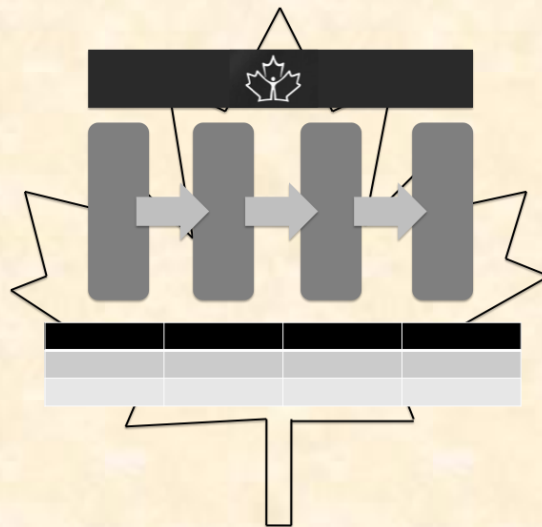# CANADIAN INSTITUTE FOR MILITARY AND VETERANS HEALTH RESEARCH IMPACT ASSESSMENT: FRAMEWORK AND RECOMMENDED INDICATORS

A REPORT FROM THE CANADIAN ACADEMY OF HEALTH SCIENCES

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CIMVHR | ICRSMV

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Contract Report
DRDC CR 2012-xxx

THE CANADIAN ACADEMY OF HEALTH SCIENCES

The Canadian Academy of Health Sciences (CAHS) was founded in 2004 as a non-profit, charitable organization composed of elected Fellows from diverse disciplines both within and external to the health sector. It is both an honorific membership organization and a policy research organization. The Fellows are elected to the Academy by a rigorous peer-review process that recognizes demonstrated leadership, creativity, distinctive competencies and a commitment to advance academic health science. In this way, the Canadian Academy of Health Sciences joins the Royal Society of Canada, which has long honoured Canadians for their accomplishments in the natural sciences, social sciences and humanities, and the Canadian Academy of Engineering, which recognizes achievements in the engineering sciences.

A unique aspect of the Canadian Academy of Health Sciences, relative to international comparators, is that its Fellows span the full breadth of academic health science from fundamental science to social science and population health; they also represent the full spectrum of health disciplines, including nursing, dentistry, veterinary medicine, rehabilitation sciences, pharmaceutical sciences, medicine and related fields such as psychology, health law, ethics and health economics. As a result, the Canadian Academy of Health Sciences is truly ecumenical and well-disposed to provide a holistic perspective on health-related subjects.

The objectives of the Canadian Academy of Health Sciences are to:
- serve as a credible, expert and independent assessor of science and technology (S&T) issues relevant to the health of Canadians;
- support the development of timely, informed and strategic advice on urgent health issues;
- support the development of sound and informed public policy related to these issues;
- enhance understanding of S&T issues affecting the public good by transmitting the results of assessments and providing opportunities for public discussion of these matters;
- provide a single authoritative and informed voice for the health science communities;
- monitor global health related events to enhance Canada's state of readiness for the future;
- represent Canadian health sciences internationally and liaise with like international academies to enhance understanding and potential collaborations on matters of mutual interest.

In short, the Canadian Academy of Health Sciences provides "scientific advice for a healthy Canada". The challenges facing governments at all levels, institutional and professional leaders in the health system, the non-governmental and business

sectors, and the public in regard to health and the health care system are complex and daunting. Such issues require careful and thoughtful analysis that is not only expert, but also unbiased and independent of vested interests and agendas. They call for an objective weighing of the available scientific evidence at arm's length from political considerations and with a focus on the public interest.

The process of the Academy's work is designed to assure appropriate expertise, the integration of the best science and the avoidance of bias and conflict of interest, the latter being a frequent dynamic that confounds solutions to difficult problems in the health sector. While those organizations that sponsor assessments have input into framing the study question(s), they cannot influence the outcomes of an assessment or the contents of a report. Academy reports undergo extensive review and evaluation by external experts who are anonymous to the panel, and whose names are revealed only once the study is released. Final approval for release and publication of an Academy Report rests only with the Board of CAHS.

EXECUTIVE SUMMARY

Defence Research and Development Canada (DRDC) desired to support the Canadian Institute for Military and Veterans Health Research (CIMVHR) in the development of metrics and indicators applied to measure the outcomes of CIMVHR research, knowledge exchange and education programs.

CIMVHR is a virtual institute (with a secretariat at Queen's University) comprising 25 Canadian universities joined together by a memorandum of understanding (MOU) created to address the health and wellbeing of Canadian military personnel, veterans and their families. Working closely with the Canadian Forces Health Services (CFHS) of the Department of National Defence (DND), Defence Research and Development Canada (DRDC) (within DND), Veterans Affairs Canada (VAC) and the Royal Canadian Legion, CIMVHR will focus on innovative research, responsive to a unique set of health needs. The principal activities of CIMVHR will be focused on research and the delivery of scientific outcomes in the form of knowledge and innovative products or material. These research-based outcomes will be supplemented by educational opportunities, and by the exchange of information and knowledge as exemplified by the annual CIMVHR Forum.

In view of the dynamic concepts upon which CIMVHR is based, the establishment of a set of metrics and indicators, early in the life of the Institute, is desirable. These metrics should be capable of assessing the range of outcomes from CIMVHR in order to capture the benefits and to identify any areas where enhancement would be beneficial. Indicators should be based on readily obtainable data from CIMVHR and its member universities, and from the Government of Canada (its agencies and departments).

In 2009, the Canadian Academy of Health Sciences (CAHS) published a report entitled: *Making an Impact – A preferred framework and indicators to measure returns on investment in health research* (CAHS 2009). Among the outcomes of that initiative was the identification of 66 metrics and indicators specific to the measurement of the impacts of health research. In their report, CAHS recommended that sets of indicators and metrics chosen from their menu should be used by funders of health research in Canada for the evaluation of health research impacts. CAHS acknowledged that the science of metrics for health research impacts is still embryonic and, invited the development of additional or complementary metrics to meet the needs of individual cases.

DRDC and its federal government partners require a set of indicators and metrics for research, education and knowledge exchange outcomes generated by CIMVHR. This report outlines an impact evaluation framework and indicators identified specifically for the Canadian Institute for Military and Veterans Health Research (CIMVHR). The evaluation framework developed in this report takes advantage of

previous efforts by CAHS in this field and expands the scope to include knowledge translation outcomes related to the changes in health care policy and procedures as a result of CIMVHR activities, and notably, the uptake of research deliverables by industry and the subsequent development of related drugs and health products. The data and sources for proposed metrics and indicators for this evaluation framework need to be readily obtainable from CIMVHR and its research community.

CAHS assembled an Expert Advisory Committee (EAC) with the task of using a combination of literature review, interviews and discussion within their committee to identify metrics and indicators suitable to assess the outcomes of CIMVHR's programs. The report is the result of work by the EAC and builds on the knowledge from previous CAHS work (CAHS 2009).

The first aspect of this project was to develop a tailored impact evaluation framework that would address the needs of CIMVHR and its multiple stakeholders (in government, the military, veterans, families, industry and in research itself).[1] The panel considered it appropriate to build on the CAHS ROI Framework, since that framework provides a basic approach that can be (and is being) modified for use by any Canadian health research funder. Figure 1 below shows the impact evaluation framework developed for CIMVHR.
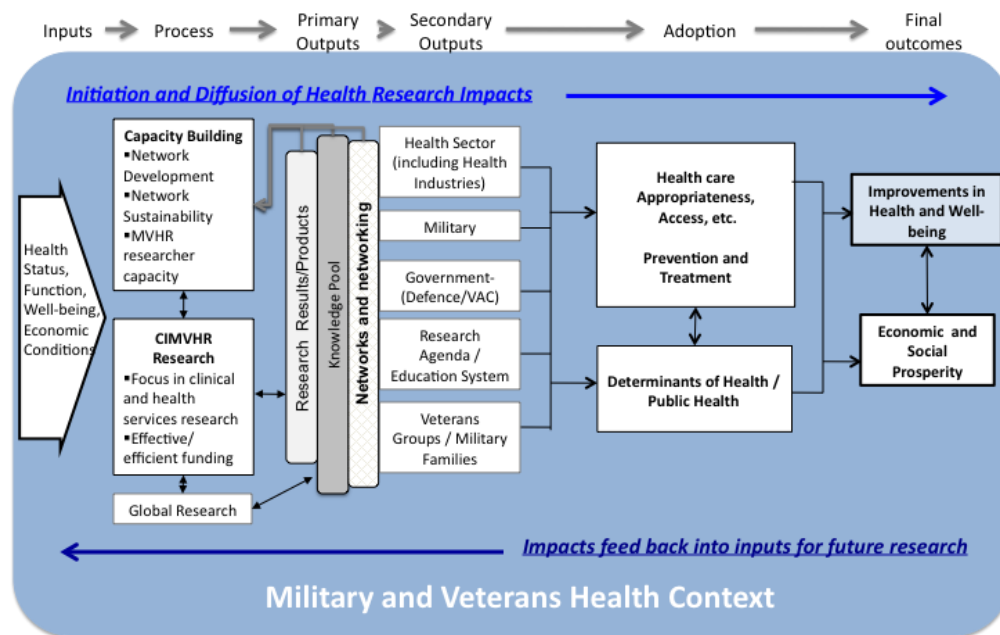
Figure 1. The CIMVHR impact evaluation framework and its relation to the Mission, Vision and Goals

The first consideration in modifying the original CAHS framework (2009) was to ensure that the proposed framework considered impacts and activities that are

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[1] The stakeholders in CIMVHR are the groups who are able to take CIMVHR outputs and turn them into useful outcomes – either through action or through the development of their own outputs based on the CIMVHR outputs (secondary outputs) such as policies, programs, training curricula etc.

relevant to the military and veterans' health context – placing the full evaluation approach within the context CIMVHR works in. By doing this, the general outcomes of CIMVHR health research (on health, health determinants, economic outcomes etc.) can be seen in light of how those outcomes occur specifically for military personnel, families and veterans.

The second consideration was to make sure that the processes and primary outputs represented the most important activities of CIMVHR – with a focus on the capacity building needed to develop CIMVHR from its recent inception, and capturing the importance of networking for a virtual institute. Third, was to identify the most important stakeholders in CIMVHR activities to populate the secondary outputs, since these are the groups who are targeted for change based on CIMVHR activities. As mentioned above, the outcomes for CIMVHR are similar to CAHS, but because they exist in a specific military and veterans' health research context, they can be considered specific to the desired outcomes of CIMVHR work. Finally, as CIMVHR uses a network as one of its mechanisms, for achieving its outcomes, it is important to consider how best to evaluate networks as well as taking into account the stage of development (e.g. early versus mature stage of development may require considering progress to outcomes rather than achievement of outcomes.)

Based on the framework and its list of the activities, stakeholders, outputs and outcomes of CIMVHR, the panel has developed multiple impact categories to address some of the main aims and goals of CIMVHR. Additional impact categories on top of those from the 2009 CAHS framework are included to ensure CIMVHR can accurately evaluate the impact of its activities on the multiple stakeholders involved, the networks that are built and knowledge translation activities.
- Advancing Knowledge
- Capacity
- Informing Decision Making
- Health Impacts[2]
- Broad Social and Economic Impacts[2]
- Impact on Host Institutions
- Networks and Networking
- Knowledge Translation

Within each of the above impact categories, the panel identified sub-categories and indicators that should allow CIMVHR to evaluate its impacts. These sub-categories represent the panel's expert opinion on where CIMVHR should collect evaluation information, and the indicators combine recommended CAHS indicators with new indicators identified by the panel as the most useful to provide evaluation evidence. It is worth noting that different indicators have suggested use at different stages of evolution of the network.

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[2] Health and Broad Social and Economic impacts are desired outcomes of CIMVHR activities (with health and wellbeing identified in the CIMVHR mission and vision). However, it is difficult to attribute change in these categories to CIMVHR activities, and as such we recommend identifying *contribution* to change, not attribution.

Table 1. Proposed CIMVHR Indicators and Metrics

Impact Category	Impact Sub-category	Indicator	Metric
Advancing Knowledge	Activity	• Knowledge created quantity	• # count of publications* • # count of innovative products* • # count of other research outputs
	Knowledge quality	• Research quality	• 5 year peer review of CIMVHR and its outputs • Relative citation value* • Highly cited publications*
Capacity	Personnel	• Graduated research students	• #/% and type of graduated students (e.g. Postdocs/PhD,/Masters) produced by CIMVHR supported members*
		• CIMVHR researchers	• # Researchers and others in CIMVHR broken down by academic level and by research subject area.
		• Network membership and non-membership composition	• Total # involved in CIMVHR-related research in Canada (includes members and non-members?)
		• Image and recognition of CIMVHR Personnel	• #/% awards and type of awards for CIMVHR members.
	Funding	• External leveraged investments	• Total ($) funding brought in through (and for) CIMVHR. • Total ($) leveraged funding by CIMVHR researchers (including matched funding from partners) * • % funding for CIMVHR research areas in Canada that comes through CIMVHR.
	Infrastructure	• Infrastructure grants	• Total amount in ($) of infrastructure funding brought in for CIMVHR projects* • % CIMVHR projects with attached infrastructure funding*
	Databases	• Database development, access and sharing	• # / % new CIMVHR developed databases • Tracking of data deposited in existing public databases (e.g. data to genomic databases) • Analysis of data sharing in the network (e.g. joint development of methods and tools etc.)
Informing Decision making	Use of research	• Use of research by stakeholders	• Citations of research by various stakeholders* • Utilization rate reported by researchers • Self-reported use of findings
Health Impacts	Health status	• Morbidity • Mortality • Quality adjusted mortality	• Standard measures of morbidity (prevalence and incidence)* for military and veterans • Standard measures of mortality (PYLL)* for military and veterans • QALYs and PROMs*
	Health system outcomes	• Health system measures	• Applying CIHI/CAHS* measures to health system outcomes that pertain to military and veterans (acceptability, accessibility, appropriateness, competence, continuity, effectiveness, efficiency, and safety).
	Quality of life	• Quality of life for military and veterans	• Self-report quality of life rating for military and veterans.
Broad Social and Economic Impacts	Broad societal economic benefits	• Value of investing in CIMVHR versus other investments • Quality of Life • Perception of health improvement	• Economic rent* • Quality of life gained per ($) dollar invested* • Patient perceived improvements per ($) dollar invested*
	Commercializa-tion	• Revenues from commercialization	• Total sum $ value of products from CIMVHR research*
	Wellbeing	• Social and socio-economic indicators for wellbeing	• Social measures* • Socio-economic measures*
	Community integration	• Integration of military / veterans into society	• Use of community integration surveys on a five year basis to assess integrating of military and veterans in society

Impact Category	Impact Sub-category	Indicator	Metric
Knowledge Translation (KT)	Dissemination	• Dissemination and reach	• # KT outputs • # of public and academic lectures given* • # of website / publications downloads* • # of Media reports*
	Positions of influence	• CIMVHR researchers in positions of influence	• # / % CIMVHR researchers on expert panels • # / % CIMVHR consultancy roles
	Evaluation of KT approaches	• Presence of KT evaluation	• Record of KT evaluation approach (present or absent)
	Integrated KT	• Strategic alignment	• Presence / absence of engagement of stakeholders in research planning • Presence / absence of engagement of stakeholders in research activity • Independent qualitative analysis of CIMVHR versus stated goals of multiple stakeholders
Impact on Host Institutions	Institutional capacity building	• Funding for capacity building	• $ funding (and infrastructure) to host organization
	Institutional reputation	• Reputation and recognition	• Ranking of host institution in Canada/world • Research rating in CIMVHR subject areas compared Canada/world • # fellowships awarded to host institution in CIMVHR areas
	Institutional Networking	• Degree of interactions and reach	• Assess interactions of hosts with Universities (e.g. measure of integration such as multiplexity, cohesion, measures of centrality, etc.) • Assess relationship with the CIMVHR board (qualitative rating)
Networks and Networking	Membership	• Network membership composition	• #/% of active members • #/% of new members • #/% of members who left the network
	Quality of the network membership	• Citation analysis of all researchers in CIMVHR-related research • Bibliometric network analysis	• % top researchers in Canada in the CIMVHR network as per HCP assessment* • % best networked researchers in CIMVHR
	Leadership	• Stakeholder satisfaction with CIMVHR leadership	• % Satisfaction rating on leadership question(s) • Assessment of CIMVHR against strategy goals
	Sustainability	• Network sustainability	• % Rating on network sustainability question(s) • Financial sustainability ($ inputs - $ outputs)
	Collaboration	• Degree of collaborative activity	• #/% of supported research projects engaging stakeholders/end users • #/% Institutional collaborations and partnerships (including with industry)* • Participation rate in CIMVHR meetings (including annual conference) • # co-publications /co-presentations by members • # Co-investigators on grants
	Network structure	• Network services and supports	• Range and type of network services and supports (qualitative)
	Administrative support	• Support in kind	• Level of in kind support from host institutions (qualitative)
	Administrative efficiency	• Administration costs and cycle times	• Administrative $ spent/total funding received (%) • Average/median cycle time from date of RFP from DND to proposal

PANEL RECOMMENDATIONS

Based on the findings of this CAHS panel's assessment, the panel makes the following five recommendations to CIMVHR:

1. **That CIMVHR and its funders use the proposed modified CAHS framework for both progress monitoring, formative (planning), and summative evaluation purposes.** Use of this framework and temporal implementation of evolving groups of indicators (in Table 2) will help guide CIMVHR activities through its start-up and its more robust evaluation over time. CIMVHR can ensure specificity and relevance by creating its own logic models that would verify the proposed framework.
2. **That each of the recommended impact categories with associated indicators and metrics be ranked immediately by CIMVHR and its funders for prioritized implementation** based on considerations of:
   a. Attractiveness and feasibility.
   b. Availability of high quality data to inform them.
   c. The incremental cost of evaluation. Wherever possible, existing and available data sources should be used during network start-up as well as identifying opportunities for collecting aspirational indicators.
3. As CIMVHR is a "volunteer virtual Network", **network members should be surveyed immediately to establish baselines in each prioritized category noted above and to introduce the impact framework to them**.
   a. Members should be asked for their opinions regarding the framework and indicators.
   b. Members and member institutions should be asked to commit to providing data to the network. A mechanism for data collection must be created to meet the stakeholder needs to allow for stakeholder differences in prioritizing impacts and indicators.
4. **CIMVHR should implement metrics and indicators using a staged approach**.
   a. In the first five years, the focus for impact evaluation should be on consolidated membership, capacity, disseminating early outputs and assessing an administratively efficient, high functioning network.
   b. In year 5 from now, CIMVHR should expand its indicators and metrics to assess research quality and knowledge outputs of relevance to its stakeholders of interest.
5. **CIMVHR should immediately establish a formal strategic partnership with CIHR, to avoid duplication in collecting data on research impacts for CIHR funded CIMVHR researchers.** This partnership may also help with future external CIMVHR evaluations. CIMVHR may also wish to form a relationship with CASRAI (Consortia Advancing Standards in Research Administration Information), with whom numerous other funders are developing standards for research impacts (aligned with the CAHS approach).

PANEL MEMBERS AND ASSESSMENT STAFF

ASSESSMENT PANEL MEMBERS

Dr. Cy Frank (University of Calgary) – Panel Chair
Dr. Vivek Goel (Public Health Ontario)
Dr. Kathryn Graham (Alberta Innovates Health Solutions)
Dr. Ian Graham (University of Ottawa)
Dr. Carol Richards (Université Laval)

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(Full bios for Assessment panel members and staff are shown in Annex A)

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1. INTRODUCTION

The Canadian Institute of Military and Veterans Health Research (CIMVHR), founded in 2010 is Canada's first national network of academic researchers addressing the unique needs of military personnel, veterans and their families in Canada. The Institute aims to coordinate existing resources and facilitate the development of new research while enabling timely and effective knowledge exchange between researchers and policy makers in order to ensure that military personnel and Veterans have access to state of the art technologies, treatment and care. CIMVHR is supported by 25 Canadian universities,[3] the Canadian Forces Health Services Group, Veteran's Affairs Canada, and Defence Research and Development Canada (DRDC). CIMVHR also partners with a number of organizations including: the Royal Canadian Legion; the Canadian Medical Association; the True Patriot Love Foundation; the Rick Hansen Institute; the Centre for Addiction and Mental Health, and the Congress of Social Sciences and Humanities (amongst others).

CIMVHR was founded in the context of a heightened awareness of the importance of military health research in light of the intense military operations of recent years. In 2010 the number of Canadian Forces casualties and the breadth of health problems arising from military operations were greater than at any time since the Korean War. With over 700,000 veterans in Canada and almost 100,000 serving personnel, there is a significant Canadian population that faces unique risks, exposures and experiences that require new standards of protection, prevention and care.[4]

CIMVHR aims to foster linkages between the Canadian academic community, defence scientists, and those who work daily with military personnel, veterans and their families in the interest of providing timely and relevant programs and treatments designed to meet their specific and unique needs. These issues are reflected in CIMVHR's Vision, Mission (Box 1) and Goals (Box 2).

> **Vision**
> The health and wellbeing of Canadian military personnel, veterans and their families is maximized through world-class research resulting in evidence-informed practices and programs.
>
> **Mission**
> To optimize the health and wellbeing of Canadian military personnel, veterans and their families by harnessing and

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[3] CIMVHR has a network of coordinated academic researchers across Canada based at 25 universities identified in Annex B: CIMVHR University Partners.

[4] See http://www.cimvhr.ca/node/3

> mobilizing the national capacity for high-impact research, knowledge creation and knowledge exchange.

Box 1. CIMVHR Vision and Mission

> **Research:** Innovative and responsive to meet the requirements of National Defence and Veterans Affairs Canada; Focusing on protection, prevention, treatment and rehabilitation; robust technology development focus; databases to capture current research programs, outstanding research requirements, study populations, funding and resources, and Canadian research teams; networking researchers, research organizations and sponsors; and providing research support for researchers.
>
> **Knowledge Exchange**: providing relevant research; showing application of knowledge generated; analyzing future trends; annual research forums; workshops; regular and targeted communications; peer-reviewed publications; and extensive use of social media.
>
> **Education**: Building the next generation of researchers; providing education on the care and protections relevant to military members, veterans and their families; and developing formally certified education programs.

Box 2. CIMVHR Key Activities and Goals

CIMVHR is currently working with the Canadian Depression Research & Intervention Network, and is exploring partnerships with the Canadian Obesity Network and the Technical Evaluation of the Elderly Network. Internationally, CIMVHR has had formal meetings with the US Department of National Defence Medical Research Community, the US Veterans Affairs Research and Development, the Australian Military and Veteran Health Research Institute, and the British Centre for Military Research. CIMVHR is also exploring collaborations with several US universities working in similar areas. These include the University of Southern California, and its program on military and veteran social work, and the extensive psychological rehabilitation research program at the VA research hospital affiliated with the University of North Carolina.

All of the above information points towards CIMVHR being an organization that needs to interact with multiple stakeholders. Based on interviews, the panel considered the following to be the main or primary stakeholders in CIMVHR activities:

- Canadian Government (particularly the Department of National Defence and Veterans Affairs Canada – although also Treasury Board for their distribution of funding to DRDC)

- The Military (Canadian Forces)
- Veterans groups (outside of government)
- Military personnel and their families
- Veterans and their families
- Universities in Canada (the virtual institute secretariat is headquartered at Queens University and the institute is co-hosted by The Royal Military College of Canada)
- Researchers in military and veterans' health research
- Wider networks of researchers and research institutions internationally

Working to fulfil the needs and desires of such a broad and diverse set of stakeholders is a challenge for a new organization such as CIMVHR, but with clarity about the role of stakeholders; it is possible to develop systems to monitor how the Institute is progressing in its work with all stakeholder groups.

1.1. MILITARY AND VETERANS' HEALTH RESEARCH

Health research is a broad discipline – spanning subjects as diverse as molecular biology and clinical psychology, even for specific groups of people such as the Military personnel and their families or Veterans.

At the writing of this report (October 2012), CIMVHR had targeted a number of research areas:
- **Mental Health**
  - Fostering resilience
  - Mental health needs of women in the military
  - Impact of injury on mental health
  - Occupational stress injuries
  - Impact of deployment on family relationships
  - Racial/ethnic differences in deployment experience
  - Dealing with death of a parent or spouse
- **Operational and Environmental Health Protection**
  - Epidemiology support
  - Exposure studies
- **Combat casualty care**
  - Improved trauma management
  - Technology development
  - Immediate and long-term effects of traumatic brain injury
- **Physical and Mental Rehabilitation**
  - Evaluation of existing programs
  - Evaluation of existing technologies
  - Impact of Return to Work programs
- **Transition from military to civilian life**
  - Physical, mental and social aspects
  - Family and external supports

- Examination of potential rural and urban disparities in health
- **Healthcare policies and programs**
    - Examination of programs and services and accessibility
    - How to impact and improve federal and provincial programs

It is clear, even from these areas in which CIMVHR is already involved, that military and veterans' health research covers a wide range of "types of research". As expected, most of the topics are more 'applied' (CIHR pillars 2, 3 and 4)[5] - setting the stage for future, more mechanistic and (likely) some basic biomedical studies. This breadth of research is an important issue, since it speaks to how researchers work together (interdisciplinarily and collaboratively) within CIMVHR and how the research portfolio of CIMVHR should be managed.

While the stakeholder groups for military and veterans' health research in Canada are quite distinct and specialized, the research to be conducted under the umbrella of military and veterans' health research, is not that different from the health research conducted with the general public in mind. For example, if you compare the work conducted through CIMVHR with research currently under the remit of the Canadian Institutes of Health Research (CIHR), it is clear that mental health, population health, epidemiology, rehabilitation, neuroscience, social psychology and health policy all fall clearly under the remit of various CIHR Institutes but none of those institutes targets military or veteran's issues specifically. In this respect, CIMVHR is similar to the population specific CIHR Institutes such as the Institute for Aboriginal Peoples' Health, Institute of Aging and the Institute of Human Development, Child and Youth Health. This similarity to existing Institute structures in Canada is important in considering how relevant existing evaluation frameworks and metrics will be for CIMVHR.

Key factors in any analysis of the impacts of research relate to the subject of the research and the stakeholder groups the research is for. Health research activities and outputs are similar across most research areas and military and veterans' health research looks similar to health research in general for the purposes of evaluating impact. This means it is possible to modify existing approaches to research impact evaluation to arrive at an approach that is specific to CIMVHR and recognizes that the outcomes in terms of stakeholders affected by the research may be more diverse.

1.2. UNDERSTANDING RESEARCH IMPACT EVALUATION

In today's world, any use of public funds brings with it a need to be accountable for the wise use and stewardship of that money. Research is no different in this respect. It is becoming increasingly prevalent in the research world, particularly the health

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[5] CIHR divides its research funding up by research pillars. Pillar one covers basic biomedical research; Pillar two covers clinical research; Pillar three covers health services research; and Pillar four covers population and public health research.

research world, to use some form of research impact evaluation to show that funding provides value for money (Brutscher, Wooding and Grant 2008).

Health research funders generally perform research impact evaluations for one (or more) of three different reasons (Figure 2):

- **Evaluation for accountability** - Organizations must evaluate the outcomes of their funding in relation to their anticipated goals. This requirement to evaluate "our mission" is a key driver of the recent shift toward evaluating public research funds. For government funding organizations, targets are often set by government for the organization to achieve (Government of Canada 2007).

- **Evaluation for advocacy** - Evaluation for advocacy is to increase awareness of the great things a research funding organization can achieve. Evaluation for advocacy needs to identify the research that best highlights the future possibilities of the organization and the "best" impact of its research investment. Identifying the "best" impact is subjective, and varies depending on the group to which the research funder is advocating.

- **Evaluation for advancing** - Evaluation for advancing is inward looking, trying to identify how a funder is performing in achieving its mission, understanding the processes it has in place, and identifying where opportunities, challenges, and successes arise for their research. In its most basic terms, evaluation for advancing asks, "What are we doing well? What are we doing badly? And how can we improve?"

Each of these reasons implies different organizational goals, and requires different evaluation strategies. In an ideal world, by addressing your evaluation to the need for accountability, advocacy, and advancing, it is possible to produce a comprehensive evaluation. However, it is worth noting that comprehensive evaluation is both complex and expensive and is often not considered value for money by most organizations undertaking evaluations.
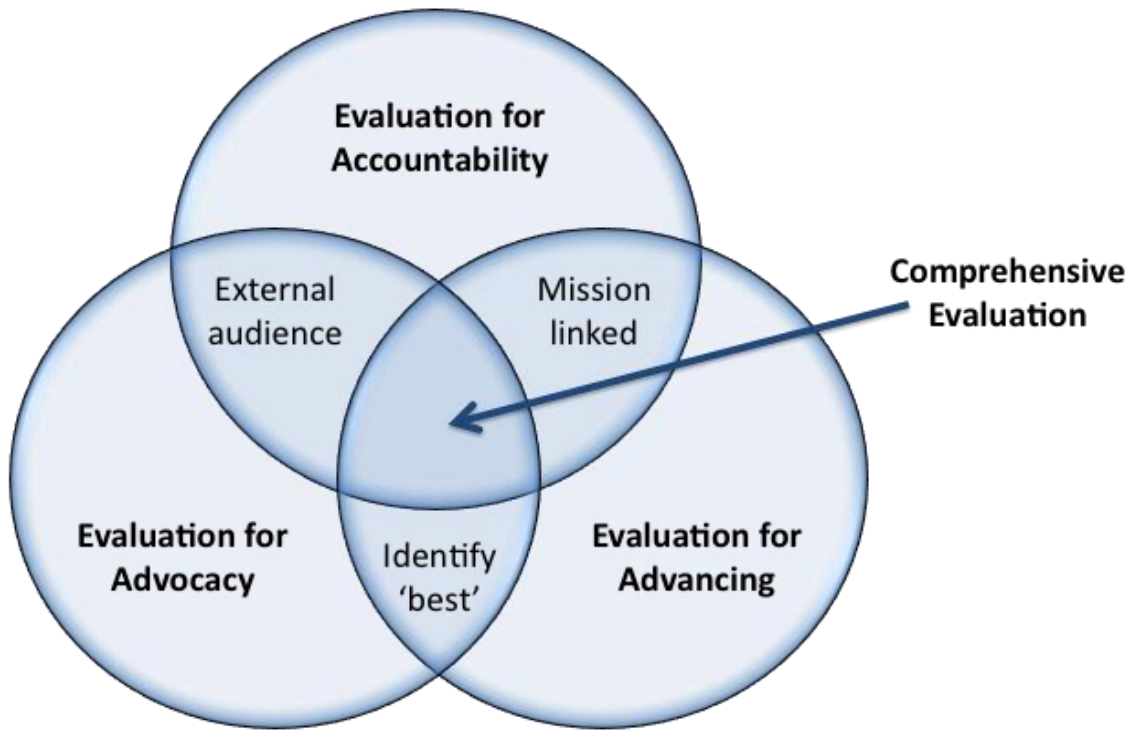
Figure 2. Links between the three reasons for evaluating research

Table 2. Addressing the reasons for CIMVHR to evaluate using any given evaluation framework.

Reason for Research Impact Evaluation	Audience	Usefulness for CIMVHR
Accountability	Funders/others	Show funders research money is well spent.
Advancing	Internal stakeholders	Allow CIMVHR to grow strategically from the beginning.
Advocacy	Funders/others	To showcase successes to future funders.

It is important when defining an impact evaluation strategy that research funders also take into account the audience for their evaluation findings. As shown in Figure 2, there are differences in evaluating impact for internal purposes (knowing what worked and what did not) versus for external purposes (showing that money was used wisely or trying to argue for additional money). Bearing in mind the audience for the research impact evaluation findings will lead to a more appropriate and useful set of evaluation results. It is also worth noting, that depending on the audience of the evaluation, research funders are likely to want differing levels of replicability (for example, when reporting to Treasury Board, it is important for

evaluation findings to be replicable, but this is less important when analyzing the impacts of a specific program or policy).

All evaluations of research impact need to take into account three major factors:
- First, the mission of the funding organization or funding stream, so that the evaluation provides useful data that reflects the stated aims of the organization.
- Second, the needs of key stakeholders in the evaluation, so that whatever findings arise from the evaluation are useful and usable for all the stakeholders relevant to the research.
- Third, the cost effective data collection for the evaluation, so that evaluating the impacts of research doesn't become so costly as to take valuable funding away from the research itself (essentially ensuring that the evaluation itself is value for money).

Some key questions that research impact evaluation needs to ask are:
- What are the impacts from health research?
- Where and when can they be expected?
- How can impacts be identified and traced over time?

Thankfully, there are some precedents to work from in assessing research impacts of Networks and Institutes, including good examples from within Canada. At this point it is worth clarifying what is meant by a research network (since this underpins much of the work that CIMVHR will perform). A network is defined as a system for interconnected actors or nodes and the ties or links between them (Robeson 2009; Hawe *et al.* 2004). Nodes are people, places or organizations that enable multidisciplinary transfer of information, broker partnerships for quality improvements, and access a variety of resources and power (Thomas *et al.* 2006). A research network is seen as purposely established groups of people that are assembled to collaborate on research activities and/or encourage evidence-informed practice (Robeson 2009). The premise is that interdependent groups of two or more organizations that consciously collaborate and cooperate with one another are more effective at providing a complex array of services than the same organizations are able to do when they act independently (Alter and Hage 1993). In other words, cooperation produces outcomes that are more favourable to both parties than when the parties compete (Axelrod 1984).

1.3. EXAMPLES OF RESEARCH IMPACT EVALUATION

In Canada, research impact evaluation has been a growing concern since around 2005, when the Canadian Institutes of Health Research (CIHR) began in earnest its approach to evaluate the impact of its funded research. While there had been pockets of research impact evaluation prior to this point, the movement of the main funder of health research in the country to address impacts, created a platform for impact evaluation across Canada. Since then, multiple parts of the health research system have begun evaluating impacts, and of particular relevance to CIMVHR,

several research networks and collaborative organizations have developed impact evaluation approaches.

1.3.1. CANADIAN INSTITUTES OF HEALTH RESEARCH (CIHR) AND IT'S 13 INSTITUTES

In Canada, CIHR is the major funder of health research, and have also been at the forefront of the development of on-going monitoring and evaluation approaches for the impact of its funded researchers' impacts. In 2005, the CIHR clarified their own version of the Payback Framework, by modifying the logic model to reflect the approach to research that is taken by the CIHR (namely the use of 13 virtual institutes) and the categories of impact to ensure the capture of CIHR-desired research impacts (Canadian Institutes for Health Research 2005). In recent years, CIHR have further developed their approach to incorporate new data collection tools for research projects, such as end of grant reporting. This approach and toolkit is used on an ongoing basis, as well as to form the basis for the rolling 5-yearly international evaluations of CIHR and its constituent virtual institutes.

1.3.2. CANADIAN STRATEGY FOR PATIENT ORIENTED RESEARCH (SPOR)

While it currently is not clear what evaluation approach CIHR's SPOR strategy will take, there is likely to be overlap with the approach taken for other CIHR funding approaches. The steering committee for SPOR has a specific remit to support the monitoring and evaluation of the strategy, which suggests the use of a standardized approach for measuring SPOR impacts.

The aim of the SPOR is to establish competencies in patient-related methodologies[6] and offer collaboration to other researchers engaged in patient-oriented research. SPOR has five broad goals:[7]
1. To grow Canada's capacity to attract, train and mentor health care professionals and health researchers in patient-oriented research and create sustainable, patient-oriented career paths across the breadth of health disciplines.
2. To establish an integrated, leading-edge, pan-Canadian clinical research infrastructure along the full continuum of patient-oriented research.
3. To strengthen organizational, regulatory and financial support for clinical studies in Canada and enhance patient and clinician engagement in these studies.
4. To improve processes for the early identification of best practices, expedite their development and harmonization into guidelines for patient care, and support their adoption by clinicians, caregivers and patients.
5. To create a collaborative, pan-Canadian process for identifying, establishing and addressing patient-oriented research priorities.

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[6] Research methods that closely link to the needs of patients in the health system (e.g. epidemiology, clinical trial analysis, etc.)

[7] See: http://www.cihr-irsc.gc.ca/e/44000.html#a4.2

In many ways, the areas identified above are very similar to the approach that CIMVHR is taking, and as such, there is relevance in understanding the way that SPOR will take forward evaluation and monitoring in the future. This is one of several reasons for CIMVHR to establish a partnership with CIHR regarding SPOR.

1.3.3. NETWORKS OF CENTRES OF EXCELLENCE (NCES)

In 2002, the NCE produced a 'Results-Based Management and Accountability Framework'. A logic model was developed as part of this process. It led to the development of indicators and an evaluation and reporting strategy. Additionally, a 'Risk-Based Audit Framework' was defined the same year. The logic model clarifies the set of activities that make up the NCE program and the sequence of outcomes expected to flow from these activities (illustrating how the activities of the NCE program lead to the achievement of final outcomes).

Monitoring NCEs is an ongoing function to ensure NCE funds are used effectively to attain the expected results. These monitoring activities that are linked to ongoing performance measurement and data collection can also be used for the purpose of periodic evaluations. Data collection takes into account existing data processes (peer review, program monitoring, financial data, NCE annual reporting). In addition, NCE reporting is based on templates to allow easy comparison of networks. The findings from evaluation and monitoring are used by the NCE Management and Steering Committees to assess whether funded centers have met their objectives, to monitor trends in centers activities and then to adjust the program as necessary. The evaluation framework also underpins summative evaluations every five years (The Networks of Centres of Excellence Secretariat 2008; Bertrand *et al.* 2009).

1.3.4. PUBLIC HEALTH ONTARIO (PHO)

Public Health Ontario (PHO) that has a mandate to promote and protect health and prevent disease in the population has identified the importance of assessing performance and accountability for its own activities. PHO decided to make use of the balanced scorecard in developing its assessment, given the popularity of report-cards in the health system. PHO chose the balanced scorecard approach to give it an overarching view of risks and benefits of strategic and operational decisions. Findings from the scorecard are then used to facilitate change and quality improvement, provide an accountability mechanism, and support the health planning process.

The PHO scorecard measures performance in four quadrants:
1. Health determinants and status;
2. Community engagement;
3. Resources and services; and,
4. Integration and responsiveness.

The indicators within these four quadrants provide information on how PHO's structure, resources and activities are aligned with its core functions, as well as performance measurement of specific public health functions for quality improvement and improved resource allocation and accountability purposes. In order for the PHO scorecard to be used within the organization there is a stipulation that PHO provide resources for an independent team to evaluate PHO activities (Woodward, Manuel and Goel 2004).

1.3.5. ONTARIO STROKE NETWORK (OSN)

One of OSN's core activities is to provide evaluation of the OSN itself in order to inform strategic planning and decision-making between equally attractive strategic directions for the network. Evaluation is identified as one of the core enablers to ensure OSN can deliver on its strategy. Evaluation at OSN takes into account three key criteria, and additional non-core criteria.

Key evaluation criteria:
> **Supports the OSN mission**: To provide provincial leadership and planning for the Ontario Stroke System by measuring performance, partnering to achieve best practices and creating innovations for stroke prevention, care, recovery and reintegration.
> **Supports the OSN Vision:** To ensure fewer strokes and better outcomes for those suffering a stroke in Ontario.
> **Supports the OSN Values:** Values are - Equity & Comprehensiveness; Accountability & Integrity; Transparency & Engagement; Learning & Performance Improvement; Leadership & Innovation.

Additional criteria are to strengthen the system of care for stroke in Ontario (sustainability, continuum of care, accessibility, etc.), support innovation and research, linked to government priorities, show measurable progress, and support prevention and care (Hall *et al.* 2012; Ontario Stroke Network 2011).

1.3.6. INSTITUTE FOR CLINICAL EVALUATIVE SCIENCES (ICES)

At ICES there is an acknowledgement of the need to develop an approach to monitoring ICES activities in research and managing provincial data. As such, ICES is currently developing an approach to investigating its activities using a combination of logic model development (showing the theory of action of ICES activities, and the stakeholder perspectives on ICES outputs and outcomes), and impact indicators linked to the goals, vision, mission and strategic directions of ICES as a whole (Nason, personal communication). Impact categories are based on existing approaches to impacts, building on the impact categories in the 2009 CAHS assessment, but with an explicit acknowledgement of the role of knowledge translation in ICES impacts.

This approach will allow the monitoring of the work of ICES. For example, evaluation of research quality can be annual, but evaluation of broad health and social care outcomes can be made on a less frequent basis.

1.4. MILITARY AND VETERANS HEALTH RESEARCH IMPACT EVALUATION

None of the above examples have a specific focus on research for military and veterans' health. This means that the contextual factors for both the development of research (ideas) and the impacts of research (outcomes for military and veterans) are unique for CIMVHR and its stakeholders. Taking this stakeholder-driven research approach into account is vital for effective evaluation of CIMVHR's research impacts. Although there are other organizations internationally that are involved in research on military and veterans' health, none have impact frameworks that might inform the development of CIMVHR's framework. There is a need to develop a specific evaluation approach for the Institute that builds on existing health research impact evaluation work in similar organizations (even where the stakeholders and context differ). Having a greater understanding of the existing frameworks and indicators for evaluating health research will allow the development of a tailored research impact evaluation approach for CIMVHR that can take into account the unique context of the organization.

The following section outlines our knowledge on research impact frameworks and introduces the Canadian Academy of Health Sciences framework which was designed as a generic (and modifiable) impact framework for any health research conducted in Canada.

2. FRAMEWORKS FOR RESEARCH IMPACT EVALUATION

Health research is wide ranging (from basic biomedical through to public health), and collectively generates a wide range of outputs along a pathway that affects health, wealth, and wellbeing. Demonstrating the causal pathways that may lead to impacts from the diverse fields of health research is complex. Issues of attribution, establishing the counterfactual, diverse stakeholder interests and time lags between investments and the realization of long-term impact are some of the underlying issues that contribute to this complexity.

This problem of complexity creates the need for a standardized solution, in which parts of the entire health research system (in our case, the military and veterans' health research system) can be identified and classified in a way that captures both generation and use of knowledge as well as the impacts that arise from the use of that knowledge over time. Classifying these elements and mapping their relationships within an impact evaluation framework helps identify the best indicators of impacts from military and veterans' health research.

Using a research impact framework that is standardized across research funders can serve four main functions: first, it allows comparison of evaluations, since they build from the same framework and categories of impacts; and second, it allows identification of unexpected outcomes of research, since a framework can help to ensure that all possible outcomes are investigated. Third, the framework also provides a "theory of change" and a visual representation of the results chain. An organization's resources and activities are linked to the organization's anticipated outcomes and strategies. Fourth, the framework is also a useful communication and engagement tool for interacting with stakeholders who wish to gain a greater understanding of the working of an organization.

Frameworks are widely used to monitor and evaluate the work of organizations across the world, and are increasingly common in the evaluation of research organizations (particularly in the health research field). One of the main attractions of using frameworks for evaluations is the ability to clearly articulate where impacts are expected to occur, and then to select indicators of impacts, activities and interactions with key audiences/end users.

2.1. EXISTING FRAMEWORKS FOR EVALUATION OF RESEARCH IMPACTS

There are many evaluation frameworks being used to help identify where and how impacts from health research occur. They attempt to link downstream impacts to the research conducted, and try to identify and attribute the impacts arising from research. They differ in approach (often focussing on either the pathway of research to impacts, or the categorization of impacts), and in their emphasis on different types of impact. They also differ in terms of level of aggregation - whether they are designed for specific research project/program/organization evaluations, or to

allow for routine data collection (i.e. monitoring progress) and/or evaluation of activities.

Frameworks that focus on the pathways from research to impacts are obviously designed to allow research to be tracked through to impacts, meaning valuable contextual factors are taken into account with regard to how research actually causes impacts. As such, these frameworks tend to be linked to evaluations for organizational learning, and tend to focus on some sort of logic model that links inputs to research processes, outputs, and outcomes (providing a theory of change). Examples of this type of framework include the research utilization ladder (Landry, Amara *et al.* 2001) and the Weiss logic model approach (Weiss 2007).

Frameworks that classify impacts solely do not provide much information about how impacts originated, interactions or the relationships between process and outcomes, but provide a standard collection method for impacts that can be comparable across different evaluations as appropriate. Hence, classification frameworks are well suited to evaluations that focus on accountability or advocacy, since they can identify a comprehensive set of impacts linked to the organization's mission. Having categories of health research impact also creates benchmarking potential with other evaluations within and across organizations at a provincial, national and international level assuming standard definitions and methodologies (with the caveat, however, that different types of research have different sorts of impacts). Having impact categories also allows an organization to identify where it is not having impacts, as well as where it is. Examples of this type of framework include the balanced scorecard (Kaplan and Norton 1992), the societal impact framework (van Ark 2007), the Health Technology Assessment organization assessment framework (Lafortune, Farand *et al.* 2008), the decision-making impact model (Lavis, Ross *et al.* 2003), and the research impact framework (Kuruvilla, Mays *et al.* 2006). For recent reviews of health research impact assessment frameworks, refer to Yazdizadeh, Majdzadeh and Salmasian 2010; and Banzi *et al.* 2011.

Perhaps the most commonly used health research impact evaluation framework in the world is currently the "payback framework," which combines both framework types described above. It features a logic model (a model that presents causal relationships and identifies inputs, processes, outputs and outcomes) that allows tracking of research from initial ideas through inputs, processes, dissemination, outputs, secondary outputs, adoption and final outcomes. It also employs a multidimensional categorization of research impacts, which runs parallel to the logic model, and contains five categories, originally identified as: knowledge production; research targeting and capacity building; informing policies and product development; health and health sector benefits; and broader economic benefits (Buxton and Hanney 1996). Research is followed as a narrative using the logic model, while collecting impacts as they arise and assigning them to the appropriate category. As a result, this particular evaluation framework can be used for learning about how impacts arise, and for accountability or advocacy purposes that demonstrate the types of impacts that have arisen from research.

Several types of research framework are currently in use in Canada. Logic model frameworks are being used by a number of provincial funders and National Alliance of Provincial Health Research Organizations (NAPHRO) (Beaudet 2007). Others use a logic model with additional framework aspects, such as the "action-reflection" approach to implementing evaluation findings used by the Saskatchewan Health Research Foundation (Saskatchewan Health Research Foundation 2007). Still other funders are using versions of the balanced scorecard (University Health Network 2008) as a process tool (not for organizational learning). CIHR's version of a new payback framework, modified from the payback model, combines a logic model and "categorization of impacts" approach. It allows evaluations to be performed according to CIHR's organizational logic model, and provides multiple categories for collecting and ordering data on research impacts (Canadian Institutes of Health Research 2005b). A number of other organizations are collecting data that can also be considered when discussing evaluation in Canada, since these data inform indicators as well (Canadian Institute for Health Information 2008a).

In terms of Canadian health research, there has been a clear trend toward the use of logic modelling as the basis for evaluation frameworks. CIHR's use of the payback framework, CHSRF's use of logic modelling, and the logic model approaches of Alberta Innovates Health Solutions (formerly Alberta Heritage Foundation for Medical Research and Manitoba's Health Research Council (Canadian Institutes of Health Research 2005b; Canadian Health Services Research Foundation 2005; Birdsell and Matthias 2001; Birdsell and Asselbergs 2006) indicate strong support for the logic model approach. The balanced scorecard used more in the USA and among private sector R&D providers (Osama 2006; Modell 2004; Bremser and Barsky 2004), has been used in Ontario to evaluate health practice (Woodward, Manuel, Goel 2004).

Data developed through these types of evaluation frameworks are also commonly displayed using "dashboards" (often for monitoring purposes) that allow simple visualization of research impacts and organizational progress. The prime example of the use of dashboards in health research impact evaluation is the UK's National Institute of Health Research (NIHR) dashcard (Turabi *et al.* 2011). In the NIHR dashcard, data is collected on research activity, funding processes and research impact using a hybrid logic model and balanced scorecard approach to evaluation. Data on indicators are then presented using the dashboard approach. Similar to NIHR Alberta Innovates Health Services (AIHS) also adapted the Balance Scorecard approach (Kaplan and Norton 1996) in developing a hybrid model that integrated logic modelling (through the CAHS framework) with the Balanced Scorecard. The purpose was to develop a routine monitoring system, and evaluate organizational performance, in addition to health research (Graham, personal communication).

In Canada, the Payback framework has been taken forward in recent years by the Canadian Academy of Health Sciences (CAHS) – on behalf of multiple stakeholders in the health research endeavour in Canada. This has led to the development of the

CAHS model of research impact evaluation; known as the CAHS Return on Investment (ROI) framework. This CAHS ROI framework has inspired CIMVHR to determine a method to measure its own research impacts.

2.2. THE CANADIAN ACADEMY OF HEALTH SCIENCES RETURN ON INVESTMENT FRAMEWORK

Developed by a panel of international experts in 2008, the CAHS ROI framework has been well accepted by research organizations in Canada and internationally.[8] Building on the Payback Framework and the CIHR impact framework, the CAHS ROI framework developed a generalized approach to evaluating research impact that could be used for any health research in Canada. The framework has been widely accepted but not used in a comprehensive manner. The CAHS framework is now being modified by numerous research funders across Canada in order to develop specific organizational research impact frameworks that speak to the mission and vision of individual organizations such as Alberta Innovates Health Solutions, or groups of organizations such as NAPHRO (Nason, personal communication). It has also been applied for specific evaluations such as through a case study in impact assessment for the Canadian Cancer Society Research Institute (CCSRI) that concluded that early results suggested that the framework provided a useful structure to display both a hierarchy of results focused on mission goals and to build an attributable research and innovation story over time (Monague and Valentim 2010).

Figure 3 shows the simplified version of the CAHS framework for assessing research impacts. This framework differs from the payback framework upon which it is based, in that the payback framework contains opportunities to investigate topic identification, selection, inputs to research, and the research process itself (Buxton and Hanney 1996). These are less important to articulate in a framework that is designed to identify the most appropriate indicators for impacts of health research.

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[8] This is based on personal feedback received by members of the original CAHS panel from health research funders in Canada and abroad.
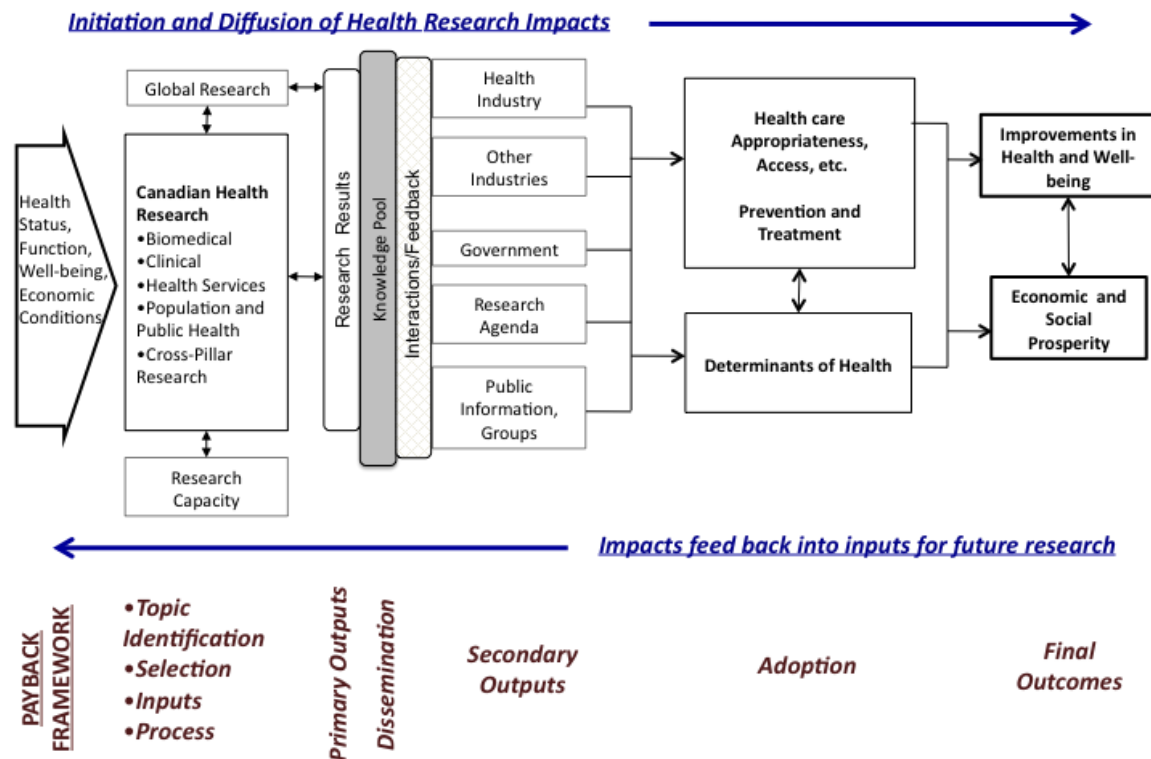
Figure 3. The CAHS ROI framework (CAHS 2009).

The CAHS framework presents a method that builds on the advantages of the "payback model" but adapts it to target specific impacts in multiple domains at multiple levels (Frank and Nason 2009). The CAHS framework provides more of a bottom-up approach than econometric approaches to assessing ROI, instead combining an impact category approach with logic model (like the Payback Framework). This adds the advantage of allowing specific program and project comparisons when compared to impact framework models, such as the balanced scorecard, which can evaluate progress against targets for an organization but cannot explain how impacts occurred or how to improve them.

The CAHS model was designed as a "roadmap of impacts version of the payback model" to help identify where proximal impacts can occur — the health industry, other industries, government, research decision-makers, or the public or public groups — and follows them distally through stages of adoption to final outcomes in health, wellbeing and social or economic prosperity. The framework is specifically designed to track impacts in 5 categories: advancing knowledge, capacity building, informing decision-making, health benefits, and broad economic and social benefits (that can potentially include cultural outcomes). For the CAHS assessment sponsors, the framework was also designed to trace research impacts in any or all impact categories for any of the 4 "pillars of health research" in Canada (basic biomedical,

applied clinical, health services and systems, and population health) or at any level (from individual projects to the whole country)(Frank and Nason 2009).

Within each of the 5 categories of impact, there are subcategories providing more detailed information on the likely impacts arising from health research in Canada (Table 3). These sub-categories represent distinct and valued impact types within each category, with sub-categories at two levels representing how specialized sub-categories must be in order to be able to populate them with relevant indicators of impact (that can be used across any type of health research).

Table 3. CAHS framework impact categories and subcategories

Category	Level 1 subcategory	Level 2 subcategory
Advancing Knowledge	Research quality	N/A
	Research activity	
	Outreach	
	Structural	
Capacity Building	Personnel	N/A
	Activity funding	
	Infrastructure	
Informing Decision Making	Health related	Health care
		Public health
		Social care
		Other
		Health-related education
	Research related	Research funding
		Research policy
		Research education
	Health products industry	N/A
	General public	Advocacy groups
		Public education
Health Impacts	Health status	Morbidity
		Mortality
		Quality-adjusted mortality
	Determinants of health	Modifiable risk factors
		Social determinants
		Environmental determinants
	Health care system	Acceptability
		Accessibility
		Appropriateness
		Competence
		Continuity
		Effectiveness
		Efficiency
		Safety
Broad Economic and Social Impacts	Research activity	N/A
	Commercialization	
	Health benefit	
	Wellbeing	
	Social benefits	

The CAHS model also provides a tool-box for evaluating health research including a comprehensive set of impact categories and definitions, and a library of indicators and metrics (including suggested methodology) at different levels of aggregation.

3. INDICATORS OF RESEARCH IMPACT

With categories of impacts identified for health research, it is important to ensure that the measures used within the categories are the most appropriate. Evaluations often use the terms indicator and metric to define the information collected within each impact category. It is important to clarify what is meant by these terms, as well as how to develop good quality indicators or metrics, and their application.

3.1. WHAT IS AN INDICATOR?

Indicators and metrics are different concepts. *Indicators* provide an "indication" of the impacts of an intervention; *metrics* are measurements of the impact itself. Indicators can be defined as factors or variables that provide simple and reliable means to measure impacts, changes to an intervention, or performance (Development Assistance Committee Working Party on Aid Evaluation 2002). Metrics provide specific information about the impacts of a system. The more generic the evaluation, the more difficult the identification of metrics because they must then relate to all the different types of impact that can occur from the research funded (CAHS 2009). Therefore, indicators provide a useful, more general tool to address any aspect of health research, including military and veterans' health research.

Indicators need to be used strategically when performing any evaluation, and should take into account the stakeholders and stated goals for the research. Additionally, indicators that work at one level of aggregation may not work at other levels (e.g. the network versus the individual project level). For example, citation indicators rely upon a threshold level of publications (>50) to be statistically viable as a measure of research quality (Moed 2005). Therefore, citation indicators are not useful for individual evaluations (and can, in fact, be misleading).

Indicators alone provide little power for an evaluation, since they can only address single aspects of research impacts. Evaluations *must therefore use multiple indicators in groups that allow the identification of the breadth of impacts accruing from health research*. To use a metaphor from health care, when visiting a doctor for a checkup, it would be inappropriate for the doctor to measure only your blood pressure and consider the job done (CAHS 2009).

In evaluations of health research organizations, there has been a growing trend towards developing overlapping and congruent research impact indicators. This can be seen in the examples of research evaluations for networks in the previous section, but is also specifically highlighted by the development of the CAHS framework and indicators for assessing ROI from health research. In the CAHS framework, indicators were identified from multiple existing evaluation approaches for health research, and assessed to determine whether they constituted useful

indicators for evaluating Canadian health research. This meant determining whether the indicators were of high quality (are usable), and also whether they represent information that can be captured broadly in Canadian health research (to develop comparable evaluations of research impact in Canada and potentially beyond).

3.2. WHAT MAKES A GOOD INDICATOR?

Identifying good indicators for evaluating health research impact is a major challenge. Having an impact framework can help define indicators, since such a framework identifies the impacts and pathways to be evaluated, and thus both where and what types of indicators are required to evaluate research impacts (CAHS 2009).

Selecting appropriate indicators for any specific evaluation of health research requires identifying the strength of individual indicators, as well as how groups of indicators can work together to produce useful, robust and effective findings.

Individual indicators must adhere to criteria that can be split to showcase the usefulness of indicators (that is, how attractive are they for an evaluator to use to provide appropriate evaluation findings for stakeholders) and the feasibility of indicators (or how likely is that they could be used) (Butler 2008). Box 3 shows the attractiveness and feasibility characteristics for individual indicators.[9] By adhering to the criteria for feasibility and attractiveness, individual indicators can be considered to be useful for an evaluation (although not necessarily appropriate, as the appropriateness of indicators will be based on the evaluation questions being asked). Balancing the attractiveness and feasibility of indicators is an important part of the evaluator's role, and can be made easier by considering groups of indicators for evaluations.

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[9] Attractiveness and feasibility are not distinct concepts and there are trade-offs between the two. For example, having a methodologically sound and wide coverage indicator (attractiveness criteria) is rarely cheap and therefore conflicts with the compliance costs and costs of data collection (feasibility criteria).

Attractiveness:
- Validity – does it relate directly to a critical aspect of the research?
- Behavioural impact – does it drive behaviour in a particular direction? Is it likely to result in any negative, unintended consequences? Does it create "perverse incentives?"
- Simplicity – is the methodology, and the strengths and weaknesses relating to the indicator, readily apparent?
- Coverage – does it cover a large proportion of output for the fields of research to be assessed?
- Recency – do the data relate to current research performance, or look over a longer timescale?
- Methodological soundness – is the calculation of the indicator methodologically sound and statistically robust?
- Replicability – can the indicators be used year on year in a comparable fashion?
- Comparable – do other organizations collect comparable information or have targets to benchmark against?
- Relevant – is it relevant to what the organization is aiming to achieve (linked to evaluation questions for that organization)?
- Responsiveness – is the data sensitive/responsive to the Minimally Important Difference (MID)?

Feasibility:
- Data availability - do the data needed to derive indicators exist, and do both the analysts and those being assessed have access to it?
- Cost of data – how expensive is it to purchase the data on license?
- Compliance costs – how labour intensive is it to extract/obtain the data?
- Transparency – can the calculations be replicated by interested external parties?
- Timeliness – can the data be obtained/provided relatively quickly?
- Attribution – can the data be discretely ascribed to the unit being assessed? Direct attribution is ideal, but unlikely; using attribution as a concept is important, though, as it provides a link between the impact seen and the research.
- Avoids gamesmanship – does the indicator provide scope for special interest groups or individuals to game the system?
- Interpretation - can the data be open to misinterpretation or misuse by commentators and/or actors using the evaluation findings (for example, university league table rankings)?
- Well-defined – does it have a clear, unambiguous definition so that data will be collected consistently, and so that the measure is easy to understand and use?

Box 3. CAHS criteria for appropriate individual indicators (CAHS 2009)

Another key aspect of any indicator driven evaluation is to understand when it is appropriate to use indicators. For example, assessing basic biomedical research against wide public health outcomes does not take into account the problems of attribution for final outcomes from research. Instead, it is more appropriate to assess research against indicators in which it can realistically expect to make a difference. For basic biomedical research this likely means producing high quality outputs (papers, devices etc.) and having the research inform the most appropriate stakeholder groups (other researchers, policy makers, industry etc.).

As identified earlier, it is also important to consider indicators that can be used at the correct level of aggregation. This is important for creating groups of indicators for any evaluation, as it is likely that evaluations of organizations or networks such as CIMVHR will require indicator groups that can span various levels of aggregation.

3.3. HOW TO USE INDICATORS

Any evaluation requires an understanding of the logic of the research impact process and a balanced view of research impacts. Since no single indicator can provide this kind of evaluation, it is necessary to produce a suite of indicators (*converging partial indicators* – CAHS 2009) that can showcase the impacts and be used to help triangulate findings (Martin 1996).

Box 4 shows the FABRIC criteria that need to be met for groups of indicators (HM Treasury, Cabinet Office *et al.* 2001).

> **F**ocused on the organization's aims and objectives
> **A**ppropriate to, and useful for, the stakeholders who are likely to use it
> **B**alanced, giving a picture of what the organization is doing, covering all significant areas of work
> **R**obust in order to withstand organizational changes or individuals leaving
> **I**ntegrated into the organization, being part of the business planning and management processes
> **C**ost effective, balancing the benefits of the information against the costs

Box 4. FABRIC criteria for "appropriate" groups of indicators (HM Treasury, Cabinet Office *et al.* 2001)

Many of the factors that apply to individual indicators also apply at the group level, since a group of indicators used for an evaluation must also have a wide coverage (similar to the *balance* criteria) and not drive behaviour in inappropriate directions – perverse incentives. When developing suites of indicators it is vital to take perverse incentives into account since it is possible to create a suite of indicators that can drive the behaviour of researchers in desired directions, even if individual indicators would normally drive behaviour in undesirable directions (CAHS 2009).[10]

3.3.1. EVALUATION COSTS AND EFFICIENCY

It is not just research that must be accountable: any evaluation must also show value for money. It is important to note that it costs money to improve data collection, and that there are trade-offs between the quantities and quality of information collected and the cost of accessing that information (CAHS 2009). Previous work has suggested that spending between 1 and 5% of the research

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[10] For example, while research quality indicators have focused on citation data (driving researchers to focus on peer-reviewed journal publications), adding measures of broader dissemination (such as presentations to the general public and consultancy to policy makers) to the suite of indicators can drive researchers away from only publishing in journals.

budget to evaluate outcomes is not unreasonable (Maredia, Byerlee *et al.* 2000; Gibbons and Georghiou 1987).[11]

One way to provide value for money for research evaluation is to ensure that the evaluation techniques use valid methods that can identify answers to specific questions. This is particularly pertinent for CIMVHR in that the CAHS model already identifies a wide range of potential indicators that can be investigated for their attractiveness and feasibility in evaluating CIMVHR activities. Another way is to use data that is already routinely collected in administrative activities (HM Treasury, Cabinet Office *et al.* 2001).[12]

3.3.2. METHODS USED TO COLLECT DATA FOR EVALUATION OF HEALTH RESEARCH

There are a wide variety of methods available to collect the kinds of impact data that health research organizations find useful in addressing their own evaluation needs.

Any evaluation in health research should use a number of different methods in order to triangulate evaluation findings and to ensure capture of the full range of impacts from health R&D (Ruegg and Feller 2003). This collection of methods may be all quantitative, all qualitative, or a combination of both, as long as the methods speak to the evaluation needs of the health research organization in hand. The main qualitative methods used have been case studies, peer review, and open answer surveys (UK Evaluation Forum 2006; CAHS 2009).

Table 4 shows a selection of possible evaluation methods that may be of interest to CIMVHR, and outlines the method's pros and cons.

There are numerous data collection methods, but most fall into two categories: quantitative methods and qualitative methods. The main quantitative methods used in health research evaluation have been bibliometrics (UK Evaluation Forum 2006; UNESCO Institute for Statistics 2005), quantitative surveys, economic analyses, and quantitative scoring of research through expert analysis (CAHS 2009). The main qualitative methods used have been case studies, peer review, and open answer surveys (UK Evaluation Forum 2006; CAHS 2009).

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[11] It is notable that by funding research evaluation, it is not only possible to identify impacts from specific funding, but also to better understand the causal pathways that lead to impacts—improving the framework for future evaluations.

[12] As an overview, the World Bank has produced documentation about how to perform impact evaluations under budgetary constraints that provides more details on reducing costs (Bamberger 2006).

Table 4. Available methods for evaluating health research impacts (Adapted from CAHS 2009)

METHOD	PROS	CONS
Bibliometrics	• Can indicate volume and quality of output • Enables analysis of global trends • Suited to repeated analyses • Can be applied to patents (technometrics) • Being developed for use with impacts as well as outputs • Objective data available from existing databases helps address research administrative burden and may be more credible	• Research fields and disciplines need to be taken into account in all analyses • Analysis complicated by the introduction of electronic publications and open and public access journals • Expensive to collect data and analyze • Only able to investigate peer-review publications
Surveys	• Can identify outputs and outcomes associated with particular pieces of funding/research • Provides qualitative analysis of outcomes (e.g., quality of trained researchers, business/academic interactions)	• Dependent on contact details being available (e.g., for past award holders) • Poor response rates can lead to biased responses
Economic rate of return	• Can be applied to variety of sectors • Can be used comparatively (e.g., contribution of cost effectiveness studies) • Quantitative • Provides big picture and context • Potentially powerful political tool	• Involves subjective decisions of what is involved and therefore what to "cost" • Difficult to value many influences involved • Heavily depend on monetary valuation of non-monetary goods (e.g., quality of life) • Difficult to identify contribution of individual funder/sector/country
Case study	• Provides in-depth analysis of the process of discovery • Can demonstrate pathways from research to application and impact • Information useful for a range of purposes (e.g., reporting to stakeholders, media)	• Potential selection bias: cases chosen may not be representative • Often difficult to track and interpret the history of scientific discovery • Problems of recall bias • Method can be highly resource intensive
Peer review	• Well understood component of research management • Widely accepted by the research community	• Time consuming for experts • Concerns about objectivity and variability of judgements and lack of transparency
Data Mining	• Access to data held by other organizations that relate to health research impacts • Quantitative data that is useful for advocacy • Often low cost of data collection	• No control over data quality or collection approaches • No control over attribution of data • Data may not precisely fit the needs of the evaluation
Benchmark-ing	• Benchmarking provides comparisons of performance with that of others (e.g. programs, institutions, regions, countries, or other entities) • Used to identify best practices used by others in order to improve one's own performance • Inform decision making where to allocate investments.	• Requires a lot of data as well as judgement. as to what is appropriate to the area under investigation • Usually time dependent, sometimes a time lag in availability of data • Data maybe at such a high level, difficult to determine the entities contribution.

Sociometric and Social Networks	• Ability to assess structure, patterns of interactions, integration, relationships and communications patterns. • Helps in understanding of how and why collaborations develop • Require relatively small amount of data that can be obtained through survey, interviews or existing databases • Visualizations can be useful in communicating complex interactions to target groups.	• Emerging method and largely unfamiliar to many stakeholders. • It does not provide a quantitative measure of its value • A network diagram may be time limited, thus requiring the process to be repeated after time.
Altmetrics	• Focus is on the "re-use" of research and includes non-traditional forms of academic publication and dissemination (e.g. research notes data sets, blogs, twitter etc.) • Useful in monitoring research reuse	• Emerging practice with little evidence supporting it, • Requires dissemination to have occurred.

4. CIMVHR FRAMEWORK AND INDICATORS

For CIMVHR to effectively understand and publicise its impacts, it will be important to have a well-documented, standardized approach to measuring and monitoring well-defined impacts. This means developing a framework to visualize the route to CIMVHR impacts, and clear indicators that allow measurement of those impacts. The framework and indicators must be standardized across time to allow CIMVHR to show progress towards its organizational goals, and also standardized with other impact frameworks to allow CIMVHR to demonstrate its adoption of best practices and finally to provide the option to compare CIMVHR to other organizations in the future.

4.1. DEVELOPING THE CAHS FRAMEWORK

The mandate for this assessment was for CAHS to provide CIMVHR with a practical and useable research impact evaluation framework. This mandate came about because of the previous work by CAHS in developing a return on investment (ROI) framework that could be applied to any area of health research in Canada. As such, it is reasonable or logical to use the CAHS ROI framework (Figure 3) as a starting point from which to develop a specific research impact evaluation framework for CIMVHR: one that can operationalize the general principles espoused in the original CAHS framework for CIMVHR's specific context and needs.

4.2. THE CIMVHR FRAMEWORK

There are aspects of the CAHS framework appropriate to the needs of CIMVHR in identifying and analysing the impact of its activities (particularly its research). Having a structure that allows CIMVHR to trace the impacts of their activities through the development of research, the research process, research outputs and then further outcomes, will prove essential to use an evaluation framework for any advancement of its work.

There are, however, factors specific to CIMVHR that suggest a need for modification of the framework. First, there is a clear need to place any analysis of health research performed by CIMVHR into the context of military and veterans' health research, rather than research more generally. This is particularly relevant when using the framework to help identify indicators for use by CIMVHR in their impact evaluation. Second, it is necessary to use the context of CIMVHR's work to help identify specific stakeholders in military and veterans' health research: health and other industries; the military; government; the research and education system; and veterans and military families (as distinct from the military itself).

CIMVHR has a clear imperative to work collaboratively as a network, since this underpins its approach to producing research impacts. As such the framework

needs to take into account the development of networks as a process of the work undertaken by CIMVHR, but also as an output of CIMVHR activities. The network itself is important to ensure maximum impacts from CIMVHR research (in terms of quality research outputs and ability to link outputs to appropriate stakeholders). Thus the CIMVHR network plays a role as an input, a process and an output in the CIMVHR framework.

4.3. FULL CIMVHR IMPACT FRAMEWORK

Breaking down the CIMVHR framework into a specific analysis of what happens through CIMVHR activities allows us to develop a specialized framework that can help to guide CIMVHR evaluations (Figure 4). This framework provides detail on the types of activities, products and impacts that we might reasonably expect to see from CIMVHR activities. It also provides the logic of how CIMVHR research activity (and research related activity such as capacity building) leads to results, decision making, health outcomes and ultimately to wellbeing and socio-economic outcomes.
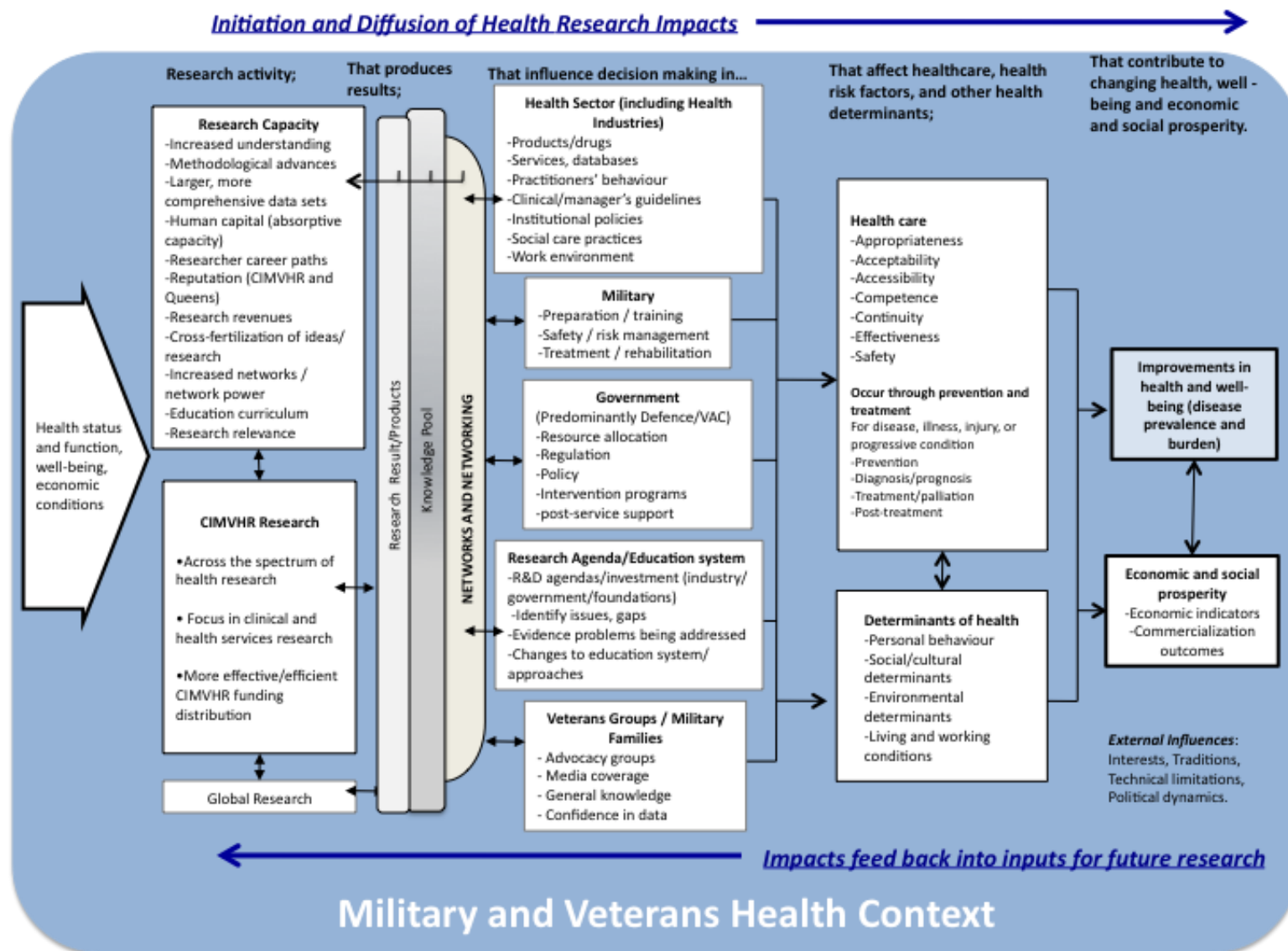
Initiation and Diffusion of Health Research Impacts →

Research activity;

That produces results;

That influence decision making in...

That affect healthcare, health risk factors, and other health determinants;

That contribute to changing health, well - being and economic and social prosperity.

Research Capacity
-Increased understanding
-Methodological advances
-Larger, more comprehensive data sets
-Human capital (absorptive capacity)
-Researcher career paths
-Reputation (CIMVHR and Queens)
-Research revenues
-Cross-fertilization of ideas/ research
-Increased networks / network power
-Education curriculum
-Research relevance

Health Sector (including Health Industries)
-Products/drugs
-Services, databases
-Practitioners' behaviour
-Clinical/manager's guidelines
-Institutional policies
-Social care practices
-Work environment

Military
-Preparation / training
-Safety / risk management
-Treatment / rehabilitation

Government
(Predominantly Defence/VAC)
-Resource allocation
-Regulation
-Policy
-Intervention programs
-post-service support

Research Agenda/Education system
-R&D agendas/investment (industry/government/foundations)
 -Identify issues, gaps
-Evidence problems being addressed
-Changes to education system/ approaches

Veterans Groups / Military Families
- Advocacy groups
- Media coverage
- General knowledge
- Confidence in data

Health care
-Appropriateness
-Acceptability
-Accessibility
-Competence
-Continuity
-Effectiveness
-Safety

Occur through prevention and treatment
For disease, illness, injury, or progressive condition
-Prevention
-Diagnosis/prognosis
-Treatment/palliation
-Post-treatment

Determinants of health
-Personal behaviour
-Social/cultural determinants
-Environmental determinants
-Living and working conditions

Improvements in health and well-being (disease prevalence and burden)

Economic and social prosperity
-Economic indicators
-Commercialization outcomes

External Influences: Interests, Traditions, Technical limitations, Political dynamics.

Health status and function, well-being, economic conditions

CIMVHR Research
•Across the spectrum of health research
• Focus in clinical and health services research
•More effective/efficient CIMVHR funding distribution

Global Research

Research Result/Products
Knowledge Pool
NETWORKS AND NETWORKING

Impacts feed back into inputs for future research ←

Military and Veterans Health Context

Figure 4. Detailed CIMVHR research impact assessment framework

4.3.1. ACTIVITIES

Research Capacity: CIMVHR has an important role to play in capacity building, both in terms of training of new researchers, but also in terms of building the capacity to perform high quality research in military and veterans' health in Canada. This means being able to increase understanding of the research (including receptor capacity for research); advancing methods and data sets to provide capacity for more complex problem solving; increasing the capacity for researchers to use existing research (absorptive capacity and cross-fertilization of ideas); developing and progressing researchers through their careers (including better curricula for education); building the reputations of CIMVHR and its affiliated institutions; increasing networks of researchers (including the quality and reach of those networks); increasing research revenues for military and veterans' health research; and, improving relevance of research (to improve the capacity for action from research). To achieve high quality research in military and veterans' health (and high impact research) there will need to be a period of capacity building prior to consistently producing excellent research and achieving long-term outcomes.

Research: The act of performing military and veterans' health research will also provide opportunities for CIMVHR to have impacts. First, there is a need to develop research across the full spectrum of health research – from basic biomedical research through to health services and population health research. Second, for CIMVHR, there is a benefit in focusing on clinical and health services research, since this aligns most closely with the needs of the main clients for CIMVHR work (the military and veterans). Finally there is a need to provide more effective and efficient distribution of funding from CIMVHR to ensure that the best research is provided for across the CIMVHR network (and across the country).

Global Research: While CIMVHR will not necessarily be funding global research (outside of Canada), its network will likely be involved in attracting global research funding on military and veterans' health issues. Health research is also inherently a global enterprise and CIMVHR needs to be part of the pursuit of global research goals (both in terms of using global research and contributing to the global research pool).

4.3.2. RESULTS

Results and Products: Research produces outputs. Sometimes these outputs are simply published; sometimes they are new products and technologies. What is always true is that for CIMVHR to understand its impacts, understanding the "things" that come out of research is vital.

Knowledge Pool: Contributing to the international knowledge pool for military and veterans' health research is a vital part of CIMVHR research results.

Networks and Networking: As a virtual institute with multiple members and groups across the country, CIMVHR has a very specific need to monitor its approach

to networks and networking of researchers. Building the network, maintaining the network and honing the skills of researchers within the network to continue networking among themselves will help to achieve CIMVHR's goals.

4.3.3.INFLUENCING DECISION MAKING

Health Sector: The development of "tangible outputs" from research is of much interest to the health sector including health industries (the healthcare sector, pharmaceutical industry, medical device industry, therapeutics etc.) with the opportunity that research results bring to develop new products (such as drugs and devices), new health care practices and services, and databases (such as new support approaches). New research findings can also influence decision making of individuals in the health and social care sector (practitioners, clinical managers, policy makers). Research findings can also inform the approaches in institutions (such as new institutional policies on treatment of veterans). Military and veterans' health research findings may also inform decision making in the workplace (such as human resource practices associated with veterans).

Military: Research on military and veterans' health naturally lends itself to influencing the military in its approach to delivering health and wellbeing for military and veterans. This includes modifications to preparation and training for the military (to prepare people for combat for example); safety and risk management for personnel; and treatment and rehabilitation for those injured or ill.

Government: Influencing government is a key part of CIMVHR's role, particularly influencing decision making in Defence and Veterans Affairs. Health research findings can help to influence decisions about resource allocation; regulation; policy development (and evaluation); government programs; and, support for service people when they leave the military.

Research Agenda/Education System: Research findings also inform future research and education around health. This means focusing future R&D agendas (including research investment) by identifying strategic issues (such as gaps in the research or education systems, where research is currently addressing issues – to reduce duplication). It can also help modify future education approaches including the approach taken to education on military and veterans' health.

Military Members and Veterans Groups and Their Families: Finally, there is a clear imperative for CIMVHR to influence the decision making of their public stakeholders – veterans and military families. This means research outputs informing advocacy groups, the media and entering general knowledge. There is also a role for research in changing an individual's behaviour, through improving the public's confidence in research data (making them more likely to change behaviours based on research findings).

4.3.4. HEALTH CARE AND DETERMINANTS OF HEALTH

Health Care: There are existing standard areas where Canada collects information on changes to health care through the Canadian Institute of Health Information (CIHI) and Statistics Canada. These are in: Appropriateness; Acceptability; Accessibility; Competence; Continuity; Effectiveness; and, Safety. Clearly for CIMVHR, these changes in the health care system are important within the context of military and veterans' health, so there is a need to consider whether these areas have specific measures that relate to military and veterans' health care.

Prevention and treatment: For disease, illness, injury, or progressive conditions, the outcomes in the health system are less important than some outcomes related to avoiding or entering the health system – i.e. by avoiding the need for healthcare through effective prevention and self-led treatment and care. These include: prevention; diagnosis and prognosis; treatment and palliation; and, post-treatment care and support for individuals.

Determinants of health: In addition to actively managing health and wellness, there are important impacts of health research (including CIMVHR research) on the determinants of health. In the case of CIMVHR, this again needs to be considered within the context of military and veterans' health, as determinants may be too broad otherwise. Areas potentially affected by CIMVHR research are: personal behaviour (of military personnel, veterans, military families); social and cultural determinants of health (within the military and social context of veterans); environmental determinants (related to the military); living and working conditions for military personnel and veterans; and, biological or genetic predisposition to conditions.

### 4.3.5. HEALTH, WELLBEING AND ECONOMIC AND SOCIAL PROSPERITY

Final outcomes to be achieved from health research, including that conducted through CIMVHR, are changes to the health and wellbeing of the target population (in this case military personnel, their families and veterans), and economic and social prosperity.

Improvements in health and wellbeing: The simple measurement of changes to health and wellbeing is through already collected data on health conditions prevalence and burden in military, veterans and their families.

Economic and social prosperity: For CIMVHR research, there are a number of opportunities to develop research findings that can lead to economic prosperity through commercialization and other routes. There are a number of potential indicators of economic benefit that can be used to assess this (to be discussed later

in the document). Social prosperity[13] is harder to identify, but there are moves to develop indicators of general social prosperity and community well-being.

Simplified Impact FrameworkFigure 5 shows how these modifications for CIMVHR look in a simplified version of the proposed CIMVHR impact framework. A simplified framework is the version that is most useful for discussing the impact framework with stakeholders in CIMVHR activities, since they will not need the full details of the framework that are necessary for evaluation of CIMVHR impacts. The logic model pathway from the CAHS framework is maintained (running from inputs to final outcomes), along with the general structure of the framework. However, there are specific differences in the alignment of the framework with the goals, mission and vision of CIMVHR (to allow for simple reporting of impacts to align with CIMVHR's approach). There is also a focus on capacity building and networking in the processes and primary outputs of research conducted by CIMVHR that speaks to the unique structure of CIMVHR in delivering its research. While the secondary outputs reflect the five main stakeholder groups with which CIMVHR works and for, the outcomes of the research remain the same (albeit within the context specifically of military and veterans' health research). Each stakeholder group in the framework depicts decision-making target audiences who are the "users" of CIMVHR research. They are the groups that should be surveyed for early evidence of research uptake.

Figure 5. Overview of CIMVHR research impact assessment framework

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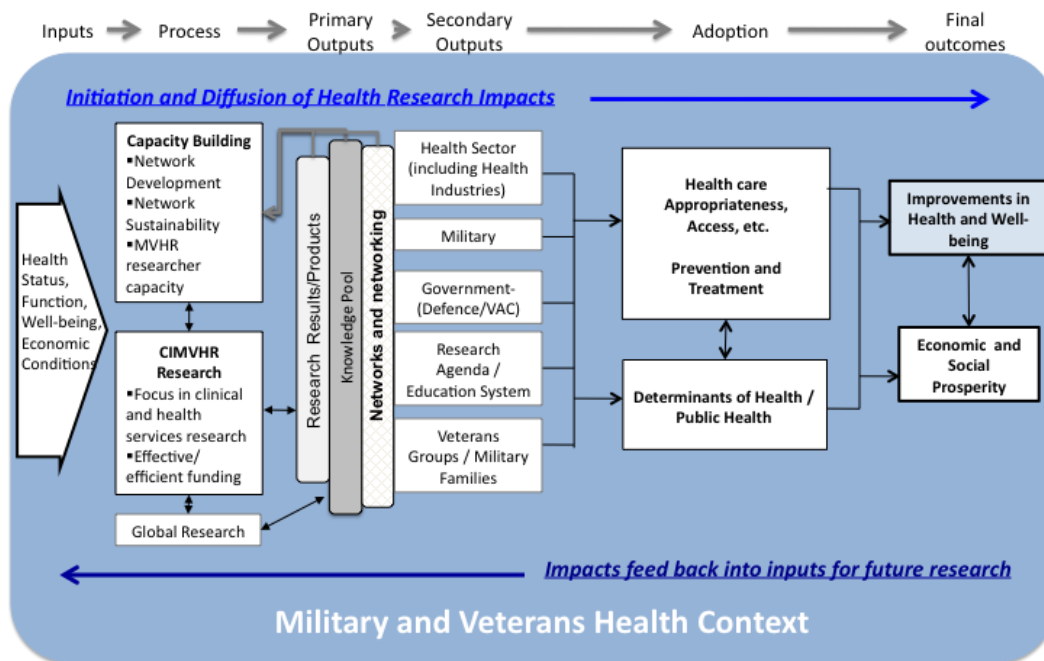
[13] Social Prosperity pertains to many of the intangible elements that enable individuals to feel a deep personal connection to their community, their ability to reach their full potential and to access community resources that contribute to the quality of life.

4.4. IMPACT CATEGORIES TO ALIGN WITH THE FRAMEWORK

The framework alone cannot provide CIMVHR with the necessary evidence to show impacts arising from their work. The framework only provides the visual representation of the activities of CIMVHR and their likely routes to desired and expected consequences. To align with the framework, we also need a collection of impact categories that allow us to analyze the outputs and outcomes of CIMVHR activities in a comprehensive and comparable manner.

For the purpose of this work, the CIMVHR model being developed has guided the panel in identifying modified categories of impact from those used in the CAHS framework that relate specifically to the needs of CIMVHR as a developing organization working specifically in military and veterans' health research. These categories were identified using a combination of the expert knowledge of the members of the panel, the knowledge of stakeholders in CIMVHR activities who were interviewed as part of the project, and through analyzing existing approaches to measuring research impacts in similar types of research organizations to CIMVHR. Table 5 shows how the proposed CIMVHR categories align with the CAHS framework categories (and the original Payback Framework that the CAHS framework was based on).

Table 5. Impact categories from the Payback Framework, CAHS ROI Framework and the proposed CIMVHR Framework

Original Payback Category (Buxton and Hanney 1996)	CAHS Categories (CAHS 2009)	Proposed CIMVHR Categories
Knowledge Production	Advancing Knowledge	Advancing Knowledge
Research Targeting, Capacity, and Absorption	Capacity Building	Capacity
Informing Policies and Product Development	Informing Decision Making	Informing Decision Making
Health and Health Sector Benefits	Health Impacts	Health Impacts
Broader Economic Benefits	Broad Economic and Social Impacts	Broad Social and Economic Impacts, Commercialization
		Knowledge Translation
		Impact on Host Institutions
		Networks and Networking

4.5. INDICATORS

Indicators for CIMVHR fall into the impact categories identified through the framework. Below we outline potential indicators for CIMVHR based on these impact categories. It is worth noting again, that indicators and measures of impact are likely to be relevant at different points in CIMVHR's development, with early measures of capacity and networking likely to be most important in CIMVHR's early development, while health and economic impacts will or should be expected to occur later in CIMVHR's development.

The CIMVHR framework provides a scaffold for the development of appropriate indicators, since the framework describes the way CIMVHR inputs can turn into desired (and unexpected) outcomes and impacts. Not only does this mean the framework can help guide where indicators of impact are needed (although not necessarily which impact category they might be in), the framework also helps to guide evaluators to the points at which they should be trying to collect data to support indicators (and with the stakeholder-driven framework, and from whom to get information from).

We have identified indicators in each of the categories identified above, and have based the selection of indicators on the concepts of attractiveness and feasibility and the likelihood that the indicator will be used by CIMVHR (an estimate of its potential usefulness to CIMVHR). We have also identified for each indicator accessibility of data, what level of aggregation to use the indicator at (to assess individuals, research groups/departments, universities, or the full CIMVHR network), as well as which stakeholders are likely to be most useful/informative from data collected on that indicator.

4.5.1. ADVANCING KNOWLEDGE

As a knowledge organization, CIMVHR states clearly in its mission the need for knowledge creation. In this impact category, we identify indicator sub-categories of: knowledge created (quantity of knowledge) and knowledge quality.

i. <u>Documentation of new knowledge created</u> – The first role of any evaluation of research is to ensure that research is being productive. This means identifying products of the research in terms of publications, innovative products and any other research outputs.

    a. **Publication counts** – By surveying researchers or mining their CV data, CIMVHR can identify publications that link to CIMVHR-related research in order to count the number of publications. This count should be verified using a bibliometric analysis of publications identified by researchers to establish how many publications are held in publication databases (and can therefore form part of any citation analysis for research quality).

b. **Innovative product counts** – Surveying researchers to identify innovative products that have arisen from their research allows the capture of specific research outputs that can go on to have likely economic or other impacts. CIMVHR should collect information on the numbers of the following innovative research products:

   i. Intellectual property (patents, trademarks, licenses) – NB. This can also be collected through the US Patents database using a technometric analysis.

   ii. Devices – new devices developed.

   iii. Services – new health or social services developed.

   iv. Practices – new healthcare or social care practices developed.

c. **Other research outputs** - Outside of peer reviewed publications and innovative products, there may be other research outputs developed through CIMVHR research (e.g. standards, guidelines, methods and tools), and the use of surveys of researchers should allow the capture of any additional research outputs.

ii. <u>Knowledge quality</u> – Being productive in research is only useful if the research is also identifiably high quality. As such, in addition to collecting information on numbers of products, there is a need to collect information on the quality of products too. For CIMVHR this can be done at both the organizational level, and at the level of individual researchers.

   a. **Peer review of outputs by CIMVHR as a whole** (5 year reviews of research quality by international panel) – At an organizational level, it is valuable for CIMVHR to know it is producing quality outputs. It is recommended that CIMVHR assess its own outputs through regular international reviews, in a process similar to CIHR Institute Reviews.

   b. **Bibliometric measures** - For peer-reviewed publications bibliometric analysis of citations is a well-established approach to assessing quality (see CAHS 2009). As such, we have identified the two citation metrics identified in the CAHS framework as equally appropriate for use by CIMVHR. These citation measures would be best collected using a professional bibliometric analysis on a regular (potentially every two years) basis.

      i. *Highly Cited Publications (HCPs)* – Citation analysis allows the identification of the world's most highly cited papers within research areas (based on citations over a given time-window). Identifying how many HCPs arise from CIMVHR researchers gives one idea of the "best research" coming out of CIMVHR.

1. Proportion of HCPs in CIMVHR areas by CIMVHR researchers – In addition to collecting the number of HCPs by CIMVHR researchers, knowing the CIMVHR proportion of total HCPs in the research area allows an understanding of the proportion of top research being produced by CIMVHR.

   ii. ***Relative citation values*** – Different fields of research have different citation patterns (Moed 2005), and to ensure that citations are compared in a fair way, it is necessary to only compare citations within a research field. As such, by comparing the level of citation of publications against the world average number of citations for publications in that field, we can develop a normalized citation score that can then compare across fields of research (since it refers to how much a publication is above/below the world average).

The table below shows the indicators and metrics for the advancing knowledge category.

Table 6. Advancing knowledge indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Advancing Knowledge	Activity	• Knowledge created quantity	• # count of publications* • # count of innovative products* • # count of other research outputs	• Volume of peer reviewed publications from CIMVHR • Volume of patents, licenses and trademarks, devices, services and practices. • Volume of other outputs (e.g. standards, guidelines, methods and tools)	• Bibliometrics • Technometrics (patent databases) • Survey
	Knowledge quality	• Research quality	• 5 year peer review of CIMVHR and its outputs • Relative citation value* • Highly cited publications*	• Similar approach to CIHR Institute review by international experts. • Citation values versus the world average by field of research. • Number of publications in the top 5% cited in the world by research field.	• Administrative data • Peer review • Bibliometrics (external analysis)

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

4.5.2.CAPACITY

We have developed a collection of indicators that address the four main aspects of capacity that CIMVHR aims to address (based on the CIMVHR stated key activities): people, infrastructure, data and funding.

i. Personnel – it will be important to collect information on the human capacity built and maintained by CIMVHR.

- **Number of trainees supported (directly and indirectly) by CIMVHR**. This indicator is a standard indicator of capacity and would allow identification of the human resources developed by CIMVHR. It is anticipated that this would identify people achieving further research degrees (Masters, PhDs) that are funded by CIMVHR. Data for this would come from administrative data and from CIMVHR mentors. Ideally, CIMVHR would also track what happens to trainees after training, but this is a difficult process requiring the development of on-going surveys and the ability to identify trainees once they have left CIMVHR training.

- **Numbers and type (researchers/pillars of research) of people in the CIMVHR network.** This gives a measure of the size and breadth of CIMVHR as a whole. Data for this indicator can be collected using existing administrative data sets that identify CIMVHR network members (but may need additional information on member role, discipline and pillar of research)

- **Total numbers involved in CIMVHR related research in Canada**. This indicator gives a measure of the total extent of health research in Canada that is relevant to military and veterans' health, and gives an idea of the size of the role played by CIMVHR in military and veterans' health research in the country. Data for this indicator needs to be collected using bibliometric analysis of researchers publishing in identified CIMVHR areas of health research. Each area for CIMVHR will need to have identifiable publications, so we would recommend aligning CIMVHR research areas with existing Web of Science or Scopus health research categories (for simplicity).

- **Honors and Awards for CIMVHR members**. This indicator provides a measure of the development of the human capacity at CIMVHR, identifying where CIMVHR members are recognized as excellent (Example of honours and awards: Major Sir Frederick Banting MC, RCAMC Award for Military Health Research). Data for this would need to be collected from researchers, but could be analyzed from the common CV or a researcher survey.

ii. <u>Funding</u>: CIMVHR also needs to build funding capacity – for itself as an organization and for its research areas more generally. As such, the panel have identified three indicators for CIMVHR to monitor funding capacity.

- **Funding brought in through CIMVHR** (including funding directly for CIMVHR): CIMVHR does not directly fund researchers, but provides a conduit for research funding to flow to the best military and veterans' health researchers in Canada. As such, monitoring the way that funds flow through CIMVHR (and indeed to CIMVHR for their own costs) will allow easy comparisons of the CIMVHR direct funding capacity. This information should be collected using standard administrative data and be able to capture the type of funding (grant, program etc.), the source (government, research council etc.), the amount (in $), the research area (e.g. mental health, rehabilitation etc.) and the duration of the funding.
- **Leveraged funding by CIMVHR researchers** (national and international): In addition to funding that flows through CIMVHR, it is also possible for CIMVHR researchers to leverage other research activity funds. By surveying CIMVHR researchers, it will be possible to collect information on leveraged funding for CIMVHR research. Again, this indicator will capture the type of funding (grant, program etc.), the source (government, research council etc.), the amount (in $), the research area (e.g. mental health, rehabilitation etc.) and the duration of the funding.
- **Proportion of funding in CIMVHR research areas that is through CIMVHR**: In order to know how successful CIMVHR is in terms of their role in providing military and veterans' health research in Canada, it would be beneficial to know what proportion of funding for military and veterans' health in CIMVHR's research areas, comes through CIMVHR (showing their market share of research funding). This information would need to be collected using a funding analysis of other research funders in Canada, and would need to occur every 2-3 years.

iii. <u>Infrastructure:</u> In addition to the members of CIMVHR, there is a clear need to monitor the levels of infrastructure capacity for CIMVHR work. Research cannot be conducted without infrastructure and CIMVHR should monitor whether their research is linked to infrastructure funding (CAHS 2009).

- **$ in infrastructure funding brought in for CIMVHR projects**. This indicator is a simple measure of how much infrastructure funding is brought in for CIMVHR research projects, and will vary year on year. Data for this indicator can be collected from funded researchers through surveys and or annual progress reports.

- **Proportion of CIMVHR projects with attached infrastructure funding.** This indicator builds on the concept of total infrastructure funding by identifying whether CIMVHR research projects are supported by infrastructure funding. Data for this indicator can be collected through researcher surveys or through university partner administrative data on indirect costs associated with research council grants.

iv. <u>Databases:</u>
  - **New databases developed by CIMVHR** – Working with a specific population (military and veterans), it is necessary to be able to access quality and appropriate data. CIMVHR should monitor the development of databases by their researchers both to track research outputs, and to provide opportunities to link researchers to databases in the future. This information would be collected through researcher surveys.
  - **Tracking of data deposited in existing databases** (e.g. data to genomic databases) – In addition to developing their own databases, CIMVHR researchers may well submit data to existing databases (such as genomic or proteomic databases). CIMVHR can track this depositing of data using data-mining of public databases for deposits that are linked to CIMVHR (in the funding or supporting organization category of data tagging). This would require annual mining of the most important databases for CIMVHR research (to be determined by CIMVHR).
  - Data sharing - Data can and should be shared by CIMVHR researchers to maximize the value of the data. CIMVHR can monitor this data sharing through analysis of both formal data sharing agreements and informal data sharing by researchers. This information should be collected through surveying researchers annually to determine levels and type of data sharing.

The table below shows the indicators for the Capacity category of indicators.

Table 7. Capacity indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Capacity	Personnel	• Graduated research students	• #/% and type of graduated students (e.g. Postdocs/ PhDs,/ Masters produced by CIMVHR supported members)*	• Tracking the success of CIMVHR's education role for researchers.	• Survey • Admin data
		• CIMVHR researchers	• # researchers and others in CIMVHR broken down by academic level and by research subject area.	• Analysis of CIMVHR researchers and other staff (by level and field of research)	• CIMVHR admin database
		• Network membership and non-membership composition	• Total # involved in CIMVHR-related research in Canada (includes members and non-members?)	• Analysis of the total # of people involved in CIMVHR-related research to see how comprehensive the CIMVHR network is (can get % of total # that is in CIMVHR)	• Research area analysis (bibliometric, funder analysis)
		• Image and recognition of CIMVHR Personnel	• #/% awards and type of awards for CIMVHR members.	• E.g. Major Sir Frederick Banting MC, RCAMC Award for Military Health Research.	• Survey • Admin data
	Funding	External leveraged investments	• Total ($) funding brought in through (and for) CIMVHR. • Total ($) leveraged funding by CIMVHR researchers (including matched funding from partners) * • % Funding for CIMVHR research areas in Canada that comes through CIMVHR.	• $ in funding that run through CIMVHR (and $ for CIMVHR itself). By type, source, area, and duration. • $ in funding that supports CIMVHR researchers but is not through CIMVHR. By type, source, area, and duration. • Proportion of total funding in military and veterans health research that is through CIMVHR. By area.	• Surveys • Financial data • Funding analysis for Canadian military and veterans health research
	Infrastruc-ture	• Infrastruc-ture grants	• Total amount in ($) of infrastructure funding brought in for CIMVHR projects* • % CIMVHR projects with attached infrastructure funding*	• General measure of infrastructure dollars for CIMVHR research. • Measure of the proportion of projects with infrastructure support attached to research funds.	• Financial / admin data
	Databases	• Database development, access and sharing	• # / % new CIMVHR developed databases • Tracking of data deposited in existing public databases (e.g. data to genomic databases) • Analysis of data sharing in the network (e.g. joint development of methods and tools etc.)	• Tracking of researchers, development of databases for CIMVHR-related research. • Data mining existing public databases to identify annual input from CIMVHR projects. • Qualitative analysis of data sharing by researchers using data sharing agreements.	• Survey • Public database mining for funder data

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

Developing knowledge is only part way to achieving outcomes for CIMVHR. To really change the lives of military and veterans, there is a need to influence decision making of a wide variety of stakeholder groups to use the knowledge created by CIMVHR.

   i. <u>Citation analysis to monitor use of CIMVHR research</u> – Being able to track the way that CIMVHR research informs decision making for various stakeholder groups related to CIMVHR will be valuable in determining how the Institute is achieving its goals. For some stakeholder groups there are formal written products that identify whether research has informed their thinking.

     a. ***Researchers - Citations in systematic reviews***: This identifies where researchers consider research to be important enough to be at the forefront of researchers minds when considering their decision making in a particular research area (since systematic reviews can be used in priority setting and identifying the next areas of research). This information would be collected in a standard bibliometric analysis.

     b. ***Healthcare providers - Citations in practice guidelines***: Health practice guidelines identify where the research that underpins their guidance for decisions comes from. Practice guidelines are also the best written proxy for identifying decision making by health care providers. As in the CAHS (2009) framework, this is a recommended indicator that can build on existing work by CIHR (Canadian Institutes of Health Research 2005b).

     c. ***Policy makers - CIMVHR research in policy documents***: Analyzing citations to research in public policy documents (grey literature) is identified in the CAHS framework (2009) as an approach to measuring informing policy. Currently there are limitations for this indicator (in methods and the citation of research in policy documents) but by the time CIMVHR uses this indicator we anticipate an appropriate tool will be available in Canada for this type of analysis. Data for this indicator would need to be collected through a professional bibliometric analysis.

     d. ***Industry - Citation analysis of stage reports in development of products by industry***: Research in industry must go through six stages in order to become a successful product: preliminary investigation, detailed investigation, development, validation, commercialization, and sales. Citation analysis of the reports produced between stages (Government of Canada 2008) could identify what research is underpinning the movement of products through the development pipeline. The information for this indicator would need to be collected through stage reports from

industry (collected by CIMVHR) and then bibliometrically analysed (professionally).

ii. <u>Survey of researchers to identify where they believe they have informed decision making:</u> Asking researchers to identify who they think their research has informed and how. This data would be collected using surveys of researchers, and in the UK, has been used at the end of grants and again 5 years after the end of the grant (Wooding *et al.* 2008).

iii. <u>Survey of stakeholders to determine use of CIMVHR knowledge:</u> This indicator is very powerful, but requires the development of a survey (or surveys) that can adequately capture the different ways different stakeholders use CIMVHR knowledge. Data collection for this indicator can be through surveying stakeholders annually and through occasional case studies on stakeholder groups (every 3 years). Stakeholder groups to survey are:

   a. Veterans/Military personnel/families – use of findings to influence personal decisions.
   b. Healthcare providers – to assess practice based on CIMVHR research.
   c. Policy makers.
   d. Industry collaborators.

The table below shows the indicators for the Informing Decision Making category.

Table 8. Informing decision making indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Informing Decision making	Use of research	• Use of research by stakeholders	• Citations of research by various stakeholders* • Utilization rate reported by researchers • Self-reported use of findings	• Citations in systematic reviews, practice guidelines, policy documents, stage reports in industry. • Surveying researchers to identify where they see research being used and by whom. • Use of findings to influence personal decisions for military, families and veterans, healthcare, policy and industry.	• Bibliometric analysis of guidelines, reviews, policy and industry reports • Surveys

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

4.5.4. HEALTH IMPACTS

CIMVHR has in its mission and vision, a desire to improve the health status of military personnel, their families and veterans. To capture these impacts, which are hard to link specifically to individual pieces of research, we have accepted the indicators identified in the CAHS model of 2009. The CAHS indicators apply to CIMVHR since the sub-categories (health outcomes, health system outcomes, and quality of life) are all considered in relation to military and veterans' health specifically. Health impacts can be very specific, and as such the indicators identified below provide the general types of health impacts to capture (such as mortality rates), rather than specific health impacts (such as reductions in blood pressure). It is important for CIMVHR to identify specific tailored health impacts for their needs (based on the types of research being conducted by CIMVHR) for their own health impact assessment.

i. <u>Health status outcomes of members of the military and veterans</u>: Improving the health status of individuals is not only the primary goal of health research, it is also the most likely to capture the imagination of public and policy maker alike. Measures of improved health are commonplace and form a vital part of understanding where to invest health care funding, and where to invest health research funding (through either directed funding or through the interest of researchers in specific health problems). There are essentially three ways to improve health: through reducing death (mortality), through reducing disease/conditions (morbidity), and by improving the quality of life of individuals (quality-adjusted mortality). As with all health impact indicators, the most appropriate health status indicators depend heavily on the aim of the research conducted. As such the "appropriate indicators" shown are classes. The specific indicators within these classes would need to be decided by CIMVHR based on their strategic research areas.

   a. *Morbidity*: This is generally measured through prevalence and incidence of conditions.
      - **Prevalence** - Prevalence is the number of cases for a condition in a population (shown as a percentage of that population). Changes in prevalence can be related to research for that condition using retrospective studies. This indicator can use Canadian data already collected on a number of conditions, such as PTSD (by, for example, the Public Health Agency of Canada – PHAC).
      - **Incidence** - Incidence is the number of new cases for a condition per 100,000 population. As with prevalence, linking incidence to research findings can be undertaken using retrospective studies. Again, as with prevalence, data are already collected on incidence for certain conditions such as traumatic brain injuries (e.g. through Statistics Canada).

b. ***Mortality***: As with the CAHS indicators, this is measured through potential years of life lost.
- **Potential Years Life Lost (PYLL)**: PYLL represents the number of years of life lost due to premature death (before 75), and provides a measure of mortality than can be standardized across conditions. Data on PYLL are already collected (Statistics Canada 2007) and retrospective studies can provide a link between the changes in PYLL and CIMVHR research findings.

c. ***Quality-adjusted mortality***: There is value in linking measures of health changes to quality of life for patients. This is done in CAHS using Quality Adjusted Life Years (external adjudication of quality of life) and Patient-reported Outcome Measures (internally assessed patient perspective on quality of life).
- i. **Quality Adjusted Life Years (QALYs):** QALYs provide a value between 1 (perfect health) and 0 (death) to represent quality of life for each year lived after a health intervention. By virtue of their link to interventions, QALYs can more readily be linked to research, since research findings can be linked to interventions more easily than health impacts (Buxton *et al.* 2008). QALY data are collected through the Canadian Community Health Survey and would need to be assessed using a health economics analysis.
- ii. **Patient Reported Outcome Measures (PROMs):** PROMs provide patient views, based on a standardized questionnaire about quality of care and quality of life post-treatment. Since this indicator uses the views of individual patients on their experience of outcomes, linking to research findings is currently a problem. However, with their inclusion in the CAHS framework, we anticipate they will be in use by the time CIMVHR require any PROM analysis. Data would likely need to be captured from other research funders using the CAHS approach to impact evaluation.

ii. <u>Health system outcomes</u>. In Canada, changes to health system performance are typically considered to come under eight different factors: acceptability, accessibility, appropriateness, competence, continuity, effectiveness, efficiency, and safety (Statistics Canada and Canadian Institute for Health Information 2008; CAHS 2009). The data currently collected in these domains by Statistics Canada and CIHI are designed to provide information on some aspects of the health system, but are not comprehensive. The specific measures for CIMVHR will need to be decided by CIMVHR based on the research being conducted and the likely areas of health system impacts.
- a. ***Acceptability***
  - Example – self-reported patient satisfaction: Acceptability is generally considered to be best measured by patient satisfaction with the health system (Canadian Institute for

Health Information 1999). Surveying patients to identify their experience of the health service links in with the PROM measure used in health outcomes. Data could be taken directly from those questionnaires to determine the acceptability of the service provided to an individual (Niagara Health System n.d.).

b. ***Accessibility***
- Example – wait times, appointment statistics: Wait times for specific conditions and/or interventions are already collected by CIHI (Canadian Institute for Health Information 2008b). The issue with wait times is that they only apply to secondary care, and so neglect other aspects of the health system. Linking wait time data to research requires specific projects to understand the factors affecting wait times. Statistics for time to appointments could help to identify accessibility to primary care, but would require collecting data from primary care providers about the time to get appointments. This could be done through the Access Response Index (AROS), which counts the number of days until the next available routine appointment with any clinician, once during every normal working day (Jones, Elwyn *et al.* 2003).

c. ***Appropriateness***
- Example – adherence to clinical guidelines: This can be done through clinical audit for health practitioners (Godwin 2001). As a measure of the adherence to clinical guidelines this measure links well to research, since research informing the guidelines has already been captured through the "analysis of clinical guidelines" indicator in the informing decision making category.

d. ***Competence***
- Example – civil law-suits against the health system: Competence is considered to be the appropriate application of skills in the health system (Canadian Institute for Health Information 1999), and can be approximated through counts of civil law suits against the health system. By monitoring the areas in which law-suits occur over time, it is possible to identify which clinical areas improve their performance. Linking these performance changes to research is difficult, however, and would require studies to identify the reasons for changes in levels of competence.

e. ***Continuity***
- Self-reported continuity of care: Surveying patients to identify their perception of the continuity of their care provides a method for identifying experience for patient groups (Centre for Health Services and Policy Research 2004). An alternative to surveying patients is to use administrative data.

f. ***Effectiveness***

- Example – re-admission rates: The numbers of re-admissions by condition over a set time period, year on year, can provide an indication of whether the care provided by the health system is effective (Canadian Institute for Health Information 2008a). The main issue with this indicator is that it can only provide information on conditions that require secondary care; there is currently no indicator that can provide a similar measure of effectiveness for primary care or social care. Data is collected on this by CIHI.

g. ***Efficiency***
- Actual versus expected hospital stay / Cost input versus output: Measuring the length of stay for a patient as compared to the expected stay for the condition can provide information about the efficiency of the secondary care provided. Collecting data on the inputs to health care services and on the different factors identified as outputs (for example, available beds, emergency admissions, etc.) provides information that can be fed into a stochastic model to identify efficiency, such as a Stochastic Frontier Analysis (SFA) (McGlynn, Shekelle *et al.* 2008; Lordan 2007). A large volume of these data, such as the costs of health care provision and the different outputs of health care, are already collected for health care providers. The benefit of using input and output data and a model in which it can be assessed is that all aspects of the health system can be addressed (not just secondary care), since data on inputs and outputs can be collected for primary and social care services. The link to research findings would need to be established for any changes in inputs/outputs through a separate analysis. As a CAHS indicator it is possible that another funder may perform this analysis that CIMVHR could then use findings from.

h. ***Safety -*** Safety is defined as reducing the risks of an intervention or health care environment (Canadian Institute for Health Information 2008a; Canadian Institute for Health Information 1999).
- Example – adverse drug effects / hospital-acquired infections (HAIs): The numbers of adverse drug effects, with their year-on-year change, is an easily measurable safety issue, and one of the most visible to the public. By linking the changes in the numbers of adverse drug effects to changes in practice, it is possible to link to any research that may have led to a reduction (or otherwise) in effects. This indicator could also apply to adverse surgical effects or reactions to anaesthesia. By measuring the levels of HAIs and monitoring the year-on-year change, it is possible to understand what effect is achieved by procedures designed to reduce HAIs. HAIs are easy to measure and link to specific policies and research findings. The data for these examples are collected by CIHI.

iii. <u>Health Related Quality of Life:</u> Knowing the health outcomes and the health system outcomes is important, but we would also want to identify how military personnel, their families and veterans would consider their own quality of life.

   a. ***Surveys of military and veterans***: By surveying military personnel, families and veterans, CIMVHR could get access to information on quality of life. Existing surveys identifying quality of life exist that could be used, although the link of these surveys to research would need to be done retrospectively.

The table below outlines the indicators identified for the Health and Healthcare Outcomes category.

Table 9. Health and Healthcare indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Health Impacts	Health status	• Morbidity • Mortality • Quality adjusted mortality	• Standard measures of morbidity (prevalence and incidence)* for military and veterans • Standard measures of mortality (PYLL)* for military and veterans • QALYs and PROMs*	• For specific conditions identified by CIMVHR can access public data on prevalence and incidence. • For specific conditions identified by CIMVHR can access public data on PYLL. • Link health outcomes to quality of life, and used in CAHS and elsewhere.	• CIHI • Statistics Canada • Other funder's health impact analyses.
	Health system outcomes	• Health system measures	• Applying CIHI/CAHS* measures to health system outcomes that pertain to military and veterans (acceptability, accessibility, appropriateness, competence, continuity, effectiveness, efficiency, and safety).	• The measures for these 8 indicator sets will need to be set by CIMVHR based on their research areas and likely areas of impacts in the health system.	• CIHI • Statistics Canada
	Quality of life	• Quality of life for military and veterans	• Self-report quality of life rating for military and veterans.	• Surveys of the recipients of healthcare related to CIMVHR research to assess quality of life outcomes.	• Survey

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

Finally, it is important for CIMVHR to consider the wider impacts it is having on society – particularly in terms of its impact on the economy, the social and socio-economic wellbeing of its target groups (military, families and veterans), and the community integration of its target groups in Canadian society. These indicators build on the CAHS indicators from 2009, but with specific recognition of the military and veterans context.

    i. <u>Economic Measures from CAHS</u>: These use the concept of economic rent, and the benefits to health that can be monetized (QALYs per dollar and PROMS per dollar).

        a. ***Economic rent (labour rents)****:* This concept is explained more fully in the CAHS framework, but in short it is the economic benefit (in $) of employing people in health research rather than in another capacity. This differential measure is the concept of labour rent, or the excess earnings over and above the marginal cost of the labour (Garau and Sussex 2007). As an indicator, economic rent can be applied as long as baseline data on research inputs can be identified and output data required can be captured through Rx&D (Rx&D 2007; Rx&D 2006). Calculating economic rent has recently been applied to research from any funding source (Buxton *et al.* 2008). To get this metric, CIMVHR would need to commission a study to identify economic rent.

        b. ***Health benefit in QALYs per health care dollar***: Using QALYs gained, divided by the cost of achieving that gain, to identify the net improvement in health is a useful approach that has been used elsewhere (Buxton *et al.* 2008), because QALYs can be monetized. This approach provides a monetary net benefit that can be compared to other uses of capital (other than on health research). However, QALYs are only calculated for some treatments, so this economic approach is not comprehensive. The use of an analysis of QALY valuations requires expert research, and would have to be outsourced to a group that is capable of performing such an analysis.

        c. ***Health benefit in PROMs per health care dollar***: As with the use of QALYs, improvements in health measured through PROMs gained could be divided by the cost of achieving that health gain. Although this approach has not been used before and PROMs have not been monetized, this was identified as a CAHS indicator and may be accessible by the time CIMVHR would need to use it. Data for this would likely require a specific analysis or piggy-backing on another funder's analysis.

    ii. <u>Economic benefits from commercialization:</u> In addition to the societal economic benefits identified above, there are also specific economic benefits that arise from commercialization of CIMVHR research. The three indicators below can be summed to provide an aggregate measure of economic benefits from commercialization.

a. ***Licensing returns ($):*** Summing the dollars spent on licensing patents related to CIMVHR allows us to link the economic impact of licensed patents to specific research findings (Science-Metrix 2008; Byrd 2002). Data for this would need to be collected from researchers.

b. ***Product sales revenues ($):*** Sales revenues of products provide a simple measure of the economic impact of health products (Science-Metrix 2008; Byrd 2002). There are difficulties, however, in linking sales revenues to research findings due to the other factors that affect sales. Data for this indicator would need to be collected from researchers.

c. ***Valuation of spin-out companies ($):*** Using the portfolio values of new spin-out companies and the sales of spin-outs to provide the value to the economy of spin-outs annually gives an indication of the economic value of new companies coming out of CIMVHR research. The number and nature of spin-out companies is relatively easy to identify (Lonmo 2008) as is their valuation if they are publicly traded. Accurately valuing privately held biotechnology spin-outs is not usually possible, because the valuations are based on perceived value to a small set of financiers. Data for this indicator would need to be collected from researchers and potentially from publicly available economic information (although it would still require researchers to identify the spin out companies related to CIMVHR research).

iii. <u>Social and socio-economic wellbeing</u>: The economic indicators identified above provide information on CIMVHR's impact on the economy, but not on individuals. As such, it will be important for CIMVHR to identify some specific measures of social wellbeing and socio-economic wellbeing for military personnel, their families and veterans.

a. ***Social measures***: These need to be measures of the military and veteran populations, and should use indicators from Statistics Canada. Potential indicators include: sense of security/safety,

b. ***Socio-economic measures***: These measures would be based on statistics from Statistics Canada. Examples of potential indicators are: income levels, equity, labour force participation, social capital, and resilience.

iv. <u>Community integration</u>: This sub-category is particularly useful for CIMVHR's research aimed at the transformation from military to civilian life.

a. ***Community integration surveys***: Using surveys of military personnel, their families and veterans to determine how they are integrated into the community (e.g. McColl *et al.* 2001). This would need to be data collected by CIMVHR.

The table below outlines the indicators from the Broad Social and Economic Outcomes category.

Table 10. Broad Social and Economic Outcomes indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Broad Social and Economic Impacts	Broad societal economic benefits	• Value of investing in CIMVHR versus other investments • Quality of Life • Perception of health improvement	• Economic rent* • Quality of life gained per ($) dollar invested* • Patient perceived improvements per ($) dollar invested*	• Allows the identification of the economic benefit of investing in CIMVHR research versus other investments. • QALYs/$ allows an identification of the cost of getting quality of life for CIMVHR-related health outcomes. • PROMS/$ provides a similar measure to the QALYs/$ measure.	• Economic rent analysis • CIHI • Survey
	Economic benefits of commercial-ization	• Revenues from commercial-ization	• Total sum $ value of products from CIMVHR research*	• Economic analysis of value of innovative products – licensing, sales, companies (where values can be identified).	• Survey
	Wellbeing	• Social and socio-economic indicators for wellbeing	• Social measures* • Socio-economic measures*	• Social measures would need to be determined by CIMVHR. • Socio-economic measures need to be determined by CIMVHR.	• Statistics Canada
	Community integration	• Integration of military and veterans into society	• Use of community integration surveys on a five year basis to assess integrating of military and veterans in society	• Using surveys of military personnel, their families and veterans to determine how they are integrated into the community.	• Community integration surveys

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

4.5.6. KNOWLEDGE TRANSLATION

Previous impact categories have addressed knowledge creation and the influence of that knowledge on stakeholder's decision making, but in-between these two impacts is a vital process that CIMVHR will need to monitor over time – end of grant/project knowledge translation. Within this impact category we have identified sub-categories of: Dissemination of CIMVHR research; Positions of influence; Use of CIMVHR research by stakeholders; Relevance of KT activities; and, Evaluations of KT approaches.

   i. <u>Dissemination of CIMVHR research</u>: The first issue in KT is to get information out to the right people. CIMVHR needs to capture its activities in KT, as well as some measures of their KT reach such as:
      a. ***Counts of CIMVHR dissemination activities and reach***: Dissemination activities would be counts of lectures, presentations (including the CIMVHR conference) and KT activities directed at specific stakeholders. Reach indicators would be downloads, and media reports. This information would be collected through a combination of researcher surveys (to identify activities) and administrative data (to identify reach – download monitoring and Google News monitoring of CIMVHR mentions).
   ii. <u>CIMVHR Researchers in positions of influence</u>:

a. **# Researchers on expert panels**: Using a simple count of CIMVHR researchers residing on expert panels (such as CAHS or IOM panels) gives an indication of how well CIMVHR can expect their research to translate to the research community and general public. This data would be collected by surveying CIMVHR researchers (or mining CVs).

b. **# Consulting to policy/ military/ healthcare / industry etc.:** A count of CIMVHR researchers providing consulting to policy, the military, healthcare or industry (or potentially others) gives an indication of how well CIMVHR can expect their research to translate to specific stakeholders. This data would be collected by surveying CIMVHR researchers (or mining CVs).

iii. <u>Evaluations of CIMVHR's KT activities:</u> Being able to know how well KT activities are working is important in improving them. This indicator is a simple presence or absence of KT evaluation at CIMVHR and is therefore simple to collect information on.

iv. <u>Integrated KT:</u> With a multitude of stakeholders involved in using the knowledge created by CIMVHR, it is wise to ensure that these stakeholders are addressed in the development of CIMVHR's knowledge creation and use strategy (to develop alignment and buy in for findings).

a. ***Engagement in prioritization***: Presence or absence of stakeholder engagement in prioritizing research questions. This would be collected through CIMVHR administrative data and surveys of CIMVHR researchers.

b. ***Participation in research***: Presence or absence of user participation in research process. This would be collected through CIMVHR administrative data and surveys of CIMVHR researchers.

c. ***Analysis of CIMVHR strategic plan versus stakeholder stated goals***: This indicator requires qualitative analysis of the CIMVHR strategic plan against the stated goals of the broad stakeholder groups involved in CIMVHR (e.g. government scientific strategy, veterans' advocacy group missions, University research plans, etc.). Data for this indicator will need to be scored against the goals of different stakeholder groups.

The table below shows the indicators and metrics for the Knowledge Translation category.

Table 11. Knowledge Translation indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Knowledge Translation (KT)	Dissemination	• Dissemination and reach	• # KT outputs • # of public and academic lectures given* • # of website / publications downloads* • # of Media reports*	• Tracking total KT activities by CIMVHR • Monitoring presentations to people by group (includes the CIMVHR conference) • Tracking reach of KT through downloads from the website and of CIMVHR publications • Monitoring media mentions of CIMVHR through Google News.	• Survey • Website data • Download analyses • Media data base (e.g. Google News)
	CIMVHR researchers in positions of influence	• Influence	• #/% researchers on expert panels • #/% consultancy roles	• Monitoring how CIMVHR researchers influence panels to effect KT. • Monitoring how CIMVHR researchers effect KT through consultancy roles.	• Survey
	Evaluation of KT approaches	• Presence of KT evaluation	• Record of KT evaluation approach (present or absent)	• Identifying whether CIMVHR has an approach to evaluating KT that is used.	• Administrative data
	Integrated KT	• Strategic alignment	• Presence / absence of engagement in research planning • Presence / absence of engagement in research activity • Independent qualitative analysis of CIMVHR versus stated goals of multiple stakeholders (qualitative)	• Identifying whether CIMVHR is engaging stakeholders in research planning (by stakeholders) – this should be at the project and organizational level. • Is CIMVHR engaging stakeholders in research activity (by stakeholders)? – this should be at the project and organizational level. • Independent assessment of whether CIMVHR has aligned its goals with those of it stakeholders (e.g. Military science strategies etc.).	• Survey • Admin data • Qualitative analysis

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

4.5.7. IMPACT ON HOST INSTITUTIONS

CIMVHR is a virtual network, but still relies on the presence of two host institutions (Queens University and Royal Military College). These two organizations will be impacted by CIMVHR, and monitoring those impacts will be important in identifying the value that hosting CIMVHR brings. Sub-categories in this impact category are: funding; profile and reputation; and networking.

   i.   Institutional capacity building: For the host organizations, CIMVHR can provide benefits in terms of funding brought to the institution that helps to build institutional capacity.

   a.   ***Funding (and infrastructure) to host organizations ($):*** This is actually a subset of a "Capacity" indicator, since it monitors the total funding brought in to institutions (in this case the CIMVHR hosts). As such, the data for this indicator would simply be broken out of the Capacity indicator (identified through CIMVHR administrative data).

ii. <u>Institutional reputation</u>: For host institutions, hosting CIMVHR can bring with it increased recognition in the scientific world. This can be measured in three main ways.

   a. ***Ranking amongst Canadian universities:*** A number of organizations (including Maclean's magazine and the Times Higher Education Supplement) produce rankings of universities. Monitoring the position of the host organizations in the ranking will provide some insight into the way that CIMVHR is improving the stature of the host. To collect this information only requires monitoring annual rankings of universities.

   b. ***Rating as a research university in relevant subject areas***: As with the ranking of universities as a whole, there are also rankings for research in specific subject areas[14] (that would be of interest to CIMVHR) and at different times. This indicator would be collected when new ranking information becomes available.

   c. ***Fellowships awarded in CIMVHR research areas at host institutions (#):*** This is a measure of the prestige that the university has, as well as its ability to bring in top researchers in CIMVHR research areas. This information would be based on administrative data from the host institutions.

iii. <u>Institutional networking:</u> CIMVHR provides a perfect opportunity for its host institutions to become better networked with other academic centres. It also provides an opportunity to be better linked to the CIMVHR board of governors and their own networks.

   a. ***University network for Queens/RMC***: Using a variety of network measures, it is possible to assess interactions of hosts with universities. These measures include multiplexity (measures of network density, based on strength and durability, number of overlapping ties between network members); cohesion (measures of how tightly knit the group is); and centrality (measures of the importance and influence of the network within the power structure and organizational ecology of its community). This data would need to be conducted using a network analysis (probably by an independent third party).

   b. ***Connection to the CIMVHR board of governors***: Since the CIMVHR board includes the Minister of Defence, developing and maintaining good links with the board and its members can benefit the host institution. By asking host institutions to rate their relationship with

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[14] See: http://www.researchinfosource.com/top50.shtml

the CIMVHR board on a scale of 1-5 (Poor -> Excellent), CIMVHR can identify how well the host institutions currently relate to the CIMVHR board and its board members. This information would need to come from annual surveys/interviews.

The table below identifies the indicators and metrics in the Host Institution category.

Table 12. Host institution indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Impact on Host Institution	Institutional capacity building	• Funding for capacity building	• $ funding (and infrastructure) to host organization	• This is a subset of a capacity building indicator, but provides specific information for host organizations	• Admin data
	Institutional reputation	• Reputation and recognition	• Ranking of host institution in Canada/world • Research rating in CIMVHR subject areas compared Canada/world • # fellowships awarded to host institution in CIMVHR areas	• Based on established ranking of universities in Canada (e.g. Macleans or THES rankings). • Based on established rankings of research departments in Canada (e.g. Re$earch Infosource) • Tracking fellowships award to host institutions	• Analysis of existing rankings • Survey
	Institutional Networking	• Degree of interactions and reach	• Assess interactions of hosts with Universities (e.g. measure of integration such as multiplexity, cohesion, measures of centrality, etc.) • Assess relationship with the CIMVHR board (qualitative rating)	• Measures of network density, strength and durability, number of overlapping ties between network members (multiplexity) • Measures of "how tightly knit a group is" (cohesion) • Measures of the importance and influence of the network within the power structure and organizational ecology of its community (Centrality) • Assessment of the relationship of the host institutions with the CIMVHR board on a five-point scale.	• Network analysis data • Survey of host institutions

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

4.5.8. NETWORKS AND NETWORKING

For a virtual institute such as CIMVHR, effective measures of networking will be key to help access achievements. We have identified eight sub-categories of networking that CIMVHR could collect data on to evaluate its impacts: Membership; Quality of the network membership; Leadership; Sustainability; Collaboration; Network structure; Administrative support; Administrative efficiency.

Evaluating the effectiveness of networks can be complex process and difficult to measure (Provan and Milward 2001). There is insufficient evidence about how networks best achieve their outcomes. Furthermore, a lack of consistency in definitions and a lack of agreement on agreed standards further compound the

issue. There are also variation issues as the criteria for determining network effectiveness varies in the literature. It is generally accepted that both quantitative (Riveria and Rogers 2006) and qualitative (Davies 2003) indicators are necessary to assess impact, as well as the suggestion of including process, structure and outcome measures (Griffiths et al. 2000). If using goal-based evaluation, networks are typically evaluated based on their ability to meet predefined objectives. However, this approach may not address some of the "value added" features of a network, (i.e. the notion that the whole is more than the sum of its parts).

As with any evaluation framework considerations, the recommendation is to consider levels of aggregation (Provan and Milward 2001). Evaluations conducted at every stage of the network life cycle will also inform measurement considerations (starting at development, management and sustainability).

i. <u>Membership:</u> The first aspect to monitor of the network is its membership. Some of this information is captured in capacity building, (where the overall network composition is identified) but additional measures would be desirable.
   a. ***#/% of active members***: Identifying the number of researchers in the CIMVHR network who are actively involved in research over a year. This would be based on administrative data.
   b. ***#/% of new members***: Identifying number and proportion of the CIMVHR network that is new every year, to provide an idea of the growth of the network. This would be based on administrative data.
   c. ***#/% of members who left the network***: Provides a view on any potential shrinkage of the network. This indicator would be available through administrative data.
ii. <u>Quality of the network membership</u>: In addition to measuring the quality of knowledge developed through CIMVHR, it is important to also be able to gage the quality of the network itself.
   a. ***Proportion of top researchers in Canada on CIMVHR subjects in the CIMVHR network (HCPs)***: By identifying how many of the best researchers in Canada in CIMVHR related-fields are part of the network, it is possible to show the academic quality of the network. This metric is based on the number of researchers with highly cited papers in their field that are part of the network. This measure would need to be collected using a bibliometric analysis.
   b. ***Identify best networked researchers in Canada (nodes in the CIMVHR network):*** Quality of the network is not just based on the academic quality of its members it is also based on the quality of actual "networkers" in the CIMVHR network (members with high connectivity). Based on bibliometric publication analysis, it is possible

to identify the best networked researchers in Canada in CIMVHR-related research fields. By identifying the proportion of those individuals in CIMVHR, we can identify the quality of networkers for the Institute. This data would need professional bibliometric analysis, but could tag onto other bibliometric indicator development.

iii. Leadership: How networks are led and governed is considered an important element in network success. As a new institute, having the right leadership for CIMVHR will be important in taking forward the organization towards strategic goals.

  a. **Satisfaction survey of members**: Members of the network can be surveyed to assess their satisfaction with the leadership (style, engagement approaches taken, links to outside organizations, leading the research enterprise). Data for this indicator will be from surveys of CIMVHR members for their satisfaction with leadership.

  b. **Assessment against strategic goals**: In addition, the leadership can be judged against achievement of strategic plan goals (as the board will be). Data for this indicator will be from evaluation of CIMVHR outcomes against goals by the board of CIMVHR.

iv. Sustainability: The CIMVHR network should be able to self-sustain and as such should look to develop sustainability metrics.

  a. **Ability of the network to work independently and sustainably:** surveying members for their opinion on the sustainability of the network will give some idea of the on-going value of CIMVHR. This survey should build on existing organizational sustainability surveys, simply within the context of CIMVHR activities.

  b. **Financial sustainability**: Having enough funding to continue as an institute will be important for CIMVHR, and monitoring the total revenue and the total expenditure annually, will give an idea of sustainability. This would be based on annual report / accounts data from CIMVHR.

v. Collaboration: Networks are essentially useless unless there is collaboration between members. While some measures of collaboration are identified already, there are specific network related collaboration measures.

  a. **Building links with stakeholders outside the research community**: This involves identifying where CIMVHR researchers are engaging stakeholders (e.g., clinicians, veterans and industry). The indicator would be based on the proportion of research projects that engage: clinicians, veterans, industry. Data for this indicator would be based on survey data for network members.

b. ***# /% Institutional collaborations and partnerships (including with industry***): This measure, identified in CAHS (2009), provides a measure of the formal links of network members to stakeholders and is measured using counts of formal collaboration documents between CIMVHR members and industry. This data would need to be requested from members using a survey.

c. ***Participation rate in CIMVHR meetings*** (including annual conference): Monitoring the rate of participation in CIMVHR meetings (including the annual conference) tells you how engaged your network is in CIMVHR. This would be monitored based on administrative data held by CIVMHR.

d. ***# Co-publications /co-presentations by members***: Monitoring co-publications and presentations with other network members (and non-members) provides a useful measure of the network's reach. Data for this would need to come from surveys of researchers and bibliometric analysis of CIMVHR publications.

e. ***# Co-investigators on grants***: As with the measure of co-publications, being a co-investigator on a grant gives CIMVHR an idea of how well interconnected their researchers are. Data for this would need to be collected using surveys of researchers.

vi. <u>Network structure</u>: Knowing the structures in place in the network will allow CIMVHR to modify and improve its networking capacity.

a. ***Range and type of services provided by the network***: By collecting information on the services provided by CIMVHR, it will be possible to identify the structure of the network (in a dynamic fashion). Data on this will be based on administrative data from CIMVHR, and on surveys of network members to determine the services they identify and use.

vii. <u>Administrative support for network</u>: For the network of CIMVHR researchers to succeed, they need to be freed up to address research questions, rather than administrative ones.

a. ***Measures of support in kind for the network***: Host institutions get benefits from hosting CIMVHR, but they also provide support. Identifying the support in kind provided annually by host institutions will allow CIMVHR to track how much support they get and need on an annual basis. Data for this indicator would be based on interviews with CIMVHR senior staff and university staff.

viii. <u>Administrative Efficiency/Organization</u>: As with all organizations, it is imperative for CIMVHR to show that it spends its money wisely and predominantly on achieving its goals in research and education.

- ***Proportion of funding versus administrative costs*** (benchmarked against other research networks/funding bodies): Many organizations now monitor the proportion of their finances spent on administration (multiple charities). CIMVHR should identify the proportion of their annual spend that goes on administration and compare it to other research organizations and networks that collect this information (assessed through annual reports). This indicator will require data from CIMVHR administration, and an analysis of similar organizations and their proportional administrative spend.
- ***Average time taken to address Request for Proposals (RFPs) from the Department of National Defence (DND)***. One of the main ways that CIMVHR works to distribute funding is to link DND requests for research with high quality researchers in the network. Producing timely proposals and research is key for government departments, and CIMVHR should monitor the average time taken to address RFPs from DND and compare year on year to show any improved performance.

The table below shows the indicators and metrics for the Networks and Networking impact category.

Table 13. Networks and networking impact category indicators and metrics

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source
Networks and Networking	Membership	• Network membership composition	• #/% of active members • #/% of new members • #/% of members who left the network	• Identifying the size of CIMVHR active network (not just potential network). • Identifying growth of the network. • Identifying any shrinkage of the network.	• Admin data
	Quality of the network membership	• Citation assessment of all researchers in CIMVHR-related research • Bibliometric network analysis	• % top researchers in Canada in the CIMVHR network as per HCP assessment* • % best networked researchers in CIMVHR	• Identifying the proportion of the highest quality researchers (with HCPs) that arise from the CIMVHR network. • Identifying what proportion of the best-networked researchers in CIMVHR related subjects in Canada are part of the network.	• Bibliometrics • Network analysis
	Leadership	• Stakeholder satisfaction with CIMVHR leadership	• % Satisfaction rating on leadership question(s) • Assessment of CIMVHR against strategy goals	• Identifying the level of satisfaction with CIMVHR leadership from members. • Identifies whether CIMVHR is achieving its goals.	• Survey • Evaluation of CIMVHR by the board
	Sustainability	• Network sustainability	• % Rating on network sustainability question(s) • Financial sustainability ($ inputs - $ outputs)	• Measure of the organizational sustainability of CIMVHR based on existing sustainability surveys • Measure of financial	• Survey • Admin data

				sustainability annually.		
	Collaboration	• Degree of collaborative activity	• #/% of supported research projects engaging stakeholders/end users • #/% Institutional collaborations and partnerships (including with industry)* • Participation rate in CIMVHR meetings (including annual conference) • # co-publications /co-presentations by members • # Co-investigators on grants	• Identifying collaboration by CIMVHR researchers. • Identifying collaboration by CIMVHR organizational members. • Identifying the level of collaboration (and interest) in CIMVHR for researchers. • Identifying the level of researcher collaboration within CIMVHR on research activity. • Identifying the level of researcher collaboration on research planning.	• Survey • Network analysis • Admin data • Bibliometrics	
	Network structure	• Network services and supports	• Range and type of network services and supports (qualitative)	• A qualitative analysis of what services and supports CIMVHR has in place for members.	• Administrative data • Survey	
	Administrative support	• Support in kind	• Level of in kind support from host institutions (qualitative)	• Measuring support received by CIMVHR that is not captured in funding capacity building measures.	• Administrative data	
	Administrative efficiency	• Administration costs and cycle times	• Administrative $ spent/total funding received (%) • Average/median cycle time from date of RFP from DND to proposal	• Measuring the efficiency of CIMVHR's admin capacity. • Measuring the efficiency of CIMVHR members in responding to government research needs.	• Financial data	

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

5. CONCLUSIONS AND RECOMMENDATIONS

For the proposed impact evaluation framework and indicators to be of use to CIMVHR, they must reflect the vision, mission and goals of the organization.[15]

The proposed framework takes into account the wide variety of activities that CIMVHR will undertake (reflecting the key activities and goals of the organization), while the impact categories speak to the specific expected impacts of CIMVHR identified in the mission and vision.[16] In addition to the expected impacts, the CAHS panel has identified additional impact categories that will provide useful information to CIMVHR on the way its activities will lead to research impacts.

5.1. REVIEWING THE FRAMEWORK

Building on the CAHS framework, the proposed CIMVHR impact evaluation framework places the inputs, process, outputs and outcomes from health research into the military and veterans' health research context. The framework (Figure 6) uses a stakeholder driven approach to describing the way inputs to CIMVHR research and activities feed into CIMVHR processes, outputs and then the use of those outputs by CIMVHR's identified stakeholder groups. The use of findings by these groups is hypothesized to lead to changes in:
1. Health determinants
2. Health care
3. Health, and finally to
4. Improved health, well-being and socio-economic benefits for military personnel, their families and veterans.

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[15] These are already identified in Box 1 and Box 2

[16] Namely: Health and well-being; World-class research; Evidence-informed practices and programs; Harnessing and mobilizing the national capacity; Knowledge creation; Knowledge exchange.
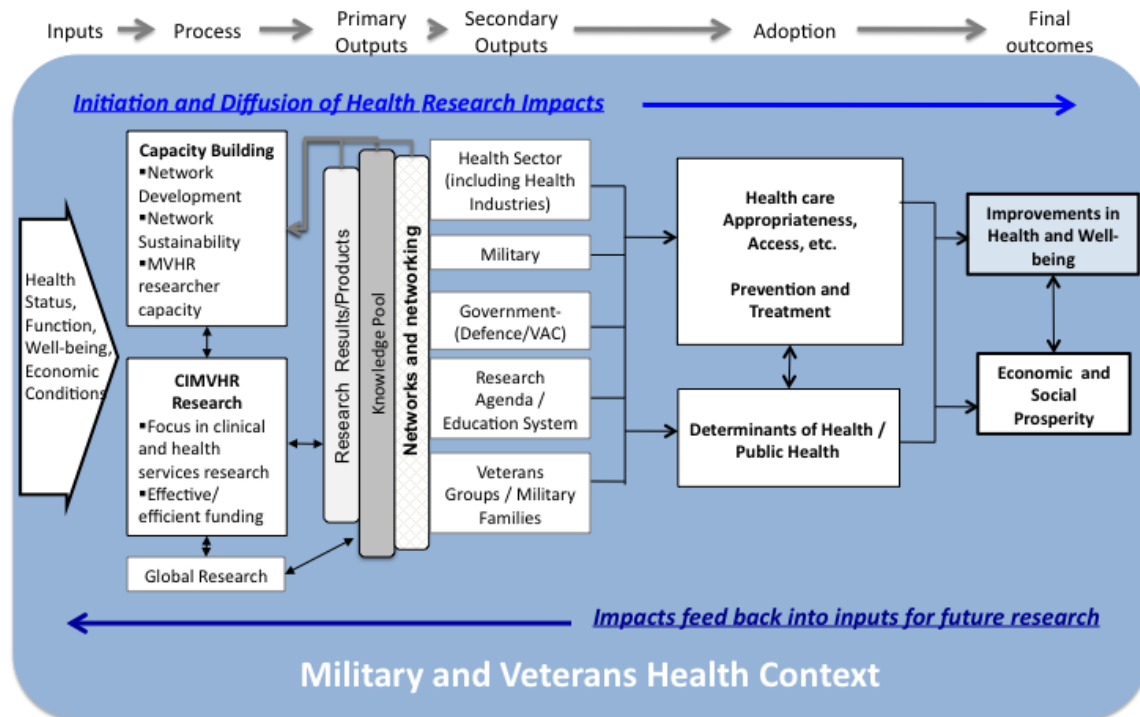
Figure 6. Simplified CIMVHR framework

The proposed framework provides the opportunity for a shared understanding for CIMVHR and its stakeholders of the way CIMVHR inputs and activities should lead to desired (and potentially unexpected) outcomes for military personnel and veterans. This shared understanding is an important process in an impact evaluation, as it allows the identification of mutually understood measures of progress towards CIMVHR's goals (indicators of success).

5.2. TABLE OF RECOMMENDED INDICATORS

Indicators for the proposed CIMVHR model fall into impact categories that represent modifications and expansions of the impact categories identified in the CAHS model. The impact categories identified for CIMVHR, developed to reflect the goals, mission and vision of CIMVHR, are:

- Advancing Knowledge
- Capacity
- Informing Decision Making
- Health and Healthcare Impacts
- Broad Social and Economic Impacts
- Knowledge Translation
- Impact on Host Institutions
- Network and Networking

The large number of indicators identified in the impact categories is displayed in Table 14. Recommended Indicators and how and when to use them. This table

combines the tables for individual indicator categories and shows the indicators, metrics, their brief description and most importantly:

- Their level of application - based on suitability of the indicators to assess: individuals or research groups; host or member organizations; CIMVHR as a whole; or national / international trends that relate to CIMVHR.
- When to use the indicator for CIMVHR (within the lifespan of CIMVHR, some indicators will be useful at specific lifecycle stages of the Institute).

The indicators should be used carefully, and will require a commitment from CIMVHR to collect data required (needed) by the indicator.

Table 14. Recommended Indicators and how and when to use them.

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
Advancing Knowledge	Activity	• Knowledge created quantity	• # count of publications* • # count of innovative products* • # count of other research outputs	• Volume of peer reviewed publications from CIMVHR • Volume of patents, licenses and trademarks, devices, services and practices. • Volume of other outputs (e.g. standards, guidelines, methods and tools)	• Bibliometrics • Technometrics (patent databases) • Survey	• Individual Researcher	0-5 years
	Knowledge quality	• Research quality	• 5 year peer review of CIMVHR and its outputs • Relative citation value* • Highly cited publications*	• Similar approach to CIHR Institute review by international experts. • Citation values versus the world average by field of research. • Number of publications in the top 5% cited in the world by research field.	• Administrative data • Peer review • Bibliometrics (external analysis)	• CIMVHR • All levels	5-10 years
Capacity	Personnel	• Graduated research students	• #/% and type of graduated students (e.g. Postdocs/PhDs,/Masters produced by CIMVHR supported members*	• Tracking the success of CIMVHR's education role for researchers.	• Survey • Administrative data	• CIMVHR	0-5 years
		• CIMVHR researchers	• # Researchers and others in CIMVHR broken down by academic level and by research subject area.	• Analysis of CIMVHR researchers and other staff (by level and field of research)	• CIMVHR administrative database	• CIMVHR	0-5 years
		• Network membership and non-membership composition	• Total # involved in CIMVHR-related research in Canada (includes members and non-members?)	• Analysis of the total # of people involved in CIMVHR-related research to see how comprehensive the CIMVHR network is (can get % of total # that is in CIMVHR)	• Research area analysis (bibliometric, funder analysis)	• CIMVHR	0-5 years
		• Image and recognition of CIMVHR Personnel	• #/% awards and type of awards for CIMVHR members.	• E.g. Major Sir Frederick Banting MC, RCAMC Award for Military Health Research.	• Survey • Administrative data	• CIMVHR	0-5 years
	Funding	• External leveraged	• Total ($) funding brought in through (and for) CIMVHR.	• $ in funding that run through CIMVHR (and $ for CIMVHR	• Surveys • Financial data	• CIMVHR	0-5 years

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
	investments		• Total ($) leveraged funding by CIMVHR researchers (including matched funding from partners) * • % Funding for CIMVHR research areas in Canada that comes through CIMVHR.	itself). By type, source, area, and duration. • $ in funding that supports CIMVHR researchers but is not through CIMVHR. By type, source, area, and duration. • Proportion of total funding in military and veterans' health research that is through CIMVHR. By area.	• Funding analysis for Canadian military and veterans' health research		
	Infrastructure	• Infrastructure grants	• Total amount in ($) of infrastructure funding brought in for CIMVHR projects* • % CIMVHR projects with attached infrastructure funding*	• General measure of infrastructure dollars for CIMVHR research. • Measure of the proportion of projects with infrastructure support attached to research funds.	• Financial / admin data	• Host Institutions? • CIMVHR	0-5 years
	Databases	• Database development, access and sharing	• # / % new CIMVHR developed databases • Tracking of data deposited in existing public databases (e.g. data to genomic databases) • Analysis of data sharing in the network (e.g. joint development of methods and tools etc.)	• Tracking of researchers development of databases for CIMVHR-related research. • Data mining existing public databases to identify annual input from CIMVHR projects. • Qualitative analysis of data sharing by researchers using data sharing agreements.	• Survey • Public database mining for funder data	• Host Institutions • CIMVHR	0-5 years
Informing Decision making	Use of research	• Use of research by stakeholders	• Citations of research by various stakeholders* • Utilization rate reported by researchers • Self-reported use of findings	• Citations in systematic reviews, practice guidelines, policy documents, stage reports in industry. • Surveying researchers to identify where they see research being used and by whom. • Use of findings to influence personal decisions for military, families and veterans, healthcare, policy and industry.	• Bibliometric analysis of guidelines, reviews, policy and industry reports • Surveys	• CIMVHR	5-10 years

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
Health Impacts	Health status	• Morbidity • Mortality • Quality adjusted mortality	• Standard measures of morbidity (prevalence and incidence)* for military and veterans • Standard measures of mortality (PYLL)* for military and veterans • QALYs and PROMs*	• For specific conditions identified by CIMVHR can access public data on prevalence and incidence. • For specific conditions identified by CIMVHR can access public data on PYLL. • Link health outcomes to quality of life, and used in CAHS and elsewhere.	• CIHI • Statistics Canada • Other funder's health impact analyses.	• Population • Provincial • National	10-15 years
	Health system outcomes	• Health system measures	• Applying CIHI/CAHS* measures to health system outcomes that pertain to military and veterans (acceptability, accessibility, appropriateness, competence, continuity, effectiveness, efficiency, and safety).	• The measures for these 8 indicator sets will need to be set by CIMVHR based on their research areas and likely areas of impacts in the health system.	• CIHI • Statistics Canada	• Population • Provincial • National	10-15 years
	Quality of life	• Quality of life for military and veterans	• Self-report quality of life rating for military and veterans.	• Surveys of the recipients of healthcare related to CIMVHR research to assess quality of life outcomes.	• Survey	• Population • Provincial • National	10-15 years
Broad Social and Economic Impacts	Broad societal economic benefits	• Value of investing in CIMVHR versus other investments • Quality of Life • Perception of health improvement	• Economic rent* • Quality of life gained per ($) dollar invested* • Patient perceived improvements per ($) dollar invested*	• Allows the identification of the economic benefit of investing in CIMVHR research versus other investments. • QALYs/$ allows an identification of the cost of getting quality of life for CIMVHR-related health outcomes. • PROMS/$ provides a similar measure to the QALYs/$ measure.	• Economic rent analysis • CIHI • Survey	• Population	10-15 years
	Economic benefits of commercialization	• Revenues from commercialization	• Total sum $ value of products from CIMVHR research*	• Economic analysis of value of innovative products – licensing, sales, companies (where values can be identified).	• Survey	• Provincial • National	10-15 years

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
	Wellbeing	• Social and socio-economic indicators for wellbeing	• Social measures* • Socio-economic measures*	• Social measures would need to be determined by CIMVHR. • Socio-economic measures need to be determined by CIMVHR.	• Statistics Canada	• Provincial • National	10-15 years
	Community integration	• Integration of military and veterans into society	• Use of community integration surveys on a five year basis to assess integrating of military and veterans in society	• Using surveys of military personnel, their families and veterans to determine how they are integrated into the community .	• Community integration surveys	• Population	10-15 years
Knowledge Translation (KT)	Dissemination	• Dissemination and reach	• # KT outputs • # of public and academic lectures given* • # of website / publications downloads* • # of Media reports*	• Tracking total KT activities by CIMVHR • Monitoring presentations to people by group (includes the CIMVHR conference) • Tracking reach of KT through downloads from the website and of CIMVHR publications • Monitoring media mentions of CIMVHR through Google News.	• Survey • Website data • Download analyses • Media data base (e.g. Google News)	• Individual • CIMVHR	0-5 years
	CIMVHR researchers in positions of influence	• Influence	• # / % CIMVHR researchers on expert panels • #/% CIMVHR consultancy roles	• Monitoring how CIMVHR researchers influence panels to effect KT. • Monitoring how CIMVHR researchers effect KT through consultancy roles.	• Survey	• Individual • CIMVHR	5-10 years
	Evaluation of KT approaches	• Presence of KT evaluation	• Record of KT evaluation approach (present or absent)	• Identifying whether CIMVHR has an approach to evaluating KT that is used.	• Administrative data	• Individual • CIMVHR institute	5-10 years
	Integrated KT	• Strategic alignment	• Presence / absence of engagement of stakeholders in research planning • Presence / absence of engagement of stakeholders in research activity • Independent qualitative	• Identifying whether CIMVHR is engaging stakeholders in research planning (by stakeholders) – this should be at the project and organizational level.	• Survey • Admin data • Qualitative analysis	• CIMVHR	0-5 years

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
			analysis of CIMVHR versus stated goals of multiple stakeholders	• Is CIMVHR engaging stakeholders in research activity (by stakeholders)? – this should be at the project and organizational level. • Independent assessment of whether CIMVHR has aligned its goals with those of it stakeholders (e.g. Military science strategies etc.).			
Impact on Host Institutions	Institutional capacity building	• Funding for capacity building	• $ funding (and infrastructure) to host organization	• This is a subset of a capacity building indicator, but provides specific information for host organizations	• Admin data	• Host institution	0-5 years
	Institutional reputation	• Reputation and recognition	• Ranking of host institution in Canada/world • Research rating in CIMVHR subject areas compared Canada/world • # fellowships awarded to host institution in CIMVHR areas	• Based on established ranking of universities in Canada (e.g. Macleans or THES rankings). • Based on established rankings of research departments in Canada (e.g. Re$earch Infosource) • Tracking fellowships award to host institutions	• Analysis of existing rankings • Survey	• Host Institutions • National/ internatio-nal	5-10 years
	Institutional Networking	• Degree of interactions and reach	• Assess interactions of hosts with Universities (e.g. measure of integration such as multiplexity, cohesion, measures of centrality, etc.) • Assess relationship with the CIMVHR board (qualitative rating)	• Measures of network density, strength and durability, number of overlapping ties between network members (multiplexity) • Measures of "how tightly knit a group is" (cohesion) • Measures of the importance and influence of the network within the power structure and organizational ecology of its community (Centrality)	• Network analysis data • Survey of host institutions	• CIMVHR • Host institutions	0-5 years

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
				• Assessment of the relationship of the host institutions with the CIMVHR board on a five-point scale.			
Networks and Networking	Membership	• Network membership composition	• #/% of active members • #/% of new members • #/% of members who left the network	• Identifying the size of CIMVHR active network (not just potential network). • Identifying growth of the network. • Identifying any shrinkage of the network.	• Admin data	• CIMVHR	0-5 years
	Quality of the network membership	• Citation assessment of all researchers in CIMVHR-related research • Bibliometric network analysis	• % top researchers in Canada in the CIMVHR network as per HCP assessment* • % best networked researchers in CIMVHR	• Identifying the proportion of the highest quality researchers (with HCPs) that arise from the CIMVHR network. • Identifying what proportion of the best-networked researchers in CIMVHR related subjects in Canada are part of the network.	• Bibliometrics • Network analysis	• CIMVHR	0-5 years
	Leadership	• Stakeholder satisfaction with CIMVHR leadership	• % Satisfaction rating on leadership question(s) • Assessment of CIMVHR against strategy goals	• Identifying the level of satisfaction with CIMVHR leadership from members. • Identifies whether CIMVHR is achieving its goals.	• Survey • Evaluation of CIMVHR by the board	• CIMVHR	0-5 years
	Sustainability	• Network sustainability	• % Rating on network sustainability question(s) • Financial sustainability ($ inputs - $ outputs)	• Measure of the organizational sustainability of CIMVHR based on existing sustainability surveys • Measure of financial sustainability annually.	• Survey • Admin data	• CIMVHR	0-5 years
	Collaboration	• Degree of collaborative activity	• #/% of supported research projects engaging stakeholders/end users • #/% Institutional collaborations and partnerships (including with industry)* • Participation rate in CIMVHR	• Identifying collaboration by CIMVHR researchers. • Identifying collaboration by CIMVHR organizational members. • Identifying the level of collaboration (and	• Survey • Network analysis • Admin data • Bibliometrics	• CIMVHR • National	0-5 years

Impact Category	Impact Sub-category	Indicator	Metric	Description	Source	Proposed Level of Application	When to use considerations
			meetings (including annual conference) • # co-publications /co-presentations by members • # Co-investigators on grants	interest) in CIMVHR for researchers. • Identifying the level of researcher collaboration within CIMVHR on research activity. • Identifying the level of researcher collaboration on research planning.			
	Network structure	• Network services and supports	• Range and type of network services and supports (qualitative)	• A qualitative analysis of what services and supports CIMVHR has in place for members.	• Administrative data • Survey	• CIMVHR	0-5 years
	Administrative support	• Support in kind	• Level of in kind support from host institutions (qualitative)	• Measuring support received by CIMVHR that is not captured in funding capacity building measures.	• Administrative data	• Host institutions	0-5 years
	Administrative efficiency	• Administration costs and cycle times	• Administrative $ spent/total funding received (%) • Average/median cycle time from date of RFP from DND to proposal	• Measuring the efficiency of CIMVHR's admin capacity. • Measuring the efficiency of CIMVHR members in responding to government research needs.	• Financial data	• CIMVHR	0-5 years

* - Starred metrics are ones that are either already used in the CAHS framework (2009) or are slight variants of ones used in the CAHS framework.

5.3. HOW AND WHEN TO USE THE PROPOSED CIMVHR FRAMEWORK

Evaluation frameworks are only useful if they meet the needs of an organization and when operationalized integrate data collection of an indicator into the organizational process. Regardless of whether an evaluation is for advocacy, accountability or advancing (see Figure 2), if the evaluation and its goals do not align with those of the organization, then the findings of the evaluation are likely to languish unused.

Aligning the evaluation framework with the strategic planning and organizational management of CIMVHR (or indeed any organization) will lead to a useful, used and inevitably transformative evaluation. This is true particularly for on-going evaluation frameworks such as the one developed for CIMVHR. To facilitate this linkage to strategy and organizational management, Figure 7 below shows how the evaluation framework can fit into CIMVHR as an organization.

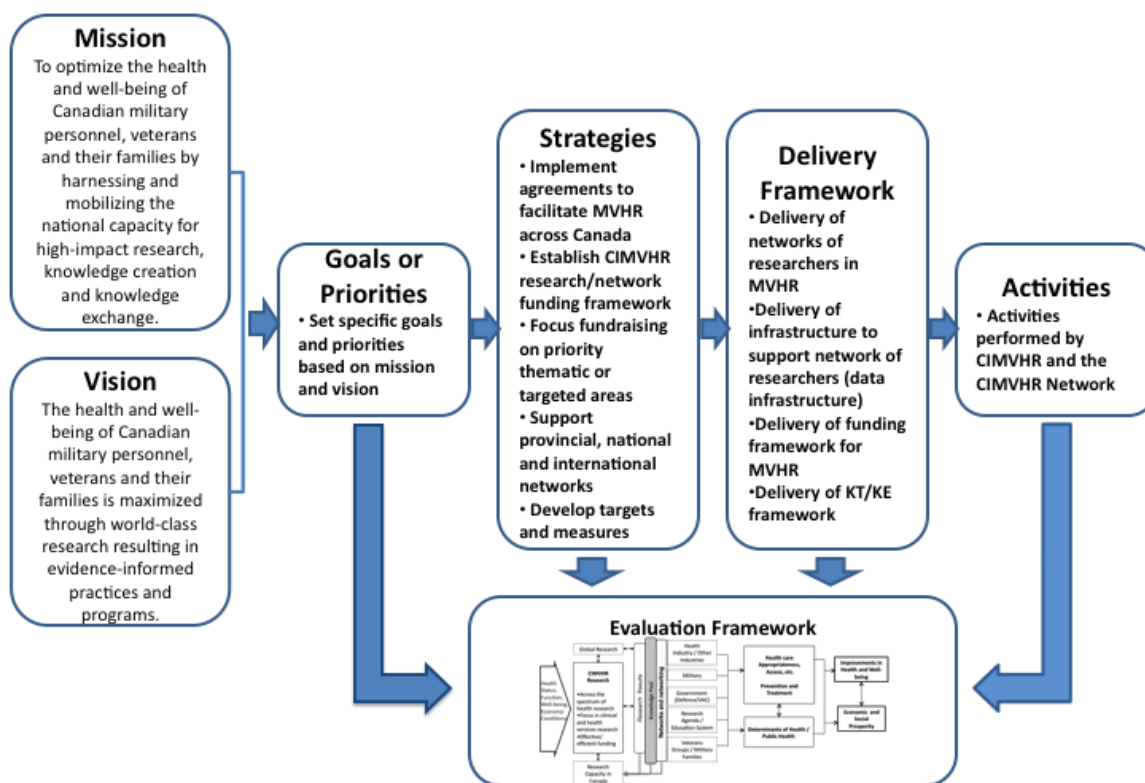**Figure 7. Aligning evaluation with mission, vision and strategic directions for CIMVHR**

The figure shows how the strategy for CIMVHR is based on the specific goals outlined through the mission and vision of the organization. The evaluation strategy then feeds directly off the strategy for CIMVHR, allowing clear linkage between the evaluation and the mission and vision of the organization. The evaluation also links

clearly to the delivery framework and activities of CIMVHR. Also this structure allows the strategy to lead to a delivery framework for CIMVHR that provides the activities that will be evaluated to test the organization against its strategy.

5.4. TIMELINES FOR EVALUATING CIMVHR

One key factor in evaluating a new venture such as CIMVHR will be to ensure that the right evaluation information is collected at the right time. It is impractical to assess research quality of CIMVHR outputs, for example, within the first five years of the organization, or to influence decision making, since research outputs will not have had enough time to accrue citations that can be analyzed (CAHS 2009). For this reason we are proposing that the CIMVHR framework and indicators be used in a three-phase approach, spanning the first 15 years of the organization.

5.4.1. PHASE I: 0-5 YEARS OF CIMVHR

In the first five years of CIMVHR, it will be important to aim *to assess the capacity building and network launch and, sustainability and relevance of the organization*. This is because these aspects are the ones that are most likely to ensure that CIMVHR continues as a growing concern, and will provide a sure footing for future research work undertaken through CIMVHR. It will also be possible to measure some outputs of CIMVHR work, although this is not a priority in years 0-5.

5.4.2. PHASE II: 5-10 YEARS OF CIMVHR

During years 5-10, CIMVHR should aim *to assess relevance, research quality and outputs (in addition to their capacity and networking assessments).* This will be important in these years, since CIMVHR will be mature enough to have developed considerable research outputs that can be readily assessed for quality using citation analyses and other methods appropriate for non-academic publications, as well as generally tracking volume of different types of outputs. It is also possible to measure changes to behaviour at this stage.

5.4.3. PHASE III: 10-15 YEARS OF CIMVHR

In years 11-15, CIMVHR should aim *to assess broader outcomes and influence of research it has undertaken.* These more distal outcomes take longer to arise, and as such, measuring them early will not provide any information on the role of CIMVHR. In addition, by this point in CIMVHR's lifecycle, there may also be new indicators of impacts on health, health systems, and broader socio-economic outcomes that are currently unavailable. These broader outcomes include impacts on decision making, on health and healthcare and social and economic impacts.

It is important to recognise that although we have linked impacts to particular timelines, research impacts are rarely linear and some may occur at unexpected times. Also, we have made an assumption in this framework that all indicators relate to CIMVHR activities. Clearly in terms of attributing changes in indicator / metric values that is not the case, but what is clear is that without CIMVHR activities, these impacts would not have occurred. This is the concept of using contribution not

attribution for research impacts (covered in detail in CAHS 2009, but not necessary to cover here). In short, the closer a research impact is to the research activity in the framework, the more likely it is that CIMVHR have control over influencing the impact.

5.5. RECOMMENDATIONS FOR CIMVHR IN HOW TO USE THE PROPOSED FRAMEWORK

In order to clarify the issues raised above, the following 5 recommendations provide guidance for CIMVHR in how to use the developed framework and indicators appropriately.

1. That CIMVHR and its funders use the proposed modified CAHS framework for both progress monitoring formative (planning) and summative evaluation purposes. Use of this framework and temporal implementation of evolving groups of indicators (in Table 2) will help guide CIMVHR activities through its start-up and its more robust evaluation over time. CIMVHR can ensure specificity and relevance by creating its own logic models that would verify the proposed framework.
2. That each of the recommended impact categories with associated indicators and metrics be ranked immediately by CIMVHR and its funders for prioritized implementation based on considerations of attractiveness and feasibility.
    a. Availability of high quality data to inform them.
    b. The incremental cost of evaluation. Wherever possible, existing and available data sources should be used during network start-up as well as identifying opportunities for collecting aspirational indicators.
3. As CIMVHR is a "volunteer virtual Network", network members should be surveyed immediately to establish baselines in each prioritized category noted above and to introduce the impact framework to them.
    a. Members should be asked for their opinions regarding the framework and indicators.
    b. Members and member institutions should be asked to commit to providing data to the network. A mechanism for data collection must be created to meet the stakeholder needs to allow for stakeholder differences in prioritizing impacts and indicators.
4. Implement metrics and indicators using a staged approach.
    a. In the first five years, the focus for impact evaluation should be on consolidated membership, capacity, disseminating early outputs and assessing an administratively efficient, high functioning network.
    b. In year 5 from now, CIMVHR should expand its indicators and metrics to assess research quality and knowledge outputs of relevance to its stakeholders of interest.
5. CIMVHR should immediately establish a formal strategic partnership with CIHR, to avoid duplication in collecting data on research impacts for CIHR funded CIMVHR researchers. This partnership may also help with future

external CIMVHR evaluations. CIMVHR may also wish to form a relationship with CASRAI (Consortia Advancing Standards in Research Administration Information), with whom numerous other funders are developing standards for research impacts (aligned with the CAHS approach).

5.6. SUMMARY

Developing a specific framework with indicators for an organization such as CIMVHR is a complex endeavour, and one that requires a nuanced understanding of health research evaluation and CIMVHR subject areas. The CAHS Panel for this analysis have built on the CAHS work on ROI frameworks for health research by placing the framework in a military and veterans' health context, and developing specific impact categories that align with CIMVHR needs. In addition, the Assessment Panel developed an approach to using the framework and indicators to provide maximum value for CIMVHR and its interested stakeholders. Impact evaluations of research are costly activities, estimated at around 2-5% of research funding provided (CAHS 2009) and require a lot of effort for data collection, analysis and reporting. However, the findings from research impact evaluations can be invaluable in directing future research endeavours to improve impacts.

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ANNEX A: PANEL MEMBERS AND ASSESSMENT STAFF BIOGRAPHIES

DR. CY FRANK

Dr. Cy Frank is currently a Professor in the Section of Orthopaedics/Department of Surgery, University of Calgary/Alberta Health Services - Calgary; Senior Scientist, Alberta Innovates – Health Solutions (AIHS, formerly the Alberta Heritage Foundation for Medical Research); the McCaig Professor of Joint Injury and Arthritis Research; Executive Director of the provincial Alberta Bone & Joint Health Institute (ABJHI); and Vice President, Research Strategy, Alberta Health Services. He practices knee surgery and enjoys research and teaching at the University of Calgary. Recent honors include being chosen as alumnus of the year at the University of Calgary in 2002, International Bone and Joint Decade "Builder" in 2005, top 40 alumni at the University of Calgary in 2006, awarded a University Research Professorship in 2007; in 2010 along with Dr. Nigel Shrive received the University of Calgary Isaak Walton Killam Interdisciplinary Research Prize; and in March 2011 he and his ABJHI colleagues received a Canadian Institutes of Health Research/Canadian Medical Association Journal Top Achievements in Health Research for 2010 Award for their work on "Improving access to hip and knee replacement and its quality by adopting a new model of care in Alberta". Previously, Dr. Frank has held the positions of President of the Canadian Orthopaedic Research Society; Canadian Orthopaedic Foundation; and the Canadian Orthopaedic Association. He has also been inducted as a Member of the International Olympic Academy of Sport Sciences in 1999.

Between 1984 and 1992, with colleagues in Calgary, Dr. Frank helped develop both the University of Calgary Sport Medicine Centre and the McCaig Centre for Joint Injury and Arthritis Research in Calgary. He was the Chief of Division of Orthopaedics for the University of Calgary/Calgary Health Region from 1992-2008. Over those years he also chaired or has been a member of many local, national and international committees for many different associations (The Arthritis Society, the Canadian Institutes of Health Research, the Canadian Orthopaedic Association, the Royal College, NIH and others). He was chosen as the inaugural Scientific Director of the Institute of Musculoskeletal Health and Arthritis of the Canadian Institutes of Health Research from 2000 to 2006 (developing national research programs in Arthritis, Bone, Skin, Muscle, Oral Health and Rehabilitation Research and Education) and he served as Deputy Editor of the Journal of Orthopaedic Research for that same period. To date, he has supervised 19 post-doctoral Fellows; 28 graduating Masters and PhD students and been on the supervisory committees of 33 others; and has supervised more than 50 undergraduate summer students. He has also supervised or co-supervised research training of many Canadian and international orthopaedic surgeons who have also received graduate research degrees. Dr. Frank was one of the founding Co-Owners of TENET Medical

Engineering, a Calgary based company which manufactures medical equipment. He currently has 249 peer-reviewed publications and 39 book chapters and he has co-authored 427 abstracts locally, nationally and internationally. With his research collaborators, he currently holds $1.3M/year of peer reviewed grants from CIHR and AIHS, including a 5 year provincial team award for 34 research investigators studying Osteoarthritis from the bench to the bedside.

While at CIHR, Dr. Frank was a member of Canadian Institutes of Health Research's "Key Results" Working Group from 2004-2006 where they developed performance measures including Knowledge Translation metrics and he was a member of CIHR's Standing Committee on Performance Measurement, Evaluation and Analysis from 2002 to 2006 and the CIHR executive committee (2004-2006). He served as an external reviewer of the RAND reports on "The Returns of Arthritis Research" for the UK Arthritis Research Campaign in 2004 and "Mapping the Impact – Exploring the Payback of Arthritis Research", in 2009. In addition, he was one of the architects of the model and pilot project on "Wait times – Alberta Bone and Joint Health Institute (ABJHI) Hip and Knee Pilot Project" that was presented to the House of Commons in 2006. He is currently the executive director of ABJHI, that continues to support Bone and Joint Canada by advancing bone and joint care pathway redesign, measurement and change management in Alberta and nationally. Dr Frank is one of 300 current members elected to the Canadian Academy of Health Sciences (CAHS) based on achievement in the academic health sciences in Canada. From September 2007 to January 2009, he was the National Chair of a Blue Ribbon International Panel for CAHS - "Defining the Best Framework and Metrics to Capture Returns on Investment in Health Research". The final report was published in January 2009 and is now being disseminated internationally.

DR. VIVEK GOEL

Vivek Goel is the President and CEO, Public Health Ontario. A respected public health physician and health services researcher, Vivek Goel brings extensive experience in health-care evaluation and research to PHO.

He has been engaged in a broad range of research activities related to public health, particularly focusing on chronic disease prevention and control. These research activities include the economic evaluation of health-care interventions, optimization of the use of laboratory tests in the periodic health examination and the development of measures for health status assessment. In addition, Goel has served on numerous local, provincial and federal committees related to public health as well as being involved in international activities.

Prior to joining PHO, Goel was vice-president and provost at the University of Toronto, and he is a professor at the Dalla Lana School of Public Health and the Institute for Health Policy, Management and Evaluation. He is also adjunct senior scientist at the Institute for Clinical Evaluative Sciences. He is Vice-Chair of the Board of Directors of the Canadian Institute for Health Information, a member of the Board of Directors of the Change Foundation, a member of the National Statistics Council, and a member of the Caribbean Health Research Council.

He holds a medical degree from McGill University, with specialty training in community medicine, a master's in Health Administration from the University of Toronto and a master's in Biostatistics from the Harvard School of Public Health.

DR. IAN GRAHAM

Dr. Ian Graham is an Associate Professor in the School of Nursing, University of Ottawa and Senior Scientist in the Clinical Epidemiology Program of the Ottawa Hospital Research Institute. He is an adjunct associate professor in the School of Nursing at Queen's University, Kingston, Ontario. From 2005-20012 he was on an interchange with the Canadian Institutes of Health Research where he held the position of Vice-President of the Knowledge Translation and Public Outreach. During his tenure at CIHR, he was responsible for the Evaluation, Analysis and Impact Branch (2006-2009), Knowledge Translation Branch (2006-2012), Partnerships and Citizen Engagement Branch (2006-2012), Communication and Public Outreach Branch (2009-2012), and Pan-institute Affairs and Initiatives Branch (2009-2012). Dr. Graham obtained a B.A (1st Class Honours) in sociology from McGill University, an M.A. in sociology from the University of Victoria, and a Ph.D. in medical sociology from McGill University. His research has largely focused on knowledge translation (the process of research use) and conducting applied research on strategies to increase implementation of research findings and evidence-based practice. He has also advanced KT science though the developed two planned action models, the Ottawa Model of Research Use and the Knowledge to Action Model. Specific research projects have related to the adaptation, implementation, and quality appraisal of clinical practice guidelines, as well as the uptake of guidelines and decision support tools by practitioners. He has published over 200 peer reviewed articles and is co-editor of Knowledge Translation in Health Care (2009) and evaluating the Impact of Implementing Evidence-based Practice (2010).

DR. KATHRYN GRAHAM

Kathryn Graham is the Director of the Performance Management Department at Alberta Innovates Health Solutions (AIHS) which is a Canadian-based, publicly-funded, not-for-profit, provincial health research and innovation organization. She has over 20 years evaluation experience in health care and has worked with provincial and federal organizations in the areas of quality assurance, health research and innovation. Her expertise is in developing evaluation strategies, frameworks and implementation across a wide range of programs and networks. Implementation included the application of the CAHS framework.

In health care, she participated in the implementation of a number of continuums of care models such as soft-tissue injuries, brain injury and chronic pain. The strategic components included a number of innovative practices such as disability management tools, medical advisory guidelines, case management protocols, as well as a process for setting standards and developing a reporting system for evaluating thousands of different health care providers across a preferred provider network in Alberta.

She has an advocate role on the Canadian Evaluation Society Board (Alberta Chapter) and is a regular contributor to both the Canadian and American annual evaluation conferences. She is also a member on a number of organizations that focus on impact including the National Alliance of Provincial Health Research Organizations (NAPHRO), the Consortia Advancing Standards in Research Administration Information (CASRAI) and the Science of Science Network on Mental Health headed by the Graham Boeckh Foundation and facilitated by RAND Europe.

She is a social scientist and her research interests are in mental health, clinical outcomes, systems level evaluation, impact evaluation, and the "Science of Science". She has a Ph.D. in Applied Psychology from the University of Cranfield, England with a specialization in human factors and measurement.

DR. CAROL RICHARDS

Carol L. Richards is a Professor in the Department of Rehabilitation, Faculty of Medicine, at Université Laval. She obtained a B.Sc. (PT) from McGill University, a M.Sc. (Rehabilitation Medicine) from the University of Saskatchewan, a Ph.D. degree from McGill University and Honorary Doctorates from the University of Ottawa in 2001 and Université de Sherbrooke in 2012. She was the founding Director of both the Centre for Interdisciplinary Research in Rehabilitation and Social Integration (CIRRIS) located in the Quebec Rehabilitation Institute (2000-2010) and of the Quebec Provincial Rehabilitation Research Network (REPAR: 1994-2003). She was a member of the Board of Directors of the Canadian Stroke Network (2006-2010), President of the International Scientific Advisory Committee of the Toronto Rehabilitation Institute (2004-2011) and a member of the International Advisory Board of the Brain Rehabilitation Research Center, University of Florida at Gainesville (2005-2009). She is presently a member of the Board of Directors of the NeurodevNet Center of Excellence and the Ontario Neurotrauma Foundation. Dr Richards held a senior Canada Research Chair in Rehabilitation from 2002-2008 and presently holds the Université Laval Research Chair in Cerebral Palsy.

She is involved in basic, clinical and knowledge translation studies related to locomotor recovery and social integration of persons with neurological disorders, particularly stroke and cerebral palsy, and has contributed to the publication of more than 168 articles and book chapters, 250 abstracts and been invited to give 174 presentations. She received a Green Visiting Professorship from the University of British Columbia (2002), the Enid Graham Memorial Lectureship (2004) from the Canadian Physiotherapy Association, the Jonas Salk Award (2005) from the Ontario March of Dimes and the Helen Saarinen Memorial Lectureship (2007) from McMaster University. She was President of the International Advisory Council of the Institute of Musculoskeletal Health and Arthritis (2001) and a member of the Governing Council of the Canadian Institutes of Health Research (CIHR) from December 2001-August 2008. She currently is President of a special Ministerial Committee of the Quebec Ministry of Health and Social Services that has the mandate of recommending optimal rehabilitation trajectories for persons post-stroke for the Quebec Stroke Strategy. A Fellow and former Secretary of the Canadian Academy of Health Sciences, Dr Richards was appointed Officer of the Order of Canada in December 2009.

ASSESSMENT STAFF

Eddy Nason, Senior Researcher

Eddy Nason is a Senior Researcher with the Institute on Governance (IOG) and their lead on health and innovation policy work. He specializes in research evaluation, particularly focusing on ROI approaches, and research impact framework and indicator development. Mr. Nason has extensive experience in research evaluation, having advised government and not-for-profit research funders in England, Ireland, the Netherlands, Australia and Canada. Mr. Nason has published and researched extensively on research evaluation, including assessing the impacts of research conducted by the Institute of Clinical Evaluative Sciences in Ontario, developing approaches to performance measurement of policy research for Canadian federal government, and was the Senior Researcher on the CAHS ROI assessment in 2008. He also formed part of a three person expert panel addressing the Canadian Institute of Health Research's internal use of evidence and research in decision making. Mr. Nason sits on the scientific advisory boards of the Institute of Health Services and Policy Research and the Institute of Clinical Evaluative Sciences as an expert in research impact evaluation.

Prior to joining IOG, Mr. Nason was a Senior Researcher at the Canadian Policy Research Networks (CPRN), Senior Researcher for the CAHS ROI assessment, and an analyst with RAND Europe (the European arm of the RAND Corporation). At RAND Europe, he advised the Department of health on the use of research evaluation as a tool for distributing over £200m to hospitals around England and Wales, produced documents on research evaluation for the Economic and Social Research Council (UK), the Health Research Board (Ireland) and co-authored numerous documents on research evaluation. He is currently a member of the Canadian Evaluation Society and has training from the UK National Audit Office.

Linda Marchuk, Project Manager
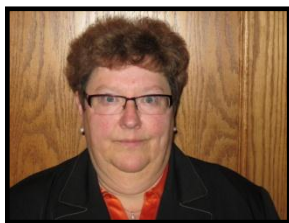
Linda Marchuk (BSc, RT) has over 35 years' experience as a research technologist and manager. She currently manages several research projects for Dr. Cy Frank in the Faculty of Medicine at the University of Calgary, where her primary interests are in the facilitation of musculoskeletal research in the field of osteoarthritis. Prior to joining Dr. Frank in Calgary, she worked as a transplantation immunology research technologist in the Faculty of Medicine and the University of Alberta Hospital in Edmonton. She has authored 44 manuscripts, 3 book chapters, and 81 scientific abstracts.

ANNEX B: CIMVHR UNIVERSITY PARTNERS

SECRETARIAT:

- Queen's University
- Royal Military College of Canada

MEMBERS: (EAST TO WEST)

- Memorial University
- Dalhousie University
- Mount St Vincent University
- University of Prince Edward Island
- Université de Moncton
- University of New Brunswick
- Université Laval
- Université de Sherbrooke
- Université de Montréal
- McGill University
- University of Ottawa
- University of Ontario Institute of Technology
- University of Toronto
- Ryerson University
- University of Waterloo
- McMaster University
- University of Western Ontario
- University of Manitoba
- University of Regina
- University of Calgary
- University of Alberta
- University of British Columbia
- University of Victoria