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Original Research

Developing model-based public health policy through knowledge translation: the need for a 'Communities of Practice'

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ABSTRACT

Objectives: The 2009 influenza A (H1N1) pandemic prompted public health agencies worldwide to respond in a context of substantial uncertainty. While many lessons around successful management strategies were learned during the influenza A (H1N1) pandemic, the usefulness and impact of mathematical models to optimize policy decisions in protecting public health were poorly realized. The authors explored the experiences of modellers and public health practitioners in trying to develop model-based public health policies in the management of the 2009 influenza A (H1N1) pandemic in Canada.

Study design: A qualitative case study design based on interviews and other textual data was used.

Methods: Individual interviews were conducted with mathematical modellers and public health professionals from academia and government health departments during the second wave of the 2009 influenza A (H1N1) pandemic (both prior to and following the vaccine roll-out), using a convergent interviewing process. Interviews were supplemented with discussions held during three separate workshops involving representatives from these groups on the role of modelling in pandemic preparedness and responses. NVivo9™ was used to analyse interview data and associated notes.

Results: Mathematical models were underutilized during the response phase of the 2009 influenza A (H1N1) pandemic, largely because many public health professionals were unaware of modelling infrastructure in Canada. Challenges were reflected in three ways: 1) the relevance of models to public health priorities; 2) the need for clear communication and plain language around modelling and its contributions and limitations; and 3) the need for increased trust and collaboration to develop strong working relationships.

Conclusions: Developing a 'Communities of Practice' between public health professionals and mathematical modellers during inter-pandemic periods based on common targeted

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goals, using plain language, and where relationships between individuals and organizations are developed early, could be an effective strategy to assist the process of public health policy decision-making, particularly when characterized by high levels of uncertainty.

Introduction

The worldwide spread of a new influenza A (H1N1) strain in spring 2009 ended another prepandemic era. Soon after the identification of initial clusters infected in April 2009 in Mexico, the World Health Organization raised its pandemic alerts to level 5; and by June 11, it was raised to level 6, indicating a sustained human-to-human transmission of the virus, causing the first influenza pandemic in the 21st century.[1] The pandemic alert lasted until August 10, 2010, although cases of H1N1 were still presenting in the 2010–2011 influenza season, particularly in the United Kingdom.[2] The impact of the outbreak on the global population has been less striking than anticipated. This may have been due to the prompt execution of pandemic plans that included modelling outcomes for preparedness strategies, in addition to within-host factors (e.g., pre-existing cellular immunity) in a sizable portion of the population.[3,4] Nonetheless, despite several postpandemic analyses by different health agencies in Canada about the effectiveness of pandemic responses,[5–8] the contribution of mathematical models in the formulation of such responses remains largely undetermined.

Mathematical modelling is a scientific research approach to generate knowledge that can be combined with evidence to have an impact on policy and practice regarding disease control activities. Experience with novel infectious diseases in the preceding decade provides compelling evidence for the important role that mathematical models could play in guiding public health policy decisions[9–11] as well as in its application to pandemic planning.[12–14] In specific terms, such models can help describe the epidemiological status of the population, estimate transmissibility of the infectious agent and the potential impact of public health responses (e.g., vaccinations, drug therapy, community-based measures, infection control and hygiene practices), highlight risk factors, and identify more nuanced, targeted or geographically specific control strategies.[15] Despite their ability to project optimal responses and identify the most effective intervention strategies, models often rely on requirements that may be challenging for public health to fulfil: 'models lead to policy but have to confront political reality'.[16]

Evaluation of mathematical modelling's capacity to inform public health decision-making have identified that modelling can only make efficient use of available data as opposed to standing in as a substitute for data.[17] Real-time modelling analysis estimates of the 2009 influenza A (H1N1) pandemic in Italy was compared to epidemiological surveillance data once it became available and found that while estimates generally were lower, the predictions were still useful in planning interventions.[18] Although the underlying uncertainty in the nature of a pandemic virus hampers forecasting efforts in real-time modelling, reflections from a 2009 H1N1 Surveillance Working Group found that modelling efforts still were useful in guiding which public health scenarios might have more or less plausibility in terms of planning priorities.[19] Despite this, a recent evaluation has indicated that the public health policy guidance derived from mathematical modelling has never been formally published beyond face-to-face meetings or meeting minutes,[17] making the research reported in this article one of the first attempts to capture these perspectives, albeit from a Canadian context.

Translation of the knowledge accrued with the use of models is often a complex and evolving process. The development of novel methods for knowledge translation therefore remains a key task to enable the application of models within an evidence-based framework for the design and implementation of effective disease intervention strategies. While Strauss and colleagues[20] describe knowledge translation as 'the methods for closing the gaps from knowledge to practice' (p.165), optimal approaches to accomplish this remain an area of active research. The Communities of Practice (CoP) concept could be a useful strategy for model-based policy in managing public health crises including pandemic emergencies.

The CoP concept, initially developed by Jean Lave and Etienne Wenger refers to groups of people who share a concern, a set of problems, or a passion about something they do, and learn how to do it better by interacting regularly.[21–23] A CoP may form organically out of informal interactions or be created intentionally to achieve identified goals. Wegner proposed that there are three interrelated dimensions needed to operate together for a successful CoP to form. Specifically, these include: the development of shared meanings; the need to work collaboratively towards a common goal; and the need for sharing both resources and a common set of 'jargon' within the CoP.[24] A CoP requires three essential characteristics: (i) the 'domain' sets boundaries around who can be a member based on minimum levels of competence; (ii) the 'community' creates the social environment that facilitates learning through interaction; and (iii) the 'practice' is the specific knowledge that is shared.[23] Despite the pervasiveness of social–professional networks in health care, the application of CoP model to health is relatively new.[21] Moreover, its effectiveness has not been documented and there is no clear understanding about how to foster a CoP.[25] Conceptually, a CoP has the potential to overcome traditional barriers between research and practice because it values both research and experiential knowledge.[22]

The objective of this research was to explore the experiences of some modellers and senior public health professionals about the usefulness of modelling during the

pandemic H1N1 response phase through interviews. These interviews were supplemented with larger discussions involving these groups during one international and two national modelling and public health workshops held in 2008, 2010 and 2012.[16,26,27] Based on findings of this analysis of the convergent interviews conducted in this study, it has been argued that establishing a CoP could be an effective approach toward addressing policy questions during an emerging crisis.

Methods

As part of a larger team project (Pan-InfORM: Pandemic Influenza Outbreak Research Modelling) on pandemic preparedness,[28] interviews were conducted with senior public health practitioners and mathematical modellers in academic as well as health policy settings. As the research project had initially been funded prior to the emergence of the 2009 influenza A (H1N1) pandemic, the authors were able to capture responses of different participants as the pandemic evolved. However, the timing of these interviews posed challenges in recruitment due to the intensive nature of the response phase during the pandemic. Eleven individuals were contacted to participate in the interviews consisting of six public health practitioners and five mathematical modellers. Eight people agreed to participate fully in the project: four public health practitioners and four mathematical modellers. As parity was sought between obtaining the perspectives of both mathematical modellers and public health practitioners, and because many of these individuals were actively involved in the response phase, the authors did not engage in further recruitment. Six interviews were conducted during the second wave and two interviews during the postpandemic alert phase. Research ethics approval was obtained by the University of Manitoba Health Research Ethics Board (H2009:201).

In addition to these interviews, three workshops were organized as part of the larger team's integrated knowledge translation framework. The first (prepandemic) workshop was held in 2008 where academics and modellers, and senior level public health practitioners and policy makers, in provincial (e.g., British Columbia Centre for Disease Control, Ontario Ministry of Health and Long Term Care, Manitoba Health), federal (e.g., Public Health Agency of Canada, Health Canada, National Collaborating Centre for Infectious Diseases), the US (e.g., US Centre for Disease Control, US Food and Drug Administration) and international (e.g., World Health Organization, Chinese Centre for Disease Control and Prevention) agencies were brought together to facilitate knowledge exchange across multiple jurisdictional boundaries.[16] The second (postpandemic) workshop was held in 2010 and included several Canadian public health administrators, key decision-makers, and leading infectious disease modellers. The objectives of this workshop were to: (i) evaluate Canada's response to the spring and autumn waves of the novel H1N1 pandemic; (ii) learn lessons from public health responses, and identify challenges that await public health planners and decision-makers; and (iii) understand how best to integrate resources to overcome these challenges.[26] The third workshop was held in 2012 to examine postpandemic responses to research with specific applicability to the health of Indigenous populations in Canada. In addition to exploring respectful engagement with First Nations, Inuit and Métis communities, it aimed to identify gaps in knowledge to be prioritized for further research and evaluation as these relate to protecting the health of indigenous populations that may be vulnerable (due to socio-economic, population demographic, and predisposing factors) to experiencing more severe health outcomes associated with future infectious disease outbreaks.[27]

For the purpose of this study, a convergent interviewing process was followed, which involves a technique that allows researchers to develop general questions requiring participants to provide feedback about what worked well (or not) on the issue under scrutiny. The interview guide involved a series of semi-structured interview questions with the flexibility to probe and explore emerging issues from both the current interview as well as previous interviews. This allowed sufficient flexibility for changing priorities and evolving discourse between wave 1 and wave 2 of the pandemic. The general nature of these questions was designed to have participants introduce what is most salient to them, exploring extensions of these ideas through additional prompting questions (seeking clarification or expansion of an idea from the participant) before proposing other important items raised by earlier participants in the interview process. In this way, the process facilitates the identification of convergence on key issues faster than traditional interview techniques.[29] In convergent interviewing, it is less important to have participants identify the same salient issues; rather, it seeks to determine the issues that arise more often, which enables the discovery of those which may be unique to the set of circumstances experienced by the participants.[30] This is particularly useful when interviewing different groups of participants that may be approaching the topic from different knowledge backgrounds and viewpoints.[31] In this study, participants were asked a series of questions to address perceptions around important aspects that modellers and public health practitioners faced during the 2009 H1N1 outbreaks regarding mathematical modelling and pandemic responses. This process provided the participants with the opportunity to comment on issues raised from the previous interviews.

During the workshops, close notes were taken from different presentations made by contributing participants. Reflections of these workshops and the knowledge translation activities have been documented elsewhere.[16,26,27] In this paper the authors drawn more broadly from these workshops to strengthen the analysis generated by the interviews.

Interview data and associated notes were analysed using NVivo9™.[32,33] Interviews were transcribed verbatim and the accuracy of the transcribed text was verified against the audio-file. Data were analysed in a constant comparative approach.[34] The interdisciplinary nature of the research team served to minimize bias in the results, as the qualitative team members are neither a public health professional nor a mathematical modeller. As part of one's reflexive process and to increase the rigour of the analysis,[35–38] frequent discussions were held with the qualitative project-lead to ensure that the analysis was not prematurely closed, to challenge emerging patterns, and to compare findings from interview data against reflections stemming from the three knowledge translation workshops involving modellers and public health practitioners.

Results and Discussion

Three main challenges to developing model-informed public health decisions emerged through the following themes: 1) models need to be relevant to public health priorities; 2) clear communication and plain language about what models can (and cannot) do is needed; and 3) the importance of developing strong working relationships through collaboration and integration. While these themes are presented separately, they are in actuality, highly integrated and related in mutually reinforcing ways.

Model relevancy to public health priorities

Common threads amongst the participants included the need for clear and practical models to use appropriate data and generate outcomes relevant for stakeholders. Public health practitioners needed models that included clear, scalable assumptions using reliable and available data that reflect the current situation. Modellers were concerned about the appropriateness of the model for public health decision-making, both in terms of the type of model utilized and the issues under investigation.

> *It [a model] needs to address questions that policy makers are raising, not questions that modellers think should be answered. So you need to give it to the policymakers, ask them the questions and then answer those questions. Models developed in collaboration with public health are important to make the work much more applicable and hence taken more seriously, because it is framed in a way that is relevant in terms of practice. (Modeller)*

> *That's the challenge but so important; to match the model to what public health is actually thinking about. (Public Health)*

Clear communication

While having a relevant model is important, understanding what the model communicates is pivotal. Because public health practitioners come from a different background than mathematical modellers, a persistent challenge is the identification of holistic approaches to providing a clear description of what models can (or cannot) show given their potential and limitations. Several participants highlighted the need for an educational component for making policy makers aware of model contributions and limitations based on the underlying assumptions, and input data and information.

> *You need a course in understanding mathematical models for policymakers because they're very complex and public health practitioners need to know how to decide on the most important questions that might be realistically answered by a model. (Modeller)*

These sentiments were also strongly expressed during the 2008 and 2010 workshops that were also held as part of this project.[16,26] Equally important, is the ability to communicate effectively what is behind the model in terms of what it can demonstrate:

> *When you get a bunch of them [modellers] in a room, they'll tear each other apart arguing about the value of this model or this assumption over another and, to me, it seems all very magical and black box. The modelling is a real challenge, but I think it has real potential to contribute. (Public Health)*

> *A model is not a crystal ball. That's really an important communication piece that we need to work on in terms of you know when a model is useful, how it can be useful and why it's useful. The model sweeps a lot of stuff under the rug and how do we communicate with decision-makers you know what's under the rug and why the model can still be useful even though we're making a lot of simplifying assumptions. (Modeller)*

Better collaboration and integration

Both modellers and public health practitioners underscored the need for increased trust and collaboration for successful working relationships, attesting to the need for a 'Community':

> *…you have to develop kind of a rapport and trust with whoever it is that is making the decisions and once you do that I think it's a lot easier to communicate between the two groups [modellers and public health]. (Public health)*

> *I think there has to be an interplay in the level of trust that we didn't really have in [geographic location] between the people doing surveillance and the people doing the modelling; we're all on the same team but doing different tasks. (Modeller)*

Participants expressed that having tools and resources identified before a severe public health crisis emerges is instrumental to its successful management. Credibility of the individuals working together is paramount to achieve this goal. An important discussion that emerged during this study with public health professionals related to the direct communication between modellers and policy makers for the creation of models that could provide meaningful information to address the needs of end-users. If developed cooperatively based on realistic population and public health assumptions, models could be used to evaluate a variety of different scenarios for optimizing health responses to pandemic emergencies:

> *…part of the problem here is you need the connection with the modellers right from the start; the modellers need to get tied into the correct team. You need the right level of planning so that models can be used at the right time, so that they [public health] are not spinning their wheels doing work that isn't even relevant. And sometimes I hear public health people say "it would be nice to have this modeled" but they don't know exactly whom to ask and how. (Public health)*

> *When modellers and public health folks can sit down to formulate the questions together, clarifying these assumptions and issues can quickly end unproductive lines of inquiry because either the data is not there or the model won't be able to help provide an appropriate set of options. (Modeller)*

In some jurisdictions, there were positive experiences between how models could inform public health decisions. This was partially achieved during the 2009 influenza A (H1N1) pandemic in Canada, particularly with the formation of the Pan-InfORM team that brought together a multidisciplinary team of researchers to develop innovative knowledge translation methodologies and inform policy makers through modelling frameworks that forged strong links between theory, policy, and practice.[28,39] With the involvement of public health professionals, policy decision-makers, and leading infectious disease modellers, Pan-InfORM aimed to apply models and translate the outcomes to improve health policy for implementation of more effective clinical and public health services, and strengthen the Canadian healthcare system in response to the 2009 influenza A (H1N1) pandemic and future emerging infectious threats. In the Canadian context, the outcome clearly indicated a collaborative success, and this was highlighted in the 10th international review report of the Canadian Institutes of Health Research, which recognized Pan-InfORM as one of the two key initiatives established in the pandemic influenza domain in the past decade.[40] The Pan-InfORM provides an example of a 'Communities of Practice' with pandemic influenza as a main focal point.

However, developing this community did not explicitly occur in Canada during the management of the 2009 influenza A (H1N1) pandemic. When the first pandemic wave began in April 2009, and advisory committees were formed, there was neither sufficient time to build new trusting relationships between modellers and policy makers, nor was there time to promote various knowledge translation tools that could be useful for the management of the new pandemic. Teaching people who were not familiar with modelling was not a realistic expectation in the midst of the pandemic. Both modellers and decision-makers felt that the true usefulness of this tool was not fully realized during influenza A (H1N1) pandemic:

> *… it would be really valuable for the modellers and the public health people to meet and assess: "Maybe it [modelling] didn't work this time but where could it have helped us [public health] and is there anything we can do in an inter-pandemic period to help inform us better?" To be frank, that's when you start to create your options. (Public health)*

Relationships needed to be established well in advance. The credibility of the modeller and the confidence in the process of modelling was only as effective and efficient as the relationships that had been previously formed. While Pan-InfORM helped to partially fill this void, its success was a fortuitous attempt of initial knowledge translation strategies as opposed to a designed intervention.

Limitations

This study has several limitations. Given that invitations for interview were extended during the pandemic response phase, it was difficult to increase the number of participants. Although eleven individuals were contacted to participate in the project, only eight agreed to be interviewed. The sample was opportunistic; therefore it is possible that more interviews would have led to diversity of results. Following the main response phase, the authors were not able to expand their interviews, as potential participants were pandemic-fatigued and many other public health priorities that were put on hold given the pandemic situation needed immediate attention. Nevertheless, the use of the convergent interviewing technique that asks subsequent participants to comment on aspects raised in earlier interviews helped to minimize the impact of a low number of interviewees than might have occurred otherwise in a non-active pandemic response phase or using other interviewing strategies. Furthermore, while two of the authors participated actively in all three of the workshops, the authors could not engage all workshop attendees during the breaks and some valuable informal conversations may have been missed that could have strengthened this analysis. To overcome this limitation, all formal presentation slides available for analysis were collected as well as notes from the discussions that took place during the formal periods of the workshops. This additional information helped us improve this analysis of data collected through interviews.

Conclusion

Based on the analysis of interview data and discussions that occurred both formally and informally during three larger two-day workshops, there is an identified need to improve communication and working relationships between health professionals, policy decision-makers and mathematical modellers. Developing an interdisciplinary CoP may be one way to address this gap. A CoP could serve as a more concrete framework to guide collaborative efforts between modellers and public health officials, within which models can be developed as rapidly and flexibly as policy questions are formulated and modified. Forming this CoP involves the identification of key individuals with diverse skill-sets to collaborate effectively. Credibility of the modellers depends greatly on the confidence that exists in their skills as well as the ability to communicate effectively (and jargon-free) about not only what is needed for modelling, but also how the models can contribute in a practical sense. However, communication needs to be bi-directional. A CoP needs to have feedback built into the process. Once a model has been completed, provided that a health intervention or decision is implemented to make evaluation possible, it is important for both modellers and decision-makers to discuss the successes and limitations of the model so that subsequent modelling activities can be informed to more explicitly address the needs of end-users. In this manner, the joint relationship enables the use of evidence to optimally inform decisions that are being made in the face of substantial uncertainty.

The experience of the 2009 influenza A (H1N1) pandemic in Canada provides compelling evidence for the significant impact that models can have on health policy and practice.[41–43] Developing a CoP as an explicit intervention is a primary objective in the knowledge translation portion of the current Pan-InfORM initiatives aimed at protecting vulnerable Canadian populations from emerging infectious diseases, an

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Author statements

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Ethical approval

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Competing interests

The authors declare that they have no competing interests.

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