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Proceedings *of the* **Influenza Research Priorities Workshop**

August 31 - September 1, 2005
Ottawa, Ontario

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EXECUTIVE SUMMARY

Canadian and international vaccine experts and researchers gathered in Ottawa on August 31 and September 1, 2005 to examine the current state of research and make recommendations on national research priorities that will enhance pandemic and inter-pandemic influenza prevention and control strategies for Canada. The event was sponsored and organized by the Public Health Agency of Canada (PHAC) and the Canadian Institutes of Health Research (CIHR) Institute of Infection and Immunity in partnership with the Canadian Association for Immunization Research and Evaluation (CAIRE).

The meeting included plenary sessions in which experts gave an overview of the current knowledge of influenza. Dr. Mark Loeb of McMaster University gave an introductory talk on influenza, which was followed by a summary of current pandemic/inter-pandemic (annual) influenza preparedness and control strategies by Dr. Theresa Tam of the Public Health Agency of Canada. Dr. Fred Aoki of the University of Manitoba spoke about antivirals for influenza control, and Dr. Susan Tamblyn reviewed influenza vaccines. Dr. David Scheifele of the Canadian Association for Immunization Research and Evaluation summarized current Canadian influenza research activities. Dr. Ben Schwartz of the Centers for Disease Control and Prevention highlighted the U.S. influenza research approach, and global influenza research strategies and activities were reviewed by Dr. Klaus Stöhr from the World Health Organization (WHO).

Participants then worked in small groups to identify key gaps in knowledge and research activities needed to enhance influenza prevention and control strategies. The research needs were prioritized, and the top three to five priorities from each break-out group were combined into ten research priority areas in the final integration and summation session. The following research priority areas are explained further in the final report.

Priority Research Areas for Pandemic and Annual Influenza prevention and control

Influenza virus characterization and ecology

Studies are needed on the basic science (virology, immunology, biology) of influenza viruses and the ecological relationships between animal and human viruses. More information concerning influenza subtypes is required to determine the nature and extent of animal reservoirs, and the factors involved in viral modification and acquisition of virulence.

Influenza virus transmission

An enhanced understanding of the influenza virus shedding patterns of infected persons and the means of transmission to susceptible contacts is needed.

Public health preventive measures

Public health research is needed to understand the effectiveness and safety of current public health interventions aimed at preventing infection both in the community and institutions, as well as knowing how populations react to influenza and influenza control.

Improving rapid diagnostic tests

Currently there is a lack of highly accurate and rapid diagnostic tests for influenza, therefore, research aimed at the development of these diagnostics is needed.

Clinical management of influenza patients

It is necessary to better understand the most effective ways to clinically manage and treat influenza patients, particularly the most ill, including new methods to rapidly diagnose influenza.

Development and optimal use of antiviral drugs

Research aimed at the development and use of antivirals in the treatment of individuals with influenza and in the prevention of infection is needed. This includes studies of novel approaches with existing antiviral medications and also research aimed at the development and evaluation of new antiviral agents.

Surge capacity of the health care system

This research gap includes activities aimed at being ready to respond quickly and effectively to increased demand in capacity encountered during annual influenza epidemics and the next pandemic.

More effective and acceptable influenza vaccines

More effective vaccines must be developed using new technologies that trigger the immune system more readily, produce longer lasting protection, produce cross-protection and non-injection delivery methods.

Immunization programs

The differences in vaccination programs across Canada provide a significant opportunity to evaluate various vaccination strategies to control influenza. Population-based data on the uptake, effectiveness and safety of influenza immunization is needed.

Preparation for a pandemic vaccine

Many challenges involved in the preparation, testing, and evaluation of a vaccine in the context of a pandemic are expected. Canada will be responsible for evaluating the pandemic vaccine produced by its domestic manufacturer.

At the conclusion of the two days, participants evaluated the workshop. Overall, participants agreed that the process in developing consensus on research priorities was appropriate, and that the objectives of the workshop were achieved but further priority-setting of the final top ten list is needed. The workshop Planning Committee and workshop participants provided further input to define the research priorities into ten research themes which are included in this report. The findings will be communicated to funding agencies and decision makers in Canada and internationally. Strategic approaches for funding the identified influenza research priorities will be developed and pursued in 2006.

INTRODUCTION

The Influenza Research Priorities Workshop was held on August 31 and September 1, 2005 at the Delta Ottawa Hotel and Suites in Ottawa, Ontario. The event was sponsored and organized by the Public Health Agency of Canada (PHAC) and the Canadian Institutes of Health Research (CIHR) Institute of Infection and Immunity in partnership with the Canadian Association for Immunization Research and Evaluation (CAIRE), with input from an expert Planning Committee (Appendix 1: Planning Committee). The workshop was attended by over 70 Canadian and international vaccine and influenza experts and researchers (Appendix 2: Workshop Participants) who gathered to make recommendations on national research priorities that will enhance pandemic and inter-pandemic influenza prevention and control strategies. The workshop included plenary sessions in which experts gave participants an overview of the current knowledge of influenza. The plenary sessions were followed by break-out sessions focusing on specific areas for influenza research. In the break-out sessions, participants discussed gaps in knowledge, research activities to help bridge the gaps and identified infrastructure and capacity requirements that are currently lacking. Through consensus, the research was prioritized and the top three to five priorities from each break-out session were presented to the plenary group and then combined in the final integration and summation session (Appendix 3: Workshop Agenda). This discussion resulted in the identification of ten research priority areas that are needed to enhance pandemic and inter-pandemic influenza prevention and control.

WELCOME AND OPENING REMARKS

Dr. Alan Bernstein, President, Canadian Institutes of Health Research

Dr. Bernstein gave opening remarks and thanked everyone for coming to the meeting, including colleagues from the National Institutes of Health, Centers for Disease Control and Prevention and the World Health Organization. He stated that there is some urgency to set a time-driven research agenda to identify what Canada's role in influenza research can and should be, so that recommendations can be made to the Public Health Agency of Canada, the Canadian Institutes of Health Research and the federal government. He mentioned that he had recently attended a meeting of the Heads of International Research Organizations (HIRO) and that influenza was discussed. He hoped that the participants over the course of the workshop would help define a national research agenda for influenza, so that when he next meets with HIRO, he will be able to discuss Canada's role and ways that the international health agencies can work together to deal with this imminent threat.

Dr. Arlene King, Director, Immunization and Respiratory Infections Division, Public Health Agency of Canada

Dr. King stated that this meeting was originally conceived by the Pandemic Influenza Committee in 2002, but it was delayed because of the outbreaks of Severe Acute Respiratory Syndrome (SARS) in 2002-2003. Ironically, it was the SARS crisis that illustrated the need for strategic and coordinated approach to research and an identification of infrastructure requiring urgent attention before a crisis occurs. The Canadian Immunization Committee has endorsed this workshop as part of the overall research component of the National Immunization Strategy. The Canadian Immunization Committee along with the Pandemic Influenza Committee will be paying close attention to the priorities identified in the meeting, which will serve to guide and inform researchers and research sponsors. Dr. King closed by thanking the Planning Committee and the Immunization and Respiratory Infections Division Secretariat for their many hours in planning and preparing for the workshop.

Workshop Co-chairs: Dr. Theresa Tam, Associate Director, Immunization and Respiratory Infections Division, Public Health Agency of Canada and Dr. David Scheifele, Director, Canadian Association for Immunization Research and Evaluation (CAIRE)

Drs. Tam and Scheifele emphasized the importance of influenza research in prevention and control of influenza and that this key public health issue is critical at this time for Canada and internationally. An overview of the workshop goals and process were provided and participants were encouraged to contribute fully as the outcome of the meeting is expected to be a focused research agenda with key infrastructure gaps identified for Canada.

PLENARY SESSIONS

Plenary speakers (Appendix 4: Plenary Speaker Biographies) gave workshop participants an overview of Canadian and international current knowledge of influenza, including annual and pandemic prevention and control strategies. Highlights of the presentations follow.

Influenza 101

Dr. Mark Loeb, Associate Professor, McMaster University

Dr. Loeb described the influenza virus and how it has evolved during the last century. The virus consists of RNA surrounded by a coat of phospholipids and proteins. Two coat proteins, hemagglutinin (HA) and neuraminidase (NA), are essential for infection of host cells and are used clinically to define specific subtypes of influenza. For example, in influenza A subtype H5N1, of current concern because some experts believe that it may trigger the next pandemic, H5 refers to the specific form of HA and N1 refers to the form of NA. The subtype forms of H and N arise from antigenic drift (mutations in the viral RNA in one subtype) and/or antigenic shift (exchange of viral RNA between subtypes in a secondary host), and are thought to allow viruses, which normally infect birds to infect humans, pigs and other animals.

Dr. Loeb also gave an overview of the communicability, pathogenesis, epidemiology and the immune response to influenza infection in humans. The principle mode of influenza viral transmission in humans appears to be through respiratory droplets resulting from coughing and sneezing; however, more information concerning the modes of transmission and efficacy of infection control is required. Several high risk populations have been identified including the elderly, those living in long-term chronic care facilities and individuals with cardiac and pulmonary disorders; however, Dr. Loeb believes that the list should be re-examined. The human immune response is mostly subtype specific, with HA and NA being the major antigens that are recognized. The immune response to another surface protein, M2 is not subtype specific, suggesting that a robust response to M2 would provide cross-subtype protection. Unfortunately, the natural immune response to M2 is weak.

Dr. Loeb closed his remarks by stating that more research is required to understand viral and human host genetics underpinning transmission and pathogenesis of influenza, as well as human influenza transmission and community spread, particularly in children and individuals in health care settings.

Current pandemic/inter-pandemic influenza preparedness and control strategies

Dr. Theresa Tam, Associate Director, Immunization and Respiratory Infections Division, Public Health Agency of Canada

Dr. Tam outlined Canadian public health programs and strategies for the prevention and control of annual influenza. Surveillance programs include monitoring viral presence in specimens sent to selected laboratories and regular reporting of flu-like symptoms by doctor's offices and long-term care facilities. Immunization programs have also been established, and Canada distributes more influenza vaccine per capita than any other country. Vaccine safety monitoring programs have been established, along with programs to guide and educate health care workers and the public. In order to more effectively design immunization programs, Dr. Tam stated that applied public health research in

surveillance, vaccine safety and effectiveness monitoring, public attitudes to vaccination, economics, modeling and basic research in the areas of genomics, immunology and new vaccines is required.

Dr. Tam also gave an update on the current pandemic threat stating that while it is difficult to predict the timing of an influenza pandemic, most experts agree that a pandemic is overdue. Conditions in southeast Asia suggest that an influenza A virus (H5N1 or another strain) may develop pandemic qualities sooner rather than later. An overview of the Canadian Pandemic Influenza Plan (CPIP; <http://www.phac-aspc.gc.ca/cpip-pclcpi/index.html>) was given. The plan was published in 2004 and updates are expected in December 2005. Some gaps in knowledge concerning the influenza pandemic that Dr. Tam identified include whether a novel virus of pandemic potential could be contained at its source, the impact that school closures and mask use would have on disease spread, and the optimal strategies and logistics for public health measures for responding to a pandemic.

Obstacles and opportunities for influenza control – antivirals

Dr. Fred Aoki, Professor, Medicine Medical Microbiology and Pharmacology & Therapeutics, University of Manitoba

Dr. Aoki gave an overview of available and new anti-influenza drugs and identified gaps in current knowledge. There are two classes of antiviral drugs: M2 inhibitors (*e.g.* amantadine) and NA inhibitors (*e.g.* zanamivir and oseltamivir). Both types are effective against most influenza subtypes, except H5N1, which is resistant to amantadine. NA inhibitors significantly decrease influenza infection rates, moderately decrease the duration of flu symptoms, decrease hospitalization and death rates and are well tolerated. They must be administered within two days following appearance of flu-like symptoms, which may limit their use. Newer antivirals currently being developed include resveratrol, T-705 and polymeric versions of zanamivir. Gaps in knowledge that were identified by Dr. Aoki include: whether physicians and health care workers have the knowledge to administer antiviral drugs and whether they and patients will comply with treatment schedules; the bioavailability of the drugs in critically ill patients and infants under one year of age; the efficacy in high risk groups, and in individuals who have had the disease for more than 48 hours; the efficacy of antivirals in reducing non-respiratory disease and the safety of the drugs; and, the development of antiviral resistance when used in the field.

Obstacles and opportunities for influenza control – vaccines

Dr. Susan Tamblyn, Public Health Consultant

Dr. Tamblyn summarized the strengths of the Canadian influenza vaccination program. Some highlights include the fact that Canada has the highest per capita vaccine uptake, our program is publicly funded and delivered by public health, we have a secure supply of annual vaccine and are securing the Canadian production capacity for pandemic vaccines. Unfortunately, we still see overflowing hospitals; outbreaks in schools and health care facilities; frequent, poor vaccine matches; and we lack information about the impact and cost-effectiveness of our vaccination programs. Dr. Tamblyn stated that we need to improve both the vaccine and vaccination programs. New types of vaccines, delivery systems (oral or intranasal instead of injection) and manufacturing methods (cell culture instead of egg production) are required. For pandemic vaccines, dose-sparing strategies, rapid clinical trials and processes for the rapid and large-scale manufacture of vaccines will be required. Different vaccination strategies are currently used in Canada - the traditional high-risk approach, age-based strategies and universal vaccination. Vaccination of school children for both direct and indirect benefit (herd immunity) is an additional promising strategy being studied in the U.S. Dr. Tamblyn suggested that we need a more standardized and organized approach to evaluate the effectiveness and impact of our vaccination programs and develop the evidence needed for program planning. She

believes that two new initiatives, the Research Advisory Council of the Canadian Immunization Committee and the Canadian Vaccine Initiative (a proposed virtual network of Canadian scientific expertise from public and non-governmental organizations and the private sector) will help to integrate and improve capacity for vaccine research in Canada.

Current national influenza research activities and gaps

Dr. David Scheifele, Director, Vaccine Evaluation Centre, British Columbia Children's Hospital

Dr. Scheifele gave an overview of recent and current influenza research in Canada. Much of the research in the areas of virology, immunology and vaccine development has been supported by the Canadian Institutes of Health Research (CIHR). CIHR funding to these areas increased five-fold from \$329,000 in 2000 to \$1.5 million in 2005. The supported research includes modeling of disease control interventions and studying the role of viral mutations in virulence. Also, the Public Health Agency of Canada (PHAC) and CIHR have launched a request for applications to assess and compare Ontario's universal influenza vaccination program with targeted programs. Other federally funded initiatives include the surveillance and analysis of the influenza virus at the PHAC National Microbiology Laboratory, surveillance networks administered by the Immunization and Respiratory Infections Division (PHAC), and monitoring of avian influenza by the Canadian Food Inspection Agency. British Columbia and Québec have strong influenza research programs, but relevant research is also performed in institutions scattered throughout the country. Individuals in networks such as Canadian Network for Vaccines and Immunotherapeutics (CANVAC) and Canadian Association for Immunization Research and Evaluation (CAIRE) have trials centers, which perform research to develop and assess influenza vaccines. Overall, there is substantial scientific expertise available across a wide range of settings and disciplines, but little of it is fully committed to influenza. Dr. Scheifele stated that while no drastic changes are warranted, investments to stabilize strategically important areas and methods to coordinate research (*e.g.* request for proposals) and provide an overview of current influenza research activities are needed.

Global influenza research strategies and activities

Dr. Klaus Stöhr, Team Coordinator, Department of Communicable Disease Surveillance and Response, Global Influenza Programme, WHO

Dr. Stöhr emphasized the urgent need to plan, prepare and conduct research to better respond to the next influenza pandemic. His remarks were mainly focused on H5N1, but are applicable to other pandemic strains that may emerge. He stated that we need to know: the likelihood and outcome of reassortment between H5N1 and human and pig influenza viruses; whether the source and pathways of transmission from animals to humans can be controlled; more about the clinical effects of H5N1 infection in humans and if antivirals and H5N1 vaccines could be used to slow down or avert a pandemic. Dr. Stöhr stated that it is estimated that the current stockpiles of antivirals are only sufficient to treat 2% of the world's population. Also, production of a strain-specific vaccine would take at least a year with current production methods, only 5% of the world's population would have access to the vaccine. Therefore, it is critical to determine the most effective non-pharmaceutical measures to slow down the spread of infection. In addition, antigen-sparing methods and improved methods for vaccine production are essential to increase surge capacity during annual and pandemic outbreaks of influenza. A research goal that may take longer to achieve, but would be very worthwhile to pursue, is to develop a cross-subtype influenza vaccine that would alleviate many of the problems associated with surge capacity. Dr. Stöhr closed by stating that although research costs money, investment in influenza research now will save many lives and much more money in the future.

U.S. influenza research strategies and activities

Dr. Ben Schwartz, National Vaccine Program Office, Centers for Disease Control and Prevention

Dr. Schwartz summarized some of the influenza research that is currently being performed in the United States. There are several research foci within the Department of Health and Human Services Agencies including the National Institutes of Health Research (NIH), Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC) and Office of Public Health Emergency Preparedness. NIH funding for influenza research related to basic science and development of diagnostics, vaccines and antivirals has increased 5 fold over the past four years, and is estimated to reach US\$119 million dollars in 2005. Critical research infrastructure includes the NIH vaccine treatment and evaluation units that are currently running, for example, H5N1 vaccine clinical trials; the CDC's Thailand Emerging Infections Program, which is conducting epidemiological studies and supporting outbreak investigations in Thailand; NIH National Institute of Allergy and Infectious Diseases influenza genome project, which has released the sequence of 300 human influenza isolates; and the NIH National Institute of General Medical Sciences Models of Infectious Disease Agents Study with the goal to model real or anticipated disease outbreaks to assist policy makers, which recently published models of strategies to contain an outbreak of a novel influenza strain in southeast Asia.

Dr. Schwartz also provided highlights of current vaccine research aimed at reducing the time to produce a pandemic vaccine, developing strategies to increase the number of doses produced via improved egg-free methods and use of adjuvants, and developing conserved antigen vaccines that could be stockpiled. Antiviral research to develop treatment regimes for infants and the severely ill and to develop new antivirals is also ongoing. Dr. Schwartz concluded by stating that influenza pandemic preparedness is a Department of Health and Human Services Agency and U.S. government priority and he predicted that the budget to support influenza pandemic preparedness would increase substantially in the next year.

Closing Remarks: Day 1

Dr. Paul Gully, Deputy Chief Public Health Officer, Public Health Agency of Canada

Dr. Gully stated that the Public Health Agency of Canada is pleased to have organized and supported, along with the CIHR and CAIRE, this important workshop. He thanked the plenary speakers for their excellent summaries of influenza research and for identifying many of the current gaps in knowledge. He noted that Canada was one of the first countries to start pandemic planning, and today, even with greater public awareness of the influenza pandemic threat, few countries are thinking about what has to be done to prevent or lessen the burden that influenza places on human health, society and the economy. Dr. Gully told the participants that their recommendations will have relevance both nationally and internationally. He closed by stating that he hoped participants would apply the knowledge they gained through the meeting to their own jurisdictions.

BREAK-OUT SESSIONS

Six break-out sessions were held during the workshop. Three were held concurrently on Day 1, and three concurrent sessions were held on Day 2. The purpose of the six break-out sessions was to focus appropriate expertise in specific areas of pandemic and inter-pandemic disease prevention and control in order to identify research priorities and gaps in infrastructure and capacity. The six break-out sessions were on the following themes:

- Session A: Challenges influenza poses in the community
- Session B: Challenges influenza poses in the health care setting
- Session C: Challenges influenza poses to basic and applied science
- Session D: Optimizing influenza vaccines
- Session E: Optimizing vaccination programs
- Session F: Optimizing the use of antiviral drugs

Workshop participants were carefully assigned to break-out sessions by the Planning Committee. Each break-out group consisted of experts in the specific area addressed in the break-out session along with researchers having a diverse range of knowledge and expertise. Sessions were led by moderators, and had a rapporteur and note-taker to document the discussion.

In the break-out sessions, moderators provided the group with a brief high-level review of the existing knowledge gaps in Canada/internationally in a particular area of disease prevention and control, guided by the question “what are the important unanswered research questions that Canadian research should address in this area?” Participants then participated in a brainstorming session on the key research priorities, aimed at reducing the burden of disease in Canada. Moderators then guided the identification of the key three to five research priorities, through consensus, from the brainstormed list. Each priority was further described by identifying examples of research activities and infrastructure/capacity gaps that currently exist. A five-point Likert relevancy scale was used by the group to assign criteria/rationale for each research priority. The criteria and rationale were:

- Urgency for Public Health – the research needs to be done as soon as possible because of immediate public health need.
- Uniqueness – the research is specific to Canada, is innovative, or relevant for Canadian populations.
- Feasibility – infrastructure and expertise already exist in Canada (or requires minimal strengthening); or there is an opportunity to involve multidisciplinary, integrated approaches in conducting the research.
- Impact – extent of significance to population/public health (impact on decreasing the burden of disease).
- Knowledge Translation – degree of potential for rapid uptake of results.

The top three to five research priorities, infrastructure and capacity gaps, and criteria and rationale for each break-out group were then presented to all of the workshop participants in subsequent plenary sessions (Appendix 5: Summary of Break-out Sessions).

Challenges influenza poses in the community

Moderators: Drs. Ian Gemmill and Karen Grimsrud

The focus of this break-out group was research pertaining to disease risk and impact assessment, as well as influenza prevention and control strategies in the community. Suggested topics for discussion included: epidemiologic and risk factor assessment, economic impact, animal to human transmission, health care system interventions, public health/vaccine interventions to control or limit the spread of influenza.

Challenges influenza poses in the health care setting

Moderators: Drs. Gary Garber and Mark Loeb

This break-out group discussed research in the clinical setting such as diagnosis, patient treatment and management (other than antivirals), infection control, ambulatory care issues, health care system interventions, clinical trials and other clinical research capacity.

Challenges influenza poses to basic and applied science

Moderators: Drs. Guy Boivin and Earl Brown

Here the emphasis was on basic and applied research on influenza such as rapid diagnostics, animal models, virulence factors, correlates of protection and transmissibility of animal influenza viruses.

Optimizing influenza vaccines

Moderators: Drs. Joanne Langley and Brian Ward

This break-out group discussed influenza vaccine-related research opportunities including novel vaccine development, increasing vaccine immunogenicity and effectiveness, adjuvants and other dose-sparing strategies, forecasting vaccine strains and vaccinating populations before a pandemic (evidence for cross-protection).

Optimizing vaccination programs

Moderators: Drs. Gaston De Serres and Susan Tamblyn

Research pertaining to immunization program issues such as assessing program effectiveness, disease impact of vaccination programs, economic impact, vaccine safety, ethical issues, communications and public opinion research was discussed in this break-out session.

Optimizing the use of antiviral drugs

Moderator: Dr. Todd Hachette

This break-out group discussed research on antiviral and other therapeutic drugs for influenza including novel therapeutics, effectiveness of antivirals for treatment and prophylaxis, drug safety, drug resistance, economic impact, ethical issues, communications and public opinion research.

INTEGRATION AND SUMMATION SESSION

Facilitators: Drs. Lorne Babiuk and Scott Halperin

During the final Integration and Summation session of Day 2, the complete list of key research priorities identified by all of the break-out groups was provided to all participants.

The purpose of this session was to further prioritize the research priorities identified by the break-out groups to form a list of the most important national research priorities.

During the integration and summation session, workshop participants, with the guidance of the facilitators, combined the top priorities identified in the break-out sessions into ten research priority areas and identified what new capacity or infrastructure is needed. Further discussion is needed to determine who the key stakeholders, clients, funders are for this research.

Following the workshop, the Planning Committee and workshop participants reviewed this report to expand upon the information and put the priorities into context using the discussion material from the break-outs.

The following 10 priorities are not listed in any order.

Influenza virus characterization and ecology

Background/rationale

Much remains to be learned about the basic science of influenza viruses and the ecological relationships between animal and human viruses. Rapid advances are being made on many fronts, with potential applications to disease prevention and control.

Key research needs

- studies at the molecular and genomic level of virus diversity and evolution, human adaptation, virulence and pathogenesis
- studies of appropriate animal models of infection
- studies at the local and global level of the ecology of animal influenza viruses and their potential control by vaccination and containment strategies
- genomic level surveillance of epidemic human strains to better understand the potential for mismatch between vaccine strains and circulating viruses, and the potential effect of circulating viruses and the potential for vaccination of populations to favor escape mutations in circulating viruses
- refinement of methods to prepare candidate vaccine strains

Relevance

Basic research informs both pandemic and inter-pandemic situations and has global application for improvements in national and international disease control and prevention. Basic research on influenza is a global enterprise to which Canadian researchers have contributed with grant support. This research is essential for ongoing collaboration and contribution toward international efforts in pandemic preparedness.

Feasibility/infrastructure required

Canada has a small number of scientists active in this area of research. A limiting factor is the requirement for researchers to have Level 3 biological containment facilities to work with dangerous strains, such as H5N1 avian virus. Only a few such facilities exist in Canada because of the high costs involved, with just one or two able to house infected animals for study. A major new animal facility is currently under construction with Canada Foundation for Innovation (CFI) support.

Among the challenges that researchers face are obtaining access to new viral strains and reagents from international and domestic sources, obtaining bioinformatics and statistical support for genomic studies and building collaborations across disciplines (e.g. virology, immunology, veterinary, public health and clinical researchers should collaborate in studying animal to human transmission issues).

Capacity development in the area of basic science research is critical, and efforts into training new scientists must be enhanced. In addition to human resource capacity-building is the need to collaborate and share essential support services, to provide suitable laboratory facilities, and collaborate internationally.

Influenza virus transmission**Background/rationale**

Knowledge gaps currently exist in the understanding of virus shedding patterns of infected persons and the pathways of transmission to susceptible contacts. This information is essential for effective disease avoidance and infection control measures.

Key research needs

- studies to determine the intensity and duration of virus shedding in the course of illness and how shedding might vary with age, infirmity, illness severity and antiviral drug treatment
- studies to establish the relative importance of respiratory droplets, hands, and fomites (inanimate objects) as modes of transmission, and whether this varies with the type of influenza virus or the care setting (hospital versus community)
- studies to describe the role of children in disease spread in households and communities
- studies to distinguish the possible differences in virus shedding and transmission with pandemic strains

Relevance

This research was considered urgent as it applies to both inter-pandemic and pandemic periods and has global application. It has the potential to improve annual control efforts and inform pandemic planning and may be applicable to other viral respiratory infections. This research is critical, since the main line of defense in a pandemic situation will be prevention of transmission – we must know more about the modes of transmission in order to inform appropriate protective measures for the population. This research area can be addressed by investigators in any country as the issues are not unique to Canada.

Feasibility/infrastructure required

This type of research has seldom been conducted in Canada. No CIHR-funded study has examined influenza virus shedding and transmission but a major CIHR-funded project is examining the epidemiology of respiratory infections (including influenza) in the elderly. The research methods to describe shedding and transmission are feasible for Canadian investigators with collaboration between specialists in infectious diseases, public health and virology.

Public health preventive measures

Background/rationale

More insight is needed into “non-pharmaceutical” interventions to reduce exposure to influenza and avoid infection. In a pandemic situation, most of the population will have only disease avoidance measures to rely upon to reduce their risk of infection, given the limited supplies of antiviral drugs and the likelihood of delayed availability of pandemic influenza vaccine. Effective disease avoidance measures are particularly important in health care settings, as the SARS experience demonstrated.

Key research needs

- studies of the effectiveness of masks, hand hygiene and other infection control measures in preventing virus transmission in a variety of health care settings
- studies to determine the role of children in the spread of infection to families and within communities, and identification of effective prevention measures, such as hand hygiene at school
- studies of the value of school closures, home “isolation” of sick individuals, quarantine of contacts and other means of increasing social distancing to reduce disease transmission
- studies of the causes and prevention of influenza outbreaks in long-term care facilities, which represent a particular challenge in community disease control
- social and behavioral research on how populations react to community infection control measures and how to foster compliance with official recommendations using risk and crisis communication strategies

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has global application, but the issues are not specific to Canada. It has potential to inform pandemic planning and also to influence annual control efforts. Insights could be rapidly implemented to decrease the burden of disease and may also apply to other respiratory viruses. These insights are urgently needed, as this research deals with the first line of defense against influenza.

Feasibility/infrastructure required

This type of research has seldom been conducted in Canada: no CIHR-funded studies have addressed this aspect of influenza. The research methods required are challenging and costly. They typically require large, prospective, cohort studies with controlled interventions and laboratory-documented effects conducted by integrated networks of interdisciplinary researchers over several influenza seasons. Mathematical modeling offers a new approach to estimating the effects of interventions, an area in which Canada has some expertise (and CIHR has funded a study), but the building of models requires accurate observational data. Hospital-based intervention studies are more readily feasible than population-based studies because they can take advantage of the existing infection control personnel.

Improving rapid diagnostic tests

Background/rationale

Until recently, influenza diagnosis has mainly consisted of clinical assessment, with only a small proportion of cases confirmed by viral culture or serologic tests. Imprecision of clinical diagnosis has hampered disease management (e.g. the use of anti-influenza drugs) and confounded epidemiologic studies. Increasing the availability of rapid diagnostic tests holds promise of improved virus detection and epidemiologic assessment, disease management, vaccine effectiveness measurement and disease epidemiology, making their further development and evaluation of cross-cutting importance.

Key research needs

- continued development and evaluation of rapid diagnostic tests for hospital laboratories and “point-of-care” applications
- studies to evaluate the utility and impact of optimized diagnostic testing, at the individual and population levels, and at various levels of the health care system

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has national application but is not unique to Canada. It will inform pandemic planning and influence annual strategies and evaluations, and insights could be rapidly implemented to guide case management. Workshop participants considered such research to be urgent and of cross-cutting importance, since the advanced technology would provide better tools for accurate and timely diagnosis of influenza or other lower respiratory tract infections.

Feasibility/infrastructure required

This type of research is readily feasible in Canada, given the existing infrastructure in applied diagnostic research, hospital-based virus identification methods and clinical studies management. Test evaluation requires collaboration between clinical investigators (such as a network of infectious diseases specialists), clinical virologists and health services researchers. CIHR has funded a study of PCR-based rapid diagnosis of influenza.

Clinical management of influenza patients

Background/rationale

About 20% of the Canadian population suffers from influenza in a typical season, which for most communities lasts only 6-8 weeks. Consequently many people become ill in a short period, straining the capacity of the health care system at all levels. Thousands of infected people die of influenza-related complications. A much larger proportion of the population will be affected in a pandemic, with many becoming severely ill or dying.

While preventive measures (i.e. antiviral drugs, vaccine) are available, they are ordinarily targeted at the most vulnerable and offer incomplete protection. Effective clinical management of influenza sufferers, particularly the most ill, is a central component of the strategy to cope with influenza.

Key research needs

- development of rapid, accurate diagnostic tests (as above) that are widely available and easy to use, to provide an accurate measure of the disease burden and to ensure appropriate individual patient management
- development of evidence-based care guidelines for influenza and its complications, across the age spectrum and in a variety of community and hospital-based care settings
- studies to determine the most effective means to educate health care providers in the application of these care guidelines (studies to assess knowledge and attitude)
- the development of evidence-based algorithms for ethical priority setting when care facilities are overwhelmed, based on severity and predictors of fatal outcome

(See also: Development and optimal use of antiviral drugs, and Surge capacity of the health care system)

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has global application. It will inform pandemic planning and influence annual coping strategies. Insights could be rapidly implemented to save lives and reduce the burden on the health care system by shortening or avoiding hospitalizations. Workshop participants considered such research to be urgently needed.

Feasibility/infrastructure required

This type of research is readily feasible in Canada. It requires formalization and support of emerging networks of researchers in primary care and infectious diseases and integration with existing CIHR-funded expert groups in respiratory diseases. No CIHR-funded studies have directly addressed this aspect of influenza. The recent increase in availability of rapid diagnostic tests in many tertiary care centers has created new opportunities for well-designed intervention studies.

Development and optimal use of antiviral drugs

Background/rationale

Several available medications have activity against influenza viruses and are useful for avoiding (prophylaxis) and treating infection. Canada is investing in a large stockpile of an antiviral drugs to mitigate the effects of pandemic infection until a vaccine becomes available and thereafter. Concerns with this approach include possible reduction of drug effectiveness against avian strains and an emergence of a resistant strain with widespread use. Many uncertainties exist regarding the treatment of severe or complicated cases.

Key research needs

- development and evaluation of new agents (drugs) and novel approaches to using existing medications (e.g. in combination, in new formulations, in injectable form for severely ill patients)
- studies of the optimal dose and duration of treatment for severe or complicated disease, in a range of populations and situations
- health services research to optimize drug utilization in ambulatory and hospitalized persons
- studies of drug effectiveness with different strains of influenza, including avian strains
- studies on the detection, development and significance of resistance to antivirals
- studies to assess the utility of antivirals as a preventive tool in high-risk populations (e.g. residents of long-term care facilities), in recently exposed susceptible people, in outbreak management, and in curbing community spread (e.g. by treating school children)
- studies to address the effects of treatment on virus shedding and transmission and on immune responses to infection
- Research aimed at the development and use of antivirals for treatment and prevention of infection is needed. This includes data on their knowledge and attitudes concerning these agents as well as studies of novel approaches...

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has global application. Insights could be rapidly implemented to improve patient outcomes and curb disease spread. This urgent research would help to ensure that optimal use is made of the large federal investment in an anti-viral drug.

Feasibility/infrastructure required

This research would be feasible in Canada if infrastructure was enhanced. A limited number of researchers in several centers have conducted industry-sponsored anti-influenza drug studies, providing a core of expertise. A larger network of investigators would need to be established and supported, drawing upon the expertise of primary care, infectious disease and public health researchers, and clinical virologists. CIHR has not funded trials of anti-influenza drugs to date but has funded the development of tests for drug resistance. With development of greater capability to evaluate anti-influenza drugs, more industry-sponsored research on newer agents would be attracted to and conducted in Canada. The drug evaluation network could also evaluate immunoglobulin preparations or anti-inflammatory agents, for example.

Surge capacity of the health care system**Background/rationale**

The annual increase in health care utilization during influenza outbreaks stresses the capacity of emergency rooms and hospitals. Disease prevention programs reduce morbidity and the need for care but are only partly effective, as substantial morbidity continues to occur. In a pandemic, demands on health care facilities will occur on an unprecedented scale. Learning how to increase the “surge capacity” of the health care system is a key coping strategy.

Key research needs

- studies to evaluate health care utilization and capacity of the system to respond during influenza (pandemic and inter-pandemic) outbreaks
- studies to evaluate innovative health care delivery methods to increase surge capacity, including mathematical modeling and economic analysis of response options
- evaluation of the effects of increased utilization on health care providers (absenteeism, staffing shortages, morale) and how to mitigate them; development of evidence-based “return to work safely” protocols for providers with influenza
- studies to determine effective means to increase ambulatory management, self-care and triage capacity
- studies to determine efficient means to restore normal system operations after a crisis

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has national application. It has the potential to influence annual control efforts and to inform pandemic planning. Insights could be rapidly implemented to cope better with the annual burden of disease and would also apply to epidemics caused by other infectious diseases. Workshop participants considered such research to be urgently needed.

Feasibility/infrastructure required

Influenza-related health care utilization research has been conducted on a modest scale by several groups of Canadian researchers, none with funding specific to influenza. A key requirement is greater access to administrative databases within the health care system, to track utilization of outpatient and inpatient services. Increasing utilization of rapid diagnostic tests will improve recognition of influenza cases and their specific health care needs.

Background/rationale

Workshop participants were mindful of the limited effectiveness of the “standard” trivalent, inactivated, egg-derived influenza vaccines. Although 70% to 90% of healthy adults can be protected when circulating and vaccine strains closely match, the protection rates for those most likely to suffer illness complications (e.g. young children, seniors) are substantially lower. Of all the vaccines currently provided in public programs, influenza vaccines are the least effective. The standard type of vaccine will offer limited protection against a pandemic strain such as avian influenza, because of the added challenges involved in eliciting (primary) immune responses to a previously unseen virus. To meet the growing expectations of the general public, more effective vaccines must be developed using new technologies that engage the immune system more reliably. Alternatives to annual injections would thus be a welcome advance. The virus is a moving target and annual changes in vaccine strain are frequently required.

Key research needs

- studies to better understand the human and animal immune response to infection and immunization including for example, the influences of virus type, host genetics, age, and co-morbid conditions
- studies that define the immunologic correlates (predictors) of protection after infection or vaccination, to guide vaccine development and evaluation
- developing means to enhance responses (especially primary responses) to vaccines using adjuvants and novel means of vaccine delivery; enhancement includes the dimensions of efficiency (rapid responses, to minimal doses), acceptability to consumers and affordability for public programs
- studies to assess the carry-over protection from vaccination in subsequent seasons
- studies to eliminate the need for annual vaccine reformulation and revaccination by seeking conserved antigens among circulating influenza viruses with potential to induce long-lasting protection, or exploring other vaccine technologies (e.g. DNA vaccines)

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has global application. It is especially relevant to the domestically produced influenza vaccine on which Canada will rely in the event of a pandemic. Insights could be rapidly applied to annual programs, improving their effectiveness and encouraging greater public participation in them.

Feasibility/infrastructure required

This type of research is readily feasible in Canada, as this country is one of the few with a domestic influenza vaccine manufacturer (ID Biomedical). A working relationship has been established between the federal government and this company to make preparations for a pandemic. The company has promising new influenza vaccine technologies in development and could be encouraged to collaborate with other Canadian innovators to assess additional options for enhancing vaccine effectiveness, such as new adjuvant strategies. CIHR has funded a study of needle-free vaccines for respiratory viruses, including influenza. Canada has the capacity to develop and test new vaccines in animal models of infection. Canada also has a number of skilled vaccine evaluation centers, which will be needed to test new candidate vaccines in people. While these centers currently cooperate in an expanding network, infrastructure support is needed to ensure that a fully functional network will be available when needed. Canada has a number of experts in influenza immunology whose expertise will be needed to evaluate responses to new products and develop standardized tests. In summary, Canada has all of the required elements to pursue this important area of research, but infrastructure investment is required.

Background/rationale

Workshop participants were reminded that Canada is a world leader in annual per capita utilization of influenza vaccine. Moreover, Ontario is a world leader in offering influenza vaccine to all residents (universal program), whereas other provinces have programs that target groups at highest risk of disease complications, with differing delivery strategies. It should follow that Canada is a world leader in evaluating the effectiveness of annual influenza programs but this has not been the case – little has been done to evaluate programs. Recently, two Requests for Proposals invited comparison of the effectiveness of the universal immunization program in Ontario to targeted immunization programs in other provinces or comparable countries.

Key research needs

- studies to evaluate universal versus targeted influenza immunization programs. (note: evaluation of the impact of vaccination programs should include estimates of reductions in health care utilization, drug prescription patterns, workplace and school absenteeism, transmission within households and work groups, occurrence of outbreaks in care facilities)
- studies to determine if immunization of school children decreases influenza transmission in other age groups
- studies to determine if immunization of health care workers decreases influenza transmission in health care settings
- studies that determine the minimum level of immunization coverage in target populations needed to reduce influenza virus transmission
- behavioral research to increase vaccine uptake in eligible populations, in annual and pandemic settings
- assess the potential benefits and short and long-term safety of influenza vaccine in specific populations, including new candidates for inclusion in targeted programs (e.g. pregnant women)
- studies to measure the economic benefits of immunization
- the development of methodologies and capacity for annual assessment of program effectiveness, including means for rapid assessment of safety and effectiveness

Relevance

This research is relevant to both inter-pandemic and pandemic periods and has global application. Insights could be rapidly implemented to increase program effectiveness and reduce the burden of disease. Participants considered such research to be urgently needed.

Feasibility/infrastructure required

Canada is uniquely positioned to measure the effectiveness of its highly subscribed influenza vaccination programs, both targeted and universal, however the infrastructure needed to do this requires substantial development.

The main challenge in evaluating influenza immunization programs (or any immunization program) lies in the inability to obtain and link administrative databases, or registries, at the individual level. Currently, there is no reliable or consistent method to obtain information on vaccination status of individuals or clinical data, such as health outcomes. Electronic provincial immunization registries will provide information on immunization status, but have not been implemented across Canada at this time. The widening availability of rapid diagnostic tests will assist with capturing clinical data for the

hospital contacts. Some provinces can link required data presently but the process is slow. Community-level comparisons of the impact of program strategies offer a manageable alternative but have not been undertaken in Canada. Public health departments are typically understaffed and ill-prepared to undertake evaluation research, explaining the lack of studies to date. Investment in developing this capacity is essential as these public programs should be continuously evaluated and improved. CIHR has funded a study of the impact of influenza on pregnant women.

Preparation for a pandemic vaccine

Background/rationale

Canada will be responsible for evaluating the pandemic vaccine produced by its domestic manufacturer. Many challenges are involved in preparing, testing and evaluating a vaccine in the context of a pandemic. It is desirable to anticipate as many of the challenges and identify remedies as possible, to save time and avoid missteps during an outbreak.

Key research needs

- study and develop efficient, reliable means to prepare seed strains for vaccine production
- develop cell-culture based vaccine production methods to eliminate the requirement for eggs in vaccine production
- evaluate prototype vaccines in animals and humans in advance of a pandemic to better understand dosing requirements for protective responses
- evaluate whether “priming” with a prototype pandemic vaccine will enhance responsiveness of populations to the definitive pandemic vaccine and be acceptable to the public
- develop and test appropriate methodologies to rapidly evaluate candidate vaccines for safety and immunogenicity (efficacy) in persons of all ages
- develop and test suitable population-based methods to evaluate vaccine effectiveness and safety following release for general use
- use mathematical modeling to identify the most effective strategies for deploying a vaccine as it becomes available, considering a range of populations and situations

Relevance

This research is central to Canada’s security of vaccine supply since we must be well prepared to assess the domestic product on which the country will rely. Efficient preparations will help to ensure a minimum delay in vaccine becoming available for general use. Testing prototype vaccines (such as H5N1 avian influenza) in advance of a pandemic will provide valuable insights regarding safety, dosing and formulation, reducing the potential for unanticipated difficulties and consequent delays. Participants considered such research to be urgent and of high priority.

Feasibility/infrastructure required

The Public Health Agency of Canada has contracted with the domestic manufacturer to ensure vaccine supply during a pandemic and to produce and evaluate a prototype H5N1 avian influenza vaccine. To facilitate clinical trials now and in the future, a network of vaccine evaluation centers needs to be established, including experts in assessing immune responses to influenza. Extensive pre-planning is needed to reduce response time for clinical trials, including prior approval of detailed protocols by the regulatory agency and research ethics boards of participating centers, negotiation of contracts between the trials sponsor and centers, training of key personnel and development of reliable methods for data and logistics management. Plans should encompass phase 1 and 2 trials conducted prior to approval for

use and phase 4 studies during use (to assess safety and effectiveness). The latter may require access to health care databases, requiring consideration of privacy concerns. Creating this infrastructure will also position Canadian researchers to evaluate other vaccines of strategic or economic importance.

Closing Remarks: Day 2

Dr. David Scheifele, Director, Canadian Association for Immunization Research and Evaluation

Dr. Scheifele commented that follow-up meetings will be required to address infrastructure gaps and the feasibility of the research described in each priority area. It will be important to identify research that builds on the strengths of the Canadian research community. Consideration will be given to research that is being performed in other countries so that research and resources are not duplicated. Related to this is a need for a repository for information on current influenza research. Dr. Scheifele stated that it is possible that the Canadian Vaccine Initiative might play a role in this repository. He then closed the workshop by thanking the participants for their contributions.

WORKSHOP EVALUATION AND NEXT STEPS

At the conclusion of the two days, participants evaluated the workshop. Overall, participants agreed that the overall process in developing consensus on research priorities was appropriate, and that the objectives of the workshop were achieved, but further priority-setting of the final top ten list is needed (Appendix 6: Abridged Workshop Evaluation). The workshop Planning Committee and workshop participants provided further input to define the research priorities into ten research themes which are included in this final report. The findings will then be communicated to funding agencies and decision makers in Canada and internationally (Appendix 7: Next Steps). Strategic approaches for funding the identified influenza research priorities will be developed and pursued in 2006.

APPENDIX 1: PLANNING COMMITTEE

Co-Chairs	
<p>David Scheifele Director, Vaccine Evaluation Centre Chair, Canadian Association for Immunization Research & Evaluation British Columbia Children's Hospital</p>	<p>Theresa Tam Associate Director, Immunization and Respiratory Infections Division Public Health Agency of Canada</p>
Members	
<p>Gordean Bjornson Administrative Chair Canadian Association for Immunization Research & Evaluation Vaccine Evaluation Centre</p>	<p>Tim Booth Director, Viral Diseases Division Public Health Agency of Canada National Laboratory for Viral Diagnostics</p>
<p>Michelle Gagnon Assistant Director Partnerships and Knowledge Translation Institute of Health Services and Policy Research Canadian Institutes of Health Research</p>	<p>Karen Grimsrud Deputy Provincial Health Officer Alberta Health and Wellness Provincial Health Office</p>
<p>Greg Hammond Director of Public Health Public Health Branch Manitoba Health</p>	<p>Mark Loeb Associate Professor, McMaster University Departments of Pathology and Molecular Medicine and Clinical Epidemiology and Biostatistics Michael G. De Groote Centre for Learning</p>
<p>Lisa Paddle A/Head, Immunization Research, Immunization and Respiratory Infections Division Public Health Agency of Canada</p>	<p>Carol Richardson Manager, Programs and Evaluation Institute of Infection and Immunity Canadian Institutes of Health Research The University of Western Ontario</p>
<p>Bhagirath Singh Scientific Director Institute of Infection and Immunity Canadian Institutes of Health Research The University of Western Ontario</p>	<p>Susan Tamblyn Public Health Consultant</p>
Secretariat	
<p>Laura Amos Project Officer, Immunization and Respiratory Infections Division Public Health Agency of Canada</p>	

Appendix 2: Workshop Participants

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Vaccine and Infectious Disease Organization

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Ping Yan

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APPENDIX 3: WORKSHOP AGENDA

Influenza Research Priorities Workshop

August 31st - September 1st, 2005

Delta Ottawa Hotel and Suites

361 Queen Street
Ottawa, Ontario
K1R 7S9

Workshop Co-Chairs:

Dr. David Scheifele, Canadian Association for Immunization Research & Evaluation
and
Dr. Theresa Tam, Immunization and Respiratory Infections Division, PHAC

Theme:

Seeking creative advances in pandemic and inter-pandemic preparedness and control.

Goal:

To gather Canadian and International vaccine experts and researchers to determine the national research priorities that will enhance pandemic and inter-pandemic influenza prevention and control strategies.

Objectives:

1. To review current knowledge on influenza, including annual and pandemic prevention and control strategies and identify key knowledge gaps to be addressed by further research
2. To identify the current state of influenza research and provide recommendations to strengthen future research activities, research response capacity and infrastructure in Canada, in order to address:
 - inter-pandemic / annual influenza prevention control
 - pandemic preparedness and response
3. To publish and use the identified key research priorities to guide and facilitate further discussions by researchers and potential influenza research sponsors.

Day One Agenda

Influenza Research Priorities Workshop

Wednesday, August 31, 2005

Time	Agenda Item	Presenter
7:00 – 8:30	Registration and Breakfast (Victoria Room)	
8:30 – 9:00	<p>Welcome and Opening Remarks</p> <p>Overview of workshop goals, objectives, and expected outcomes.</p>	<p>Alan Bernstein Arlene King</p> <p>David Scheifele Theresa Tam</p>
9:00 – 9:30	<p>Influenza 101</p> <ul style="list-style-type: none"> • Overview of viral evolution, pathogenesis, communicability, epidemiology and natural immunity. 	Mark Loeb
9:30 – 10:00	<p>Current pandemic/inter-pandemic influenza preparedness and control strategies</p> <ul style="list-style-type: none"> • Overview of current annual control strategies and tools. • Overview of the Pandemic Influenza Plan. • Overview of the current state of pandemic threat. 	Theresa Tam
10:00 – 10:30	Break (Foyer)	
10:30 – 11:00	<p>Obstacles and opportunities for influenza control - antivirals</p> <ul style="list-style-type: none"> • Overview of the available and new anti-influenza drugs. • What are the gaps in knowledge? • What other immunotherapeutic options exist? 	Fred Aoki
11:00 – 11 :30	<p>Obstacles and opportunities for influenza control – vaccines</p> <ul style="list-style-type: none"> • Limitations of current vaccines and control programs and how they might be addressed. • Opportunities for improved control provided by new vaccine technologies. 	Susan Tambyn
11:30 – 12 :00	<p>Current national influenza research activities and gaps</p> <ul style="list-style-type: none"> • Overview of current Canadian research activities on influenza, including themes, investigators, networks, funding sources, and suggested improved approaches to influenza-related research in Canada. 	David Scheifele

Time	Agenda Item	Presenter
12:00 – 12:15	Break-Out Session Instructions (participants will be pre-assigned to one of three break-out sessions) <ul style="list-style-type: none"> For each break-out topic, participants will identify the important unknowns (knowledge gaps), research response, capacity and infrastructure gaps/needs with respect to both inter-pandemic and pandemic periods. Each break-out group will make recommendations for the key three to five research priorities for their assigned topic area. 	David Scheifele Theresa Tam
12:15 – 12:35	Working Lunch/Break	
12:35 – 15:00	Session A (Victoria Room) Challenges influenza poses in the community This break-out group will discuss research pertaining to disease risk and impact assessment, as well as influenza prevention and control strategies in the community e.g. epidemiologic and risk factor assessment, economic impact, animal to human transmission, health care system interventions, public health/vaccine interventions to control or limit the spread of influenza.	Moderators: Ian Gemmill Karen Grimrud
	Session B (Delta Room B) Challenges influenza poses in the health care setting This break-out group will discuss research in the clinical setting e.g. diagnosis, patient treatment and management (other than antivirals), infection control, ambulatory care issues, health care system interventions, clinical trials and other clinical research capacity.	Moderators: Gary Garber Mark Loeb
	Session C (Delta Room A) Challenges influenza poses to basic and applied science This break-out group will discuss basic and applied research on influenza e.g. rapid diagnostics, animal models, virulence factors, correlates of protection, transmissibility of animal influenza viruses.	Moderators: Guy Boivin Earl Brown
15:00 – 15:30	Break Moderators (with Rapporteurs) compile summary for presentation to Plenary group	
15:30 – 16:45	PLENARY – Reporting back from break-out sessions A-C	Break-out Moderators
16:45 – 17:00	Closing remarks for Day 1	Paul Gully

Day Two Agenda

Influenza Research Priorities Workshop

Thursday, September 1, 2005

Time	Agenda Item	Presenter
7:00 – 8:30	Breakfast (Victoria Room)	
8:30 – 9:00	Global influenza research strategies and activities <ul style="list-style-type: none"> Overview of critical global research needs and how individual countries can address the gaps. 	Klaus Stöhr
9:00 – 9:30	U.S. influenza research strategies and activities <ul style="list-style-type: none"> Overview of how the U.S. is preparing for research pertaining to influenza pandemic and inter-pandemic control and prevention measures. 	Ben Schwartz
9:30 – 10:00	Break (Foyer)	
10:00 – 12:30	Session D (Delta Room A) Optimizing influenza vaccines This break-out group will discuss influenza vaccine-related research e.g. novel vaccine development, increasing vaccine immunogenicity and effectiveness, adjuvants and other dose sparing strategies, forecasting vaccine strains, vaccinating populations before a pandemic (evidence for cross-protection).	Moderators: Joanne Langley Brian Ward
	Session E (Victoria Room) Optimizing vaccination programs This break-out group will discuss immunization program issues e.g. assessing program effectiveness, disease impact of vaccination programs, economic impact, vaccine safety, ethical issues, communications and public opinion research.	Moderators: Gaston De Serres Susan Tamblyn
	Session F (Delta Room B) Optimizing the use of antiviral drugs This break-out group will discuss research on antiviral and other therapeutic drugs for influenza e.g. novel therapeutics, effectiveness of antivirals for treatment and prophylaxis, drug safety, drug resistance, economic impact, ethical issues, communications and public opinion research.	Moderators: Todd Hatchette Coleman Rotstein
12:30 – 13:00	Working Lunch (VICTORIA ROOM) Moderators (with Rapporteurs) compile summary for presentation to Plenary group	

Time	Agenda Item	Presenter
13:00 – 14:00	PLENARY – Reporting back from break-out sessions D-F	Break-out Moderators
14:00 – 16:00	INTEGRATION & SUMMATION <ol style="list-style-type: none"> 1. What are the ten key research priorities pertaining to annual epidemic and pandemic control? 2. Which of these questions are most urgent? 3. When will this research be needed? 4. What new research capacity and infrastructure (including funding strategies) is needed to facilitate research in the critical areas? 5. Who are the key stakeholders, clients, and funders? 	Lorne Babiuk Scott Halperin
16:00 – 16:30	WRAP-UP & CLOSING REMARKS <ul style="list-style-type: none"> • Identify key next steps to move the identified priorities forward • Closing remarks 	Theresa Tam David Scheifele

APPENDIX 4: PLENARY SPEAKER BIOGRAPHIES

Dr. Alan Bernstein

Dr. Bernstein is the inaugural President of the Canadian Institutes of Health Research (CIHR), Canada's lead agency for the support of health research. An internationally respected researcher, mentor and scientific leader, he has made key contributions to our understanding of embryonic development, hematopoiesis and cancer. Prior to his appointment at CIHR in 2000, he was Director of Research at the Samuel Lunenfeld Research Institute of Mount Sinai Hospital from 1994-2000 and Professor in the Department of Molecular and Medical Genetics at the University of Toronto, where he is a Senior Fellow, Massey College. Dr. Bernstein has received numerous awards, including the McLaughlin Medal of the Royal Society of Canada, the Genetics Society of Canada Award of Excellence, the 2001 Australian Society of Medical Research Medal, and the Order of Canada in 2002.

Dr. Arlene King

Dr. King is the Director of the Immunization and Respiratory Infections Division, Public Health Agency of Canada and an adjunct professor in the Faculty of Medicine, Department of Health Care and Epidemiology, University of British Columbia, Vancouver, Canada. She received her medical degree from McMaster University in Hamilton, Ontario in 1981, certification in Family Medicine from the University of Calgary, Alberta in 1984 and practiced Family Medicine in northern Alberta from 1985 to 1989. In 1990, she received a Masters Degree in Health Sciences from the University of British Columbia and in 1992, became a Fellow of the Royal College of Physicians and Surgeons of Canada in Community Medicine. She served as a medical officer of health in British Columbia from 1992 to 1994, and subsequently held various positions in communicable disease control at the British Columbia Centre for Disease Control in Vancouver. She joined Health Canada/the Public Health Agency of Canada in 1999.

In 2003, she received Health Canada's Deputy Minister's Award of Merit for her contribution to Canada's National SARS Response. She has been a consultant to the World Health Organization on polio, SARS and influenza, and to the World Bank and CIDA on Emerging Infectious Diseases. She is a member of the World Health Organization Africa Region Polio Eradication Certification Commission. In 2004, she was appointed to the Board of the Global Alliance on Immunization (GAVI).

Dr. David Scheifele

Dr. Scheifele holds the CIHR/Wyeth Chair in Clinical Vaccine Research at the University of British Columbia and serves as Director of the Vaccine Evaluation Center at BC Children's Hospital. Since he established the Vaccine Evaluation Center in 1988, he has been involved in more than 100 clinical studies and has published over 200 related research papers. He is a past chair of the National Advisory Committee on Immunization. He currently chairs the Canadian Association for Immunization Research & Evaluation (CAIRE) whose members comprise of more than 100 Canadian researchers who are dedicated to building the scientific foundation of optimal immunization programs.

Dr. Theresa Tam

Dr. Tam is the Associate Director of the Immunization and Respiratory Infections Division, Public Health Agency of Canada (PHAC). She has provided leadership and technical support for national pandemic influenza preparedness since 1999 and played a key role in the realization and publication of the Canadian Pandemic Influenza Plan. After completing her residency training in Paediatrics at the University of Alberta and a fellowship in Infectious Diseases at the University of British Columbia, she

joined Health Canada as a Field Epidemiologist. Since then she has continued her career in public health with a focus on respiratory infections and immunization. She was part of the Health Canada response team on Severe Acute Respiratory Syndrome (SARS) in 2004. She has supported the World Health Organization as a technical consultant on influenza surveillance in China, pandemic preparedness and the response to avian influenza in Thailand and Vietnam in 2005. She is the current Executive Secretary of the National Advisory Committee on Immunization.

Dr. Mark Loeb

Dr. Loeb is an Associate Professor in the Departments of Pathology and Molecular Medicine and Clinical Epidemiology and Biostatistics at McMaster University. He is Director of Infection Control at Hamilton Health Sciences. He trained in Internal Medicine, Medical Microbiology, Infectious Diseases, and Epidemiology at the University of Toronto and McMaster University, and completed a research fellowship at the University of Toronto. Dr. Loeb has served on Canadian and U.S. advisory committees about respiratory infections and receives research funding from CIHR, NIH, and CDC. He has been Principal Investigator on several CIHR grants related to respiratory infections, including the Canadian SARS Research Network. He is Co-Editor of the BMJ textbook Evidence-Based Infectious Diseases, serves as section editor for the BMJ Clinical Evidence chapter on Pneumonia and is Associate Editor of Evidence-Based Medicine/ACP Journal Club. He holds a CIHR New Investigator award, a Premier's Research Excellence Award, and last year received the Society for Healthcare Epidemiology of America Investigator Award.

Dr. Fred Aoki

Dr. Aoki is a Professor of Medicine, Medical Microbiology and Pharmacology & Therapeutics at the University of Manitoba. He trained in clinical pharmacology at the Montreal General Hospital and in infectious diseases at the Medical Research Council (MRC) Division of Communicable Diseases, Harrow, and the MRC Common Cold Unit, Salisbury, England. His research has focused on the clinical pharmacology of antiviral drugs and clinical trials of viral vaccines. He is a member of the Antiviral Subcommittee of the Canadian Pandemic Influenza Planning Committee.

Dr. Susan Tamblyn

Dr. Tamblyn is a public health consultant and Associate Clinical Professor in the Faculty of Medicine at the University of Western Ontario. She retired from her 30-year position as Medical Officer of Health for the Perth District Health Unit in June 2004 but has remained active in influenza work. Throughout her career Dr. Tamblyn served on advisory committees for the Ontario Ministry of Health and Long-Term Care, Health Canada, the Canadian Paediatric Society, CDC and WHO. She was chair of Canada's National Advisory Committee on Immunization for four years and the Ontario Advisory Committee on Communicable Disease for three years.

Dr. Tamblyn has been involved in pandemic planning for over two decades and is currently co-chair of the Ontario Pandemic Influenza Health Steering Committee and chair of the Antiviral Working Group for the National Pandemic Influenza Committee. She also chairs the Local Public Health Capacity Review Committee which will recommend ways to strengthen Ontario's public health units.

Dr. Paul Gully

Dr. Gully is the Deputy Chief Public Health Officer, Public Health Agency of Canada. In this position he works with the Chief Public Health Officer in the management of the Agency to enable it to fulfill its mission and mandate.

Dr. Gully joined Health Canada in 1990 and subsequently held a number of positions within the former Laboratory Centre for Disease Control, Health Protection Branch. In July 2000, he was appointed the first Director General of the new Centre for Infectious Disease Prevention and Control, PPHB and in

March 2002, he was appointed Senior Director General of the Population and Public Health Branch.

Dr. Gully is a physician with specialty training in public health in the United Kingdom and Canada. Prior to training in public health, he worked in the United Kingdom (UK), Zambia, Vancouver and the Northwest Territories. Before joining Health Canada, Dr. Gully was attached to the UK Communicable Disease Surveillance Centre. He was also Medical Officer of Health in Saskatoon from 1986-1990.

Dr. Gully has written several publications on infectious disease epidemiology and has held honorary and adjunct academic positions in the UK and Canada. He was past-president of the National Specialty Society for Community Medicine.

Dr. Klaus Stöhr

Dr. Stöhr is the Coordinator of the Global Influenza Programme in the Department for Communicable Disease Surveillance and Response at the World Health Organization, located in Geneva, Switzerland. He is responsible for coordinating the work of the WHO Global Influenza Programme, including the WHO Influenza Surveillance Network, and for providing advice to WHO and national health authorities on policies and strategies for the surveillance and prevention of seasonal influenza and on influenza pandemic preparedness.

Dr. Stöhr completed his Masters Degree in Germany in 1984, and completed his PhD (Dissertation on Epidemiology and Infectious Disease Control) in 1987. Since that time, he became a Fellow at the Faculty of Veterinary Medicine, (University Leipzig, Germany); was a scientist in the Department of Infectious Diseases, National Institute for Epidemiology and Infectious Disease Control in Animals (Eastern Germany); was a Department Head of Infectious Diseases at the National Institute for Epidemiology and Infectious Disease Control in Animals, (Germany); has 10 years of experience as a scientist with the WHO's Veterinary Public Health Unit, Zoonotic Disease Unit, and the Animal and Food related Public Health Risks Division; most recently, he was the Coordinator of the WHO's SARS aetiology and diagnosis activities.

He is a corresponding member of the European Society for Clinical Virology since November 2003, has published over 60 scientific publications and has been invited to present at over 120 international meetings since 1992.

Dr. Benjamin Schwartz

Dr. Schwartz is the Senior Science Advisor, National Vaccine Program Office (NVPO), U.S. Department of Health and Human Services. In this position, Dr. Schwartz has had a lead scientific role in developing the draft HHS Pandemic Influenza Preparedness and Response Plan and providing technical expertise in pandemic preparedness activities. He also coordinates the NVPO Unmet Needs program which provides support to priority vaccine research studies conducted collaboratively by HHS agencies and scientists. Dr. Schwartz received his medical degree from Washington University in St. Louis, Missouri; served as a pediatric resident at Case Western University in Cleveland, Ohio; and completed a fellowship in pediatric infectious diseases at Emory University in Atlanta, Georgia. In 1986, Dr. Schwartz began his public health career as an Epidemic Intelligence Officer at the Centers for Disease Control and Prevention. At CDC, in the National Center for Infectious Diseases and the National Immunization program, he developed and coordinated CDC's judicious antimicrobial use program to decrease the spread of resistance; studied the epidemiology of group A streptococcal infections including the streptococcal toxic shock syndrome; developed the New Vaccine Surveillance Network to study the epidemiology of vaccine preventable diseases and the impacts of new vaccines; and completed multiple international consultancies on acute respiratory infections, antimicrobial resistance, and vaccine preventable diseases.

APPENDIX 5: SUMMARY OF BREAK-OUT SESSIONS

Session A

Challenges influenza poses in the community

Knowledge gaps identified:

- Surveillance gaps (defining disease and impact burden; reliable/rapid diagnostics) We know little about the excretion pattern/transmission pattern of influenza virus
- Epidemiological (reviewing/confirming modes of transmission; period of communicability; role of children in spread; why are LTC facilities hit harder and how can we prevent this?; what about other non-LTC facilities?)
- Controlling transmission; role of masks; hand hygiene; closure of schools/events; restriction of travel; contact tracing and quarantine; human-animal interface in the community
- Impact of public education on public behaviour; self-care
- Modeling of economic impact; projected impact of intervention in Canada; “is modeling a good surrogate for research in the community setting?”
- Early containment strategies: Do early pandemic interventions (culling, antivirals, vaccines) work? Stockpiling antivirals
- What special interventions are needed for remote communities?
- How can we engage family physicians, public health practitioners/nurses, other health practitioners, complementary practices?
- Operational/feasibility public health measures – capacity of public health system
- Understand public behaviour in crisis situation using meaningful methodology, determinance of vaccine uptake
- Ability to predict patterns of spread
- Clear, planned communication (to the public and private sectors) must be addressed; effective risk communication/crisis communication; best methods of mass communication (technology choices)
- Relationship between people buying antivirals and supply
- Clinical management of severe influenza disease (due to short supply issues of vaccine/AV stockpile during pandemic)
- Knowledge about personal and corporate preparedness – what is happening, what is optimal? (personal and public)
- Equity (disparities in access? What are our public values regarding treatment, etc.)

Research priorities brainstorming results:

- What are effective measures to control spread (non-vaccine measures) what are risk groups, transmission patterns, effectiveness of interventions?
- Transmissibility (how influenza spreads); interaction between people (contact networks) Intrafamilial versus institutions versus community
- Social behaviours (consumers and providers) (how people behave now and during a pandemic – is there a difference?, how can we intervene meaningfully? Why is there complacency? Why does widespread panic occur when unwarranted? Why is there resistance among some populations to receive vaccine, and how do we reverse this trend, gain trust, obtain buy-in for both methods, does practice work?) How do people respond to public health interventions?
- Need to understand the impact of current influenza programs, burden/characteristics/diagnosis of disease to establish incidence reduction goals (do more pop-based studies looking at effectiveness of current strategies) using consistent laboratory approaches

- Impact of vaccination program (e.g. school setting)
- How effective are interventions (contact tracing, hand washing, mask use) as a public health control measure during pandemic (what works best to reduce morbidity/mortality?)
- Knowledge of supply, use of non-publicly funded vaccine, feasible practical ways of capturing coverage in a database
- Refining transmission patterns of influenza
- What are the effectiveness of non-medical interventions

Research Priorities Identified in Session A

#1 How do we gather a greater depth of understanding of influenza transmission?

Research response (research activities)

- What are the patterns of spread (who gets it?)
- Defining shedding patterns
- What is the behaviour of new strains?
- How do current vs. pandemic strains differ?
- Defining infective dose
- Aerosol spread vs fomite spread (airborne, droplet, contact)
- What is the impact of setting on transmission? (household/community)

Infrastructure/capacity gaps

- Rapid deployment capacity
- Integrated networks of researchers are needed
- National historical outbreak data needed for modeling

Comments

- Clinical trial comparing N95 mask to standard surgical mask
- This informs pandemic planning activities but also potential to influence/modify annual control efforts

#2 What are the effectiveness of public health interventions/control measures

Research response (research activities)

- Hand washing effectiveness
- Value of using masks
- Value of contact follow up and quarantine
- Value of closing schools/public places
- Value of restricting travel

Infrastructure/capacity gaps

- Take advantage of system opportunities (e.g. school closures during pre-scheduled breaks)
- Public Health human resources are scanty

Comments

- Many are only feasible through modeling

#3 How do populations react to influenza, pandemic influenza, and influenza control measures (Social/behavioural science)

Research response (research activities)

- Fostering compliance with disease reduction recommendations
- Determinants of vaccine uptake by the public during pandemic and inter-pandemic periods.
- Determinants of vaccine uptake or antiviral use for health care workers
- Testing messages developed based on risk and crisis communication principles.

Comments

- (IMPACT) May understand determinants, but it may not result in behaviour change
- Could be enhanced in pandemic
- Behaviours could completely change in a pandemic

Session B

Challenges influenza poses in the health care setting

Knowledge gaps identified:

- Transmissibility in health care setting
- Use of prophylactic antivirals in the HCS
- Effectiveness of immunizing HCW in the acute care setting
- Effectiveness of hospital based immunization programs for patients
- Appropriate triggers for isolation
- Effectiveness of infection control measures
- Viral shedding in hospital patients, is it prolonged
- Role of self administration of antivirals

Research Priorities Identified in Session B

#1 Understanding transmission and effective preventive measures in health care settings

Research response (research activities)

- Personnel protective equipment
- Viral shedding
- Role of physical environment
- Efficacy of preventative measures
- Epidemiology of transmissions
- Comparisons of Rural versus urban health care settings
- Comparison of health care settings with and without outbreaks

Infrastructure/capacity gaps

- Interdisciplinary,
- Lack of transmission models
- Lack of rapid diagnostics

Comments

- Feasible with funding
- Broadly applicable to other viral infections

#2 Clinical management of influenza infection and outcomes

Research response (research activities)

- Appropriate antibiotic use
- Self administration/care
- Use of antivirals and non-prescribed medications (timing)
- Clinical priority setting for treating infection, when support equipment is limited (includes qualitative, ethics)
- Optimizing early detection/treatment
- Ethics of decision making
- What are the predictors of fatal outcomes
- Special populations
- Education of health care providers
- Management in the rural versus urban setting

Infrastructure/capacity gaps

- Lack of rapid diagnostics

#3 Immunization of (patients and personnel) in the Health Care Settings

Research response (research activities)

- Evaluation of the economics
- Determinants of uptake
- Improving uptake
- Knowledge, attitudes and beliefs
- Ethical issues
- How to overcome barriers
- Evaluation program options (ie not every year)
- Evaluation of efficient delivery systems
- Vaccine safety
- Impact of adverse events on uptake

Infrastructure/capacity gaps

- Need database registries

Comments

- Overcoming the barriers

#4 Evaluating surge capacity, delivery and response in the health care system

Research response (research activities)

- Modelling
- Innovative delivery methods
- Economic analysis
- Quantitative and qualitative
- Impact on health/human resources (absenteeism, staff shortage, moral)

Infrastructure/Capacity Gaps

- Access to data elements

#5 Evaluation of the Utility, determinants and Impact of optimized Diagnostic testing at the individual and population level

Research response (research activities)

- What is the impact of early diagnosis
- Uptake and use of diagnostics at the various levels of health care

Infrastructure/capacity gaps

- Lack of highly accurate diagnostic testing

Comments

- This is a cross cutting priority and applies to all other priorities.

Session C

Challenges influenza poses to basic and applied science

Research priorities brainstorming session:

- Immune correlates of cross reactive immune protection
- Viral evolution
- Strain characterization, surveillance
- Antigenicity versus genetics
- Genetics to disease outcome – properties
- Scientific surveillance – systematic surveillance, human and animal
- Validation of diagnostic tests for swine
- Better vaccines for animal and humans
- Collaboration between influenza experts – animal, human, clinical
- Correlation of advances in human and vet. species
- Improved adjuvants
- Investigating responses in different aged groups
- Genetic differences and disease outcomes – genetic basis for host response
- Predicting disease severity, predicting complications, host response
- Determinants of severe complications – mechanisms, diagnosis, prognosis
- Determinants for transmission between hosts, host switching
- Infectious dose, route of transmission for animals, characterize infection in different species
- Human epidemiology
- Bird migration patterns of infected animals – identify viruses in water fowl, migration
- Animal surveillance and behaviour e.g. migration
- Samples in populations
- Mucosal protection and cross protection
- Cross protection from vaccine – Priming and cross reactivity, efficacy of mismatched vaccine
- Induction of cross reactivity
- Would immunizing school children result in herd immunity

Results of brainstorming activity:

- Host (animal and human) response – innate immunity, correlates of protection and cross reactive protection, priming response, immune enhancements, immunopathology, host genetics, better animal and human vaccines, clinical predictors of outcome, natural history of disease and determinants of pathology, high risk groups, age related issues, mucosal immunity
- Influenza genetics – species to species transmission, survival and geographic movement in animal reservoirs and the environment, molecular evolution and population dynamics, genetics

of virulence, ecology, viral genomics, determinants of reassortment, effects of vaccination on viral evolution

- Diagnostics and surveillance (animal and humans) – rapid, community, public health, improved diagnostics, full genome sequencing, diagnosis of resistance, virus/host co-evolution, drug resistance, clinical predictors of outcome, systematic surveillance
- Prevention – behavioural, compliance, modes of transmission, infection control programs, universal versus targeted programs, feasibility of achieving herd immunity, animal vaccination
- New viral targets and approaches - accine centres/platform, all serotypes, reverse genetics platforms, animal model facilities, testing, new antivirals, immunomodulator agents, modes of formulation and delivery

Research Priorities Identified in Session C

#1 Diagnostics, surveillance and viral evolution (animal and humans)

Research response (research activities)

- Rapid tests, improved diagnostics, full genome sequencing, diagnosis of drug resistance, virus/host co-evolution, clinical predictors of outcome, systematic surveillance, survival and geographic movement in animal reservoirs and the environment, molecular evolution and population dynamics, species to species transmission, genetics of virulence, ecology, viral genomics, determinants of reassortment, effects of vaccination on viral evolution

Infrastructure/capacity gaps

- Safety and regulatory issues, clinical and animal facilities, P3 labs, bioinformatics, coordination, databases, ethics approval between centres, dissemination of information, public health and clinical care collaboration, coordination between human and animal biology, reference strains - database of viral strains and reagents, access to strains, standardization and validation of assays, biostatistics and modeling, training/new labs (scientific capacity), population modeling

#2 Host (animal and human) response

Research response (research activities)

- Innate immunity, correlates of protection and cross reactive protection, priming response, immune enhancement, immunopathology, host genetics, better animal and human vaccines, clinical predictors of outcome, natural history of disease and determinants of pathology, high risk groups, age related issues, mucosal immunity

Infrastructure/capacity gaps

- Low number of level 3 labs, limited animal models and facilities, interdisciplinary teams linking basic and clinical, collaborative protocols for sampling and sharing of samples, coordinating centres for samples

Comments

- Rapid uptake of findings

#3 Prevention

Research response (research activities)

- Behavioural approaches, compliance, modes of transmission, infection control programs, universal versus targeted vaccine programs, feasibility of achieving herd immunity, animal vaccination

Infrastructure/capacity gaps

- Animal models, P3 labs, randomized trials in communities, funding, methodological problems in evaluation of infection control

#4 New viral targets and approaches**Research response (research activities)**

- Vaccine centres/platform – all serotypes, reverse genetics platforms, animal model facilities, testing, new antivirals, immunomodulator agents, modes of formulation and delivery

Infrastructure/capacity gaps

- Need for collaboration, core funding for platforms, P3 facilities, standardized assays

Session D**Optimizing influenza vaccines****Research Priorities Identified in Session D****#1 Improved vaccines and correlates of protection**

- Correlates of immunity - cross protection, formulation and delivery, clinical immune response, immunopathology, different populations, novel/better vaccine development, dose sparing, adjuvant use, cross priming, primary immunization, optimize efficacy and effectiveness, route, devices, schedule, ease of use, societal acceptance

Research response (research activities)

- cross protection, formulation and delivery, clinical immune response, immunopathology, different populations, novel/better vaccine development, dose sparing, adjuvant use, cross priming, primary immunization, optimize efficacy and effectiveness, route, devices, schedule, ease of use, societal acceptance

Infrastructure/capacity gaps

- Capacity to do all phases of research on vaccines
- Vaccine centres to do preclinical laboratory testing and clinical testing [immunophenotyping, high throughput, monitor immune and immunopathologic responses, correlates of immunity, linking laboratory with epidemiological and clinical studies (phase 1 to 4 studies)]

Comments

- Population-based surveillance system to identify clinical events, vaccine effectiveness and adverse events - database and management of vaccine efficacy and effectiveness, adverse events
- Standardized protocols for lab assays evaluating efficacy and safety (an integrated lab/clinical system)

2 Pandemic preparation

- Pandemic preparation - dry run [from seed lot to requirements for licensure (regulatory approval to support strategy)], modeling (different vaccines with different effectiveness)]

Research response (research activities)

- Dry run - from seed lot to requirements for licensure (regulatory approval to support strategy)
- Modeling – use of vaccine(s) for different populations in different situations

Infrastructure/capacity gaps

- Capacity to do all phases of research on vaccines
- Vaccine centres to do preclinical laboratory testing and clinical testing [immunophenotyping, high throughput, monitor immune and immunopathologic responses, correlates of immunity, linking laboratory with epidemiological and clinical studies (phase 1 to 4 studies)]
- Population-based surveillance system to identify clinical events, vaccine effectiveness and adverse events - database and management of vaccine efficacy and effectiveness, adverse events
- Standardized protocols for lab assays evaluating efficacy and safety (an integrated lab/clinical system)

Additional comments

- Roles and responsibilities
- Identify opportunities and mechanisms for effective interactions between academia government and industry in developing vaccine priorities
- This group recommends that influenza should be the Canadian Vaccine Initiative priority
- Need clear regulatory pathways for dealing with novel vaccines

Session E**Optimizing vaccination programs****Knowledge gaps identified:**

- Population level impact of annual vaccination programs
 - Are there additional high risk groups e.g. pregnant women?
- Monitoring uptake, effectiveness and safety
 - Vaccine coverage in our targeted groups and at P/T/local level
 - Most effective delivery strategies for target groups including HCWs
 - Rapid assessment of vaccine effectiveness
 - Rapid assessment of vaccine safety issues
 - Vaccine safety in pregnancy and young children
- What strategies should we use for our annual program?
 - Phase 2 evaluation of the Ontario universal program
 - Can we use P/T variations to evaluate different program strategies?
 - Does immunization of school children decrease community transmission?
 - Does vaccination of HCWs and close contacts make a difference?
- Cost-effectiveness of new programs/strategies
- Consumer and provider KAB re flu vaccination
- Pandemic vaccination strategies e.g. priming with H5 vaccine, choosing priority groups

Research Priorities Identified in Session E**#1 Comparing alternative vaccination program strategies to control influenza****Research response (research activities)**

- Evaluate Ontario universal program in comparison to targeted programs
- Does vaccination of school children decrease transmission in different age groups?
- Does health care worker immunization reduce transmission?
- Evaluation to include drugs, health care utilization, morbidity and mortality, effect on transmission, coverage, outbreaks, workplace and school absenteeism.
- What level of coverage is needed to reduce transmission?
- Use modelling approach for missing data

Infrastructure/capacity gaps

- Administrative databases (e.g. access, compatibility)
- Individual level vaccination and diagnostic data

2 Population based rapid assessment of vaccine effectiveness and safety, both annual and pandemic**Research response (research activities)**

- Short term and long term safety of vaccine in specific populations
- Development of methodologies and capacity for assessment, including rapid assessment of safety and effectiveness
- Population based impact (mortality and morbidity)
- Economic benefit, or not
- Assess the carry over protection of vaccination over more than one year

Infrastructure/capacity gaps

- Human resources (e.g. rapid analytical capability)
- Administrative database
- Data sharing agreements
- Role of ethics boards
- Who funds? Availability of rapid funding mechanisms is essential.

Comments

- Privacy concerns
- Conflict of interest issues
- What is surveillance versus what is research

#3 How do we increase vaccination coverage rates in the general population**Research response (research activities)**

- Evaluate barriers to vaccination (e.g. at individual, institutional and societal levels)
- Evaluate interventions to increase vaccination coverage such as policy approaches, social marketing and messaging
- How can we predict pandemic vaccination behaviour in consumers and health care providers?
- Will a priming strategy with a pandemic strain be acceptable to the public, health care providers and targeted groups?
- Operational issues to deliver vaccination programs rapidly and efficiently
- In the absence of immunization registries what are the alternatives to measure coverage?

Infrastructure/capacity gaps

- Ability to measure and assess vaccine coverage (registries)
- Supply issues

Comments

- Research on pandemic uptake and behaviour to be done pre pandemic

Session F
Optimizing the use of antiviral drugs

Knowledge gaps identified:

- New approaches vs existing approaches
- Knowledge and Attitudes
 - MD / HCW / Patients
 - Acceptance
 - Compliance
 - Public opinion
 - Education strategies
- Pharmacology
 - Bioavailability in critically ill patients
 - infants
- Prophylaxis efficacy
 - Special populations – school outbreaks
 - How does this influence antibody response to infection
- Treatment efficacy
 - In high risk groups
 - Patients with severe or neurological disease
 - > 48 hrs
 - Can we predict who will fail
 - What are the appropriate regimens in HPAI
 - Treatment of the critically ill
 - Treatment at hospital admission
- Safety
 - Long term prophylaxis
- Resistance
 - What is the incidence in “field” conditions
 - What drives resistance
 - Dose / duration / compliance
- New approaches
 - Treatment / prophylaxis / non-conventional
- Pandemic Questions
 - How to optimize use
 - How to deploy / store
 - Can they abort a pandemic

Research priorities brainstorming results:

- Treatment at hospital admission
- Treatment in ICU – formulations (severely ill patients). Adjunctive tx for severely ill patients. Treatment of special populations (children under the age of 1; immunocompromised patients; resistance)
- Identification of AV which are effective after 48 hours
- Time to deliver a response in LTC/hospital facilities (how long does it take to get the drug, how effective is it vs. vaccination programs?)
- Treatment reducing the duration of infectiousness
- Treatment in hospital and follow up (natural history of critically ill patients)
- Impact of treatment on viral titres
- Treatment of severe infection
- Treatment of community acquired infection, rapid access to AV

- Stage of viral replication - understanding differences between virus (infectious dose)
- Pharmacokinetic study regarding use of existing capsules (new adjunctive therapy)
- Operationalize strategies for public health response
- Years with mismatch of vaccines – should we px in LTC (outbreak control)
- Methodology – clinical dx differs in elderly versus children
- Better surrogate markers of treatment - prognosis – who will likely end up in hospitals
- Better data on outcomes post-flu (clinical dx and epi tools)
- Lab issues: Linkage between funding agency and research to use information to decide in pandemic situation – need PCR-based methodology, more integrated testing system (INFRASST. GAP)
- Px of elderly – better outcomes/evaluation of outbreak
- Role of post-exposure px in hospital, outbreak management in LTC.
- Test hypothesis that children are a reservoir and impact on families
- Study previously healthy and immunocompromised hosts or special populations (onset of tx; other outcomes)
- Develop a response plan to shutdown an annual outbreak; Infrastructure needs for stopping an outbreak in community
- Duration of treatment
- Co-administration of antibiotics

Research Priorities Identified in Session F

#1 Research into the management (treatment/rapid diagnosis) of severely ill individuals

Research response (research activities)

- Study the role of adjunctive therapy
- Combined therapies
- Resistance among special populations
- Special populations (children, elderly); immunocompromised patients
- Adjunctive treatments
- Rapid dx, improved access
- Assessment of viral shedding
- Outcome criteria (length of stay, ventilation) Severity markers/markers of response
- Dose/duration of therapy

Infrastructure/capacity gaps

- Lack of surveillance capacity
- Require clinical trials network
- Ethics and contractual issues must be timely, reduce bureaucratic burden
- Technology/databases

Comments

- FEASIBILITY requires Clinical Trials Network and \$\$\$

#2 Novel approaches using existing medications or new agents (conventional or non-conventional)

Research response (research activities)

- Development and evaluation of new AV agents
- Develop clinical trials networks

- Ethics discussions
- Role of adjunctive therapies
- Health services research to improve drug delivery
- Optimal dose and duration/delivery of existing AV

Infrastructure/capacity gaps

- Clinical trials network

Comments

- Commercially available, novel agents
- Adjunctive therapies

#3 Optimal dose and duration/delivery of existing Antivirals

Research response (research activities)

- Various populations
- Different virusus
- Effect on resistance
- parenteral vs. oral therapy vs. nebulized
- PK/PD studies

Infrastructure/capacity gaps

- Clinical trials network

Comments

- Cross-cutting issue

#4 Utility of Antivirals as a preventive tool

Research response (research activities)

- Efficacy/Optimal duration in high risk populations
- Efficacy in LTC facilities
- Post-exposure Px of contacts
- Management of outbreaks
- Px of school children
- Effect on transmission
- Effect on antibody response
- Effect on viral evolution/shedding
- Resistance
- KAB of HCW, patients, MDs (Px issues)
- Cost-effectiveness
- Modeling of impact (need data)
- Optimal dose and duration/delivery of existing AV

Infrastructure/capacity gaps

- Clinical/Public Health network

APPENDIX 6: ABRIDGED WORKSHOP EVALUATION

The following is an abridged version of the final Evaluation Summary Report for the Influenza Research Priorities Workshop, held in Ottawa on August 31 and September 1, 2005. A complete version of the evaluation, including participant comments, can be requested of the Immunization and Respiratory Infections Division (IRID) of the Public Health Agency of Canada.

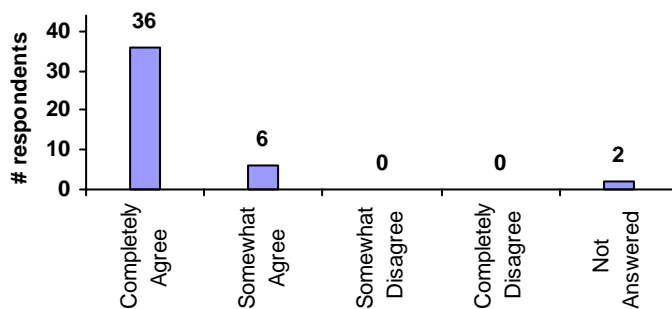
Evaluation results:

At the conclusion of the workshop, participants were asked to complete a two-page evaluation form to provide feedback and rate various aspects of the workshop, including: plenary presentations, break-out sessions, overall process and objectives, logistical arrangements, and facilitators preparedness. Participants were also asked to comment on gaps in the workshop and suggest improvements for future research priorities workshops.

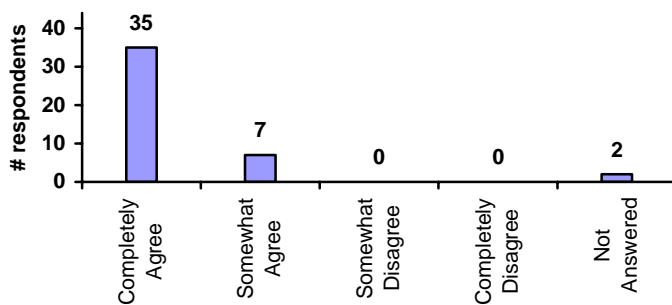
The evaluation was distributed to 74 workshop participants, and 44 people completed and returned the evaluation, reflecting a 59.5% response rate.

Plenary sessions:

“The plenary session topics were appropriate and useful for a basis of discussion.”



“The time allotted in the plenary sessions was sufficient.”



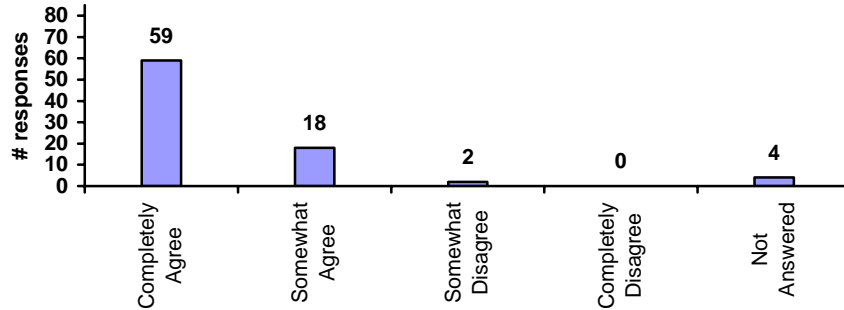
Break-out sessions:

For the questions pertaining to ‘Break-Out Sessions’, respondents were asked to specify which 2 of the 6 break-out groups he/she attended.

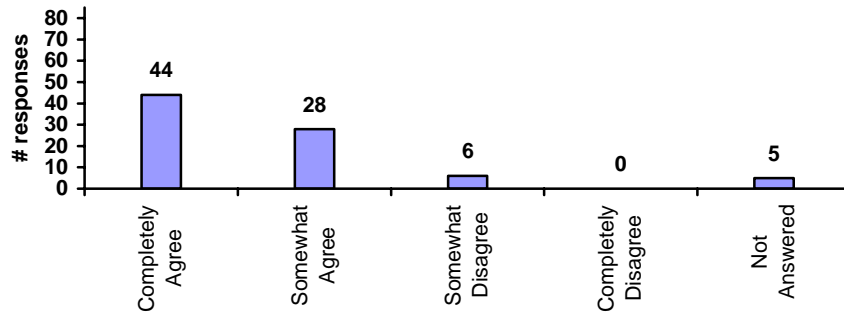
The number of respondents who submitted an evaluation, by break-out is as follows:

Break-out session	A	B	C	D	E	F	Not specified	Total
# Responses	14	13	12	15	12	13	4	83

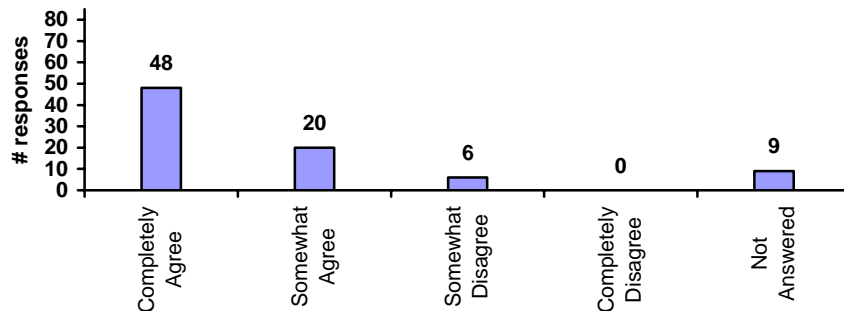
“The break-out session moderators were well prepared to facilitate the discussions and meet the objectives”.



“The number of participants and level of expertise was appropriate for interactive discussions in the break-out session.”



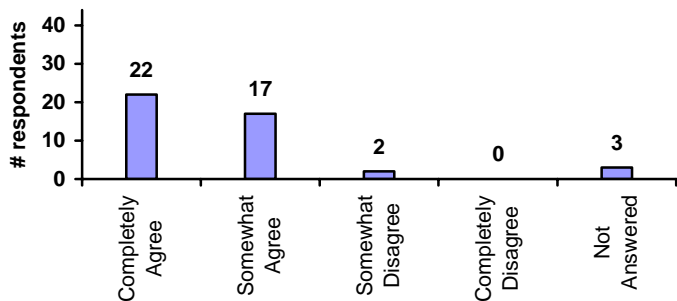
“The summary presentations from the break-out sessions covered appropriate topics to inform the selection of research priorities.”



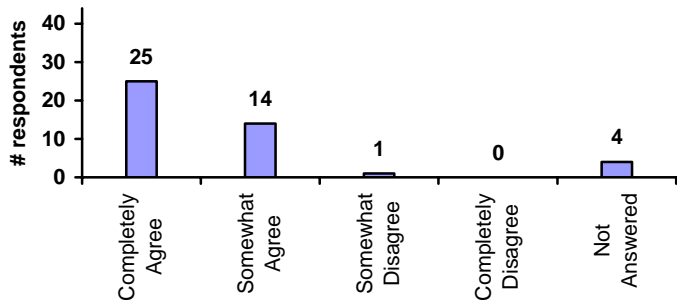
“The time in the break-out session was sufficient to make appropriate recommendations”

Day 1:

Note: This question is categorized into respondents (n=44), since all participants were in the concurrent break-out sessions for the same amount of time.

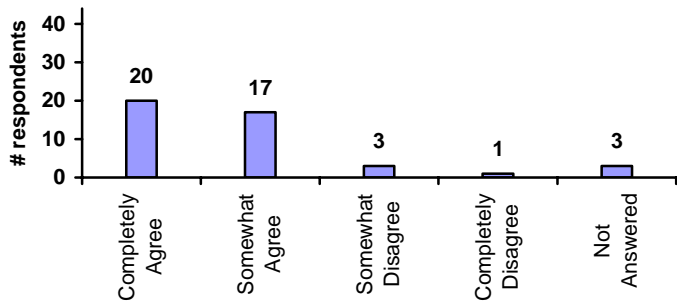


Day 2:

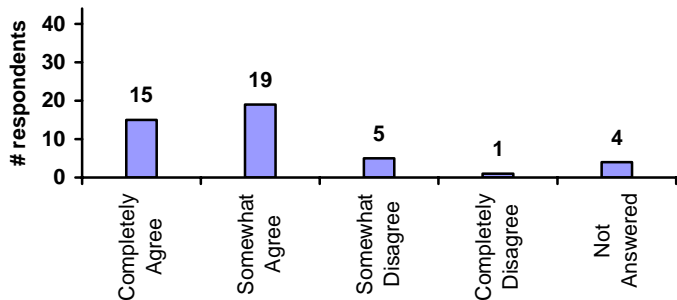


Overall:

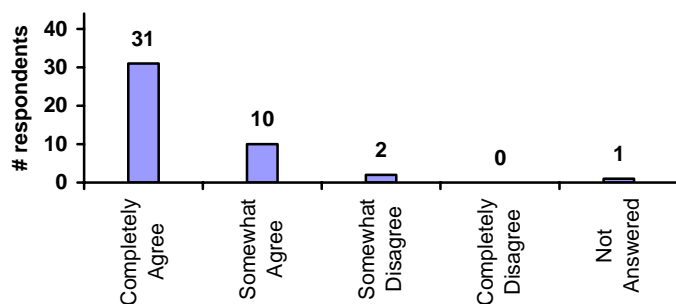
“The overall process in developing consensus on research priorities for influenza was appropriate.”



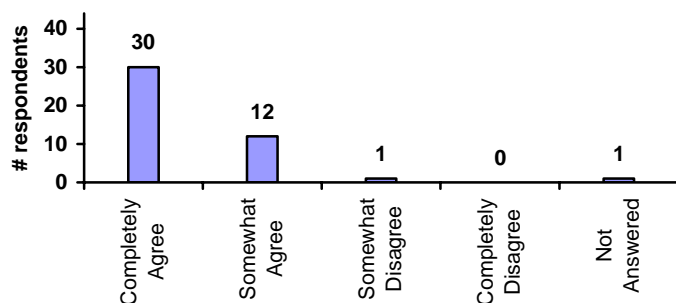
“In general, the overall objectives of the workshop were achieved and distinct next steps were identified.”



"The logistical arrangements were adequate i.e. venue/hospitality/presentation material/ room set-up etc."



"The Facilitators were well prepared to moderate the discussions and meet the objectives."



Analysis of Participant Comments:

In general, participants commented very favorably to the format of the workshop, the networking opportunities, and the plenary presentations were well received. Participants felt that the workshop resulted in a very comprehensive summary of the necessary research areas for pandemic and inter-pandemic preparedness. The logistical arrangements and details were rated very high as well. Some commented that a plenary session focused more on the ‘real’ threat of a pandemic may have resulted in pandemic-related research being placed higher on the priority list. There was also a suggestion that we separate pandemic from inter-pandemic as the urgency for these periods differs.

Future workshops will need to make more effort to ensure all participants (in break-out sessions and in plenary) actively participate. There were some comments that groups may have felt overwhelmed by strong personalities in break-out sessions, and that the reporting back sessions needed more discussion.

The criteria rating for the priorities seemed unclear to some participants and the ranking was rather arbitrary. There was some question as to the appropriateness of seeking “consensus” at a research meeting where the participants are from various backgrounds and specialties.

There were several comments on the need to further synthesize and prioritize within the list of ten priority areas, as this list is too exhaustive and would require levels of funding that is not feasible in the current Canadian environment. The list requires some further analysis to identify short and long term priorities as the list (as it stands) is “unactionable”. Participants identified the need to discuss funding research infrastructure and research initiatives in the next steps, as well as the need to conduct further ranking of the bullets within the prioritized items.

Many respondents requested a follow-up report of the synthesized material.

APPENDIX 7: NEXT STEPS

The following next steps were not agreed to during the workshop, but are based on discussion with the planning committee, and feedback in the participant evaluations.

Activity	Timeline	Responsibility
Further analysis to summarize and further define 10 research priority areas, associated research activities and infrastructure/capacity gaps	September 2005	Planning Committee, rapporteurs
Circulate Workshop proceedings to all participants	2006	PHAC
Publish Workshop findings and analysis in manuscript	2006	David Scheifele Theresa Tam
Publicize findings (broadly) and circulate to national and international key stakeholders, decision-makers, funders, such as: NATIONAL: PHAC (Communicable Disease Control Network via PIC, CIC, NACI); other federal agencies Emerging Infectious Disease Network; Infectious Disease Collaborating Centre (Integrated Infectious Disease Strategy); CIHR and its institutes; University and other research networks; Industry (BioteCanada – Vaccines group) INTERNATIONAL: CDC; WHO; Global Health Research Initiative (GHRI) through the International Development Research Centre; CAREID	Ongoing	PHAC, CAIRE, CIHR, workshop participants
Develop strategic approach for funding mechanisms and opportunities and national/international liaison for identified research priorities	2006	PHAC, CIHR