists,” clinicians who both see patients and do research, although their hybrid counterparts in the governance or management of the health service are yet to evolve.

Knowledge brokering in Canada

With a budget of approximately \$C16m (£7m; €11m, \$14m) a year, the Canadian Health Services Research

Foundation has adopted a role as a knowledge brokering agency for the past 10 years. We have defined knowledge brokering 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.”¹³ Box 3 lists some of the approaches we have used to link the people leading research processes (mostly in universities and granting councils) and those leading decision processes (health service managers and policy makers).

Adopting a knowledge brokering role has both philosophical and practical dimensions. The philosophy leads us to build into all our activities and programmes the expectation of ongoing linkage and exchange between the researchers and their decision making counterparts. Capacity development—for researchers to be able to do applied research and decision makers to be able to use it—is part of the philosophy. The practice of knowledge brokering in itself leads us to support knowledge brokers, both with employment and with tools and resources such as synthesis of research, plain language research summaries, networks and exchange events bringing together researchers and managers, self assessment checklists for organisational capacity to use research, and other “knowledge transfer and exchange” mechanisms.

We recently surveyed the network of more than 400 Canadian health system knowledge brokers we have supported since 2003, only a few of whom have full time designation for this role.¹³ They report, as have others,¹⁸ that the supporting resources and tools are central to their role as brokers. They spend about 30% of their time on knowledge transformation (reading and disseminating research) and 20% on intermedia-tion (actually linking researchers and decision makers). The remaining time, spent doing management duties or teaching, reflects the fact that this is often a part time role. About 30% of knowledge brokers are based in universities, about 10% in foundations or research funding agencies, and the remaining 60% in different levels of the health system (Gold I et al, National symposium on knowledge transfer and exchange, Toronto, 2006).

SUMMARY POINTS

Neither universities nor the health service provide much incentive for ongoing connections between researchers and clinicians, managers, or policy makers

More formal recognition is needed for the interpersonal role of knowledge brokering in connecting the research and decision making processes

Knowledge brokering uses a portfolio of resources to make health services research and decision making more accessible to each other

Initial experience in Canada suggests that adopting a knowledge brokering approach improves the culture for evidence informed decision making

ADDITIONAL RESOURCES

Lomas J. Improving research dissemination and uptake in the health sector: beyond the sound of one hand clapping. 1997 (www.chsrf.ca/knowledge_transfer/pdf/handclapping_e.pdf)

Oldham G, McLean R. Approaches to knowledge-brokering. 1997. (www.iisd.org/pdf/2001/networks_knowledge_brokering.pdf)

Max Lock Centre, School of the Built Environment, Westminster University, London. Intermediaries in knowledge transfer and exchange. 1998. (www.wmin.ac.uk/builtenv/maxlock/KTweb/KT_Guide4.htm)

Scottish Executive, Office of the Chief Researcher. New directions for knowledge transfer and knowledge brokerage in Scotland. 2005. (www.chsrf.ca/brokering/pdf/scotland-KT-KB-keyfindings_e.pdf)

Australian Government Land and Water Australia. Knowledge for regional NRM: connecting researchers & practitioners. 2006. (www.lwa.gov.au/downloads/publications_pdf/PB051023.pdf)

Canadian Health Services Research Foundation. Knowledge brokering. 2006. (www.chsrf.ca/brokering/index_e.php)

The effect of our capacity development and resources for knowledge brokering are demonstrable, although more cultural than instrumental in their impact. Brokering research priorities with people working in the health system attracts the attention, resources, and engagement of these decision makers to the resulting research agenda.¹⁷ Research funded under the model is four times more likely than that funded by traditional means to be subject to active efforts at dissemination and implementation (Graham ID et al, Translating research into practice: advancing excellence from discovery to delivery, Washington, 2004). Graduates from our researcher training programmes are just as likely to take up research careers in the health service as in a university. Our brief, plain language summaries of research—*Mythbusters* or *Evidence Boost*—or our decision support syntheses of research are routinely used by brokers in governments, health authorities, and the health professions to generate dialogue and debate.

Developing capacity on the use of research for those working in the health system also has results. For instance, only 21% of the health system managers entering our executive training for research application programme report using research in their day to day work “most or all of the time;” two years later, at graduation, this proportion has more than doubled to 50%. Sixty five per cent of these graduates also report an excellent or very good ability to create a more evidence based working environment in their home organisations; for those entering the programme the figure is only 8%.

Knowledge brokering is not a universal panacea. However, the interpersonal linkages it creates are certainly very promising as one of the “in-between” missing pieces that can bridge the know-do gap for health services. Perhaps for the new year every health services researcher should adopt a health services decision maker, and vice versa.

The general picture is one of poorly connected worlds lacking knowledge of (and respect for) each other

With apologies to M G Vassanji (and Vikram Lal) for the title of this paper.

Contributors: The concepts behind this article are based on JL's 25 years' experience as a knowledge broker: initially as an academic leading an applied health services research unit at McMaster University in Hamilton, ON, Canada (15 years), and then as the inaugural chief executive officer of a national knowledge brokering agency in Canada (10 years). JL developed the specific elements of the article for an invited presentation at the World Ministerial Summit on Health Research in Mexico City on 18 November 2004. He further refined these elements on the basis of collegial feedback after subsequent presentations and finalised them for this version at the request of the *BMJ's* editorial staff.

Competing interests: JL is employed by the organisation featured in the final section of this paper, the Canadian Health Services Research Foundation.

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Endpiece

A historical view of the future

There is virtually no limit to the amount of health care an individual is capable of absorbing.
J Enoch Powell, British minister of health 1960-1963
Submitted by Ruth Reed, senior house officer in psychiatry, Enfield, Middlesex