Using systems thinking methodologies to address health care complexities and evidence implementation

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ABSTRACT

Background: Despite health care advances, artificial intelligence and government interventions aiming to improve the health and wellbeing of citizens, huge disparities and failures in care provision exist. This is demonstrated by the rising number of medical errors, increase in readmission rates and mortality rates, and the failure of many health systems to successfully cope with events, such as pandemics and natural disasters. This shortfall is in part because of the complexity of the health care system, the interconnectedness of various parts of service, funding models, the complexity of patients' conditions, patient and carer needs, and the clinical processes needed for patients via multiple providers.

Objective: The objective of this paper is to describe the use of system thinking methodologies to address complex problems such as those in the public health and health services domains.

Method: A description of the system thinking methodology and its associated methods including causal loop diagrams, social network analysis and soft system methodology are described with examples in the health care setting.

Results: There are various models of knowledge translation that have been employed including the Joanna Briggs Institute model of implementation of evidence into practice, the triple C, and the Promoting Action on Research Implementation in Health Services. However, many of these models are neither scalable nor sustainable, and are most effective for localized projects implemented by trained clinicians and champions in relevant settings.
System thinking is essentially a modelling process, which aims to create opportunities for change via an appreciation of perspective, and recognition that complex problems are a result of interconnected factors. The article argues that systems thinking applications need to move beyond that of addressing complex health issues pertaining to a population, and rather consider complex problems surrounding the delivery of high-quality health care.

Conclusion: It is important that methods to implement systems thinking methodologies in health care settings are developed and tested.

Key words: causal loop diagrams, complex problems, healthcare, implementation, social network analysis, soft system methodology, system thinking

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What is known about the topic?

- Health care systems are experiencing several unprecedented challenges.
- Despite many advances in health care, there are huge disparities and failures in provision of health care.
- Systems thinking methodologies are largely employed to address complex health problems, while not complex problems involving health care delivery.

What does this article add?

- System thinking methodologies can be useful to address complex and wicked problems in health care and perhaps yield innovative solutions.
- Training can support health managers to utilize these methods.
- Managers, planners, and practitioners who can understand system thinking methodologies are better equipped to address the challenges of health-related problems.

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Introduction

Globally, health care systems are experiencing several unprecedented challenges. For example, the coronavirus disease 2019 (COVID-19) pandemic has put enormous pressure on health service resources and workforce supply, while also contributing to the fragmentation of services.[1,2] Additionally, people in the western world are living longer, which is resulting in an increase in chronic diseases, multimorbidity, and frailty. Several global health initiatives and government strategies were devised to cope with some of these issues.[3] Examples included WHO initiatives into health ageing, cervical cancer, yellow fever, and emergency and trauma care.[4,5] In the United States, federal health initiatives have concerned childhood obesity, diabetes, and health disparities in cancer.[6] In Australia, the Commonwealth government aims to improve health outcomes for all Australians and ensure that the health system is sustainable through a National Health Reform Agreement.[7]

Despite many advances in health care, artificial intelligence and the programs that are initiated by governments to improve citizen health and wellbeing, huge disparities and failures in provision of care exist.[2,8,9] This is demonstrated by the rising number of medical errors, increase in readmission rates and mortality rates, and the failure of many health systems to successfully cope with events, such as pandemics and natural disasters.[1]

There are many reasons why national programs to address health issues are not successful.[2,10,11] A major reason is the complexity of the health care system, the interconnectedness of the various parts of service, funding models, the complexity of patients' conditions, patient and carer needs, and the clinical processes needed for patients from multiple providers.[3,12] The health care system has been likened to aviation, where the cockpit has been compared with the operating theatre, and the plane captain to the surgeon.[13] Over the past two decades, the rate of airplane fatal accidents has decreased whereas the number of flights has increased dramatically. On the other hand, the number of death and errors in the health care systems has increased considerably.[2] Both systems strive for optimizing safety and minimizing risk. Clearly, there is room for health care improvement. To this end, we need to explore innovative methodologies to improve our current health care system.[13] This commentary covers current methodologies used in health care and argues that applying system thinking methodologies to address complex health care delivery problems are worthwhile, and an important step forward.

The current methodologies employed in health care

Several efforts around the world have been employed to improve health care systems.[7,8,14] These have involved changing the hardware and software of systems.[3] Examples of hardware changes include restructuring organizations, upgrading infrastructure, changing financial models, and key performance indicators.[3] Software changes include changing workplace culture and implementing activities/interventions to promote staff wellbeing. These changes are generally localized in nature. Adapting implementation science is a software change, which has been applied across health services.[3] There are various models of knowledge translation that have been employed, including the Joanna Briggs Institute (JBI) model of implementation of evidence into practice, the triple C, and the Promoting Action on Research Implementation in Health Services (PARIHS).[15–17] However, many of these models are neither scalable nor sustainable, and are most effective for localized projects implemented by trained clinicians and champions in relevant settings. Furthermore, there is lack of adequate training of those who are involved in delivering health care initiatives which aim to promote service improvement.[15–17]

System thinking methods and health care

Our greatest health and social challenges, for example obesity, diabetes,[18] and homelessness,[19] are regarded as complex problems. These are problems which lack a clear cause, are the responsibility of multiple stakeholders, and addressing them largely require a change in behaviour.[20] Complexity theory has increased in popularity over the last two decades as a way forward to account for the intricacies found in health care.[3,10,21] Despite our most significant health issues being complex, health, and social policy,[20,22] and health care delivery has been characterized as following antiquated linear methods, which fail to address complexity. Systems thinking approaches, approaches which recognize that factors relating to a problem are connected and dynamic, are considerate of diverse perspectives, and are aware of boundaries surrounding issues, have been identified as the ideal approach to address complex problems.[20] The authors affirm that systems thinking methods can be opportune when employed to address health service issues.

Health service and health care management is rife with its own set of complex problems.[23] In their review, Rusoja *et al.*[26] synthesize evidence affirming that health care complexity is because of the complex nature of health problems and social determinants of health inequities, in combination with health service issues

(including training, structures, and policies and procedures). Yet, systems thinking approaches have seldom been used to address the complex problems specifically regarding the delivery of health care.

System thinking is for the most part characterized as a modelling process that involves turning qualitative conceptual models into a quantitative simulation where stakeholders are key to any project or a problem under investigation.[24] (This is not to negate that qualitative systems thinking approaches exist.[25]) Systems thinking is generally recognized as a sense making process that includes three domains: interrelationships, perspectives, and boundaries.[25] Interrelationships recognizes that things, elements, variables, and/or factors within a system are connected and that an intervention, process, or program to amend one has an impact on others within the system. Perspectives involves recognizing that different stakeholders/groups 'see' the system and/or issue (or elements within the system) in different ways and as a consequence have differing understandings of the system, issue, and/or ways to address the issue. Finally, boundaries involves recognizing that there is a boundary, which establishes which things, elements, variables, and/or factors are within the system under consideration, or external to the system.

A recent systematic review by Rusoja *et al.*[26] highlighted the lack of consensus on key terms, methods, resources used within system thinking methodologies, and complexity theories. The authors identified a total of 515 articles published between 2002 until 2015. Most of the articles were listed in medicine/healthcare, followed by public health, health policy, and management journals. Systems thinking methods were mentioned in reviewed manuscripts 259 times, with System Dynamic Modelling ($n = 58$), Agent Based Modelling ($n = 43$), Causal Loop Diagrams ($n = 43$), and Social Network Analysis ($n = 37$) making up the majority of the methods employed. The authors are of the opinion that there is potential for these methods to be used by planners and health managers to provide an alternative method to address challenging problems the health care system is currently facing. Examples of these include the increased health cases aligned with the COVID-19 pandemic, chronic health conditions, and mental health issues.[18,26] Some of the methodologies detailed by Rusoja *et al.* 2018 have been summarized below.

Social network analysis

Social network analysis (SNA) is a method that depicts unclear means of collaboration, communication, and information flow between many actors (health care networks, teams, or individuals).[27] SNA has been used to examine the interaction and collaboration between individuals and groups and the impact of their connections on health outcomes affecting a population in question. It has been used by social movements as a method of analysis. It is founded on the idea that a network structure has an impact on health outcomes and behaviours.[27,28] For example, the case of obesity prevalence in a particular group of people relies on multiple connections, which may be interconnecting over a long period of time that involve both diet and exercise. Various types of social network data exist, including egocentric data (based on individuals), sociometric (based on sociographic data), and quasi-network data (based on social relationships). The data collected are dependent on the question. Examples of data collected could be related to the types of people a patient goes to ask for a particular advice and how these people are interconnected. The measures used from these data include the positions of the individuals within the network, the density of each member, and the distance between them in a resulted map. For example, van Beek *et al.*[27] in 2011 investigated the advice seeking networks among nursing staff working in long-term care units and how this was related to job satisfaction. In relation to health care, the approach could be used to investigate the level of coordination and collaboration between health services, and the association with collaboration on patient outcomes.

Causal loop diagrams

A causal loop diagram (CLD) is a translational diagram clarifying the interrelation and connection between direct and indirect factors contributing to a complex problem.[29] Factors and their relationships can be developed by diverse methods including consultation with stakeholders, a review of the literature, and/or a predetermined theory. The set of notation and best practices when constructing causal loop diagrams has been detailed by Kim.[30] In part, the aim of a CLD is to establish leverage points for intervention to promote change. As a practical example, consider the CLD 'Social isolation and loneliness during COVID-19' included as Fig. 1. In addition to directional arrows within the diagram, 'O' and 'S' notations clarify where variables, respectively, move in the opposite or same direction as the variable they are affected by.

As clarified in the diagram, for ageing adults, having a larger social network, being satisfied with communication experiences,[31] increased interactions with people,[31] being employed prior to the pandemic,[32] and being married or in a relationship, and/or living with someone[32] all reduce social isolation and loneliness. Having

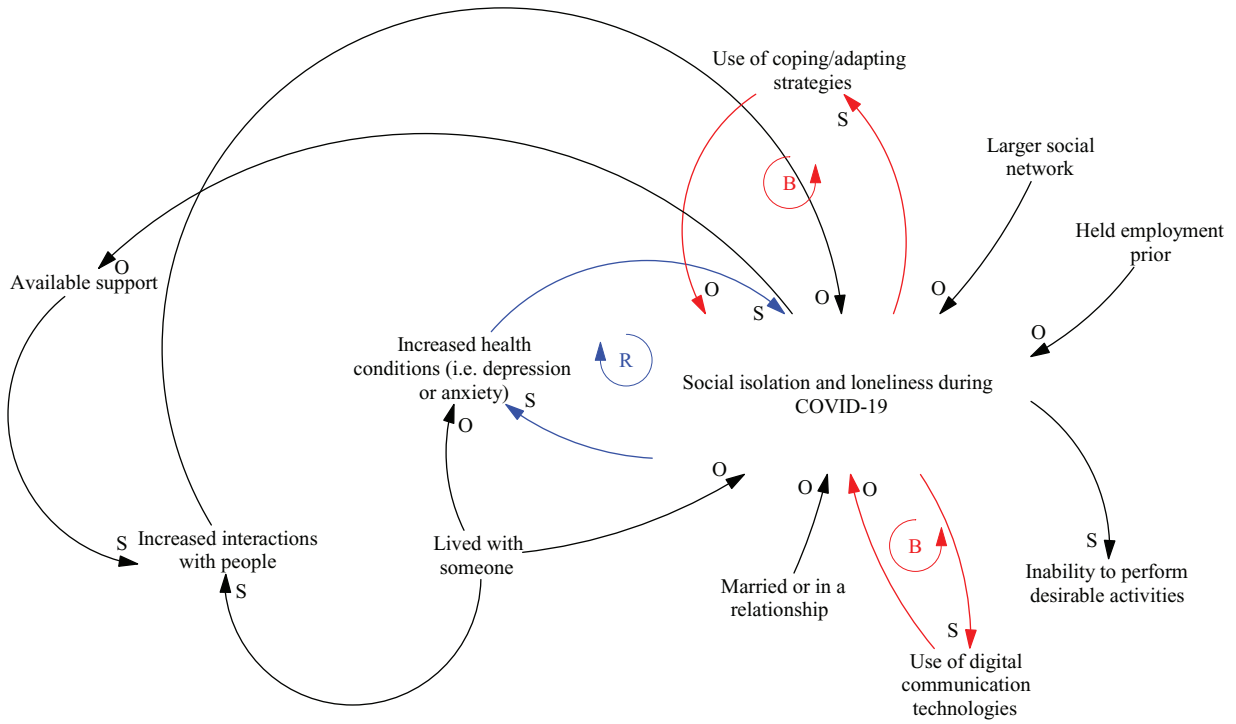

Figure 1. Social isolation and loneliness during coronavirus disease 2019.

increased support increases interactions with people,[31] which can reduce social isolation and loneliness;[31] however, increased social isolation reduces the availability of support.[33] Additionally, increased social isolation limits the ability to perform daily activities.[34] The CLD includes a single reinforcing loop and two balancing loops. A reinforcing loop (clarified in blue) exists between social isolation and loneliness and health conditions where increased health conditions[31] – including depression,[32] and anxiety[35] – increase social isolation, while increased social isolation increases these health conditions (e.g. anxiety[35]). In relation to balancing loops, social isolation and loneliness promote the development of coping and adapting strategies[34] and the use of digital communication technologies.[34] It is assumed that employing coping and adaptation strategies and the increased use of digital communication technologies reduce social isolation and loneliness, thus balancing loops between these variables and social isolation exist (clarified in red). Leverage points identifiable within the social isolation and loneliness during COVID-19 CLD pertain to modifiable factors, which can reduce social isolation and loneliness. In this respect, providing education and resources to support the development and implementation of healthy coping and adaptation strategies for people approaching their end-of-life, and their carers, would be advantageous. Similarly, programs which can increase the social network of people approaching the end-of-life may also work to reduce isolation and loneliness during COVID-19. In relation to health care problems, this CLD approach could be employed to establish the diverse health service-related factors, which contribute to medical errors, misdiagnosis, and/or readmission rates. In this respect, collecting the perspectives from clinicians, and health service managers via a set of interviews and/or focus group discussions could be mapped within a CLD and establish the interrelationships between diverse factors and their relationship to a key problem.

Soft system methodology

This methodology was initially developed by a systems engineer in which people are involved to bring in various perspectives on a particular problem. This can be undertaken in a workshop where participants get asked about the value of a particular service from the perspective of various stakeholders. Central to the approach is establishing a root definition (where key stakeholders and issues are clarified) and a rich picture of the scenario from multiple perspectives.[25] Martin and O'Meara[36] in 2020 recently applied this method to explore key stakeholders, perspectives about the value of community

paramedicine in rural Australia. The results of this study identified several barriers for implementation of the proposed community medicine model largely because of the lack of understanding of the concept amongst stakeholders. The soft system methodology facilitated the engagement of various stakeholders, promoting their inclusion, and highlighted the value of their perspectives.

Moving systems thinking beyond health problems, to problems in health care delivery

Applications of systems thinking methods need to move beyond considering health issues as complex problems and consider the delivery of high-quality health care as the complex problem requiring interrogation. In this respect, those applying systems thinking approaches need to adhere to characteristics of systems thinking – for example, appreciating perspectives, acknowledging that there are interdependencies between factors/variables, and being aware of boundaries[25] – and in relation to problem definition, recognize that the conceptualization of problems differ, for different stakeholders with differing perspectives. For example, research has established that culturally and linguistically diverse (CALD) people can be unfamiliar with health services and experience access difficulties.[37] This issue – the issue of health disparities and/or health service access issues among CALD people – has typically been regarded as a complex problem, which systems thinking methods have been used to address. In the context of refugee and asylum-seeking people, this work has been exceptionally valuable as it has identified the diverse interrelated set of factors, which contribute to health outcomes.[38] However, as barriers to health service access and health services, which do not meet the distinct needs of CALD people, are identified as contributing to adverse outcomes among CALD people and refugee and asylum-seeking people, it is necessary that the complex problems which systems thinking methods address are re-considered. In this respect, considering the perspectives of end-users pertaining to problem definition may affirm that it is important to address the health service side of the issue, perhaps around ensuring high-quality care for CALD people, may be opportune. The use of systems thinking methods towards this aim may yield innovative solutions.[39] Health service researchers and practitioners are beginning to utilize systems thinking methods to address the health service-related side of the problem. For example, Parmar *et al.*[39] involved government workers, community health volunteers, refugee patients, and non-government organizations in a CLD workshop to establish how community health volunteers could address diabetes and hypertension among refugee and asylum-seeking people. The approach produced strategies to involve community health volunteers to promote refugee and asylum-seeking health were identified.

Ensuring that systems thinking methods are widely employed within health care settings to address healthcare related problems requires a shift in the way leadership and the management within health services operate. Embedding systems thinking within health services requires the development of system thinkers and system leaders.[25,40] Those who are able to consider diverse perspectives recognize that complex issues have no single solution, and that problems are dynamic and ever-changing.[25] Furthermore, it involves ensuring that leaders are provided opportunities to develop an understanding that systems thinking is a sense making process where interrelationships, perspectives, and boundaries are integral. Trbovich[40] provides five strategies to promote systems thinking within healthcare organizations including: developing an evaluation to understand system wide effects of an intervention or process (with the aim of capturing unintended consequences), and building safe environments where dialogue and critical reflection is respected opposed to reliance on well-established cause-and-effect relationships. Increasing systems thinking as an education component throughout clinical and health service management training[41] can, in part, work towards ensuring better uptake of the systems thinking methods in health service delivery. Such training should prioritize content focusing on complex problem classification, well established systems thinking approaches with a proven track record in addressing complex health and social problems, and critical thinking exercises, which align with systems thinking leader competencies.

Conclusion

System thinking might present a way to address complex health care delivery problems where many stakeholders are involved and where factors contributing to a problem are dynamic and interrelated. Clinician and health service manager training is critical towards ensuring its application within health care settings. Additionally, it is important that methods to implement systems thinking methodologies in health care settings are developed and tested.

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Conflicts of interest

The authors report no conflicts of interest.

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