A framework for developing open source economic models of mental health systems

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Abstract

Summary: There is strong in principle support for open source health economic models, but practical barriers limit their availability. We propose a set of principles and standards for the implementation of open source health economic models that are TIMELY - Transparent, Iterative, Modular, Epitomised and Yielding. We then describe a software framework that we have developed for developing TIMELY models in youth mental health and illustrate this framework with an open source utility mapping project.

Data: Data

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1 Introduction

Computational models have become essential tools for healthcare policy development [1]. Although influential and widely used, these models routinely contain errors [2], are rarely adequately validated [3], can be difficult to reproduce [4–6] and are likely to be infrequently updated or revised [7]. To help address these issues, there is growing support for greater use of open source health economics models (OSHEMs) that grant open access to and liberal permissions to re-use model source code [8]. However, to date actual implementations of OSHEMs remain rare [9–11]. Barriers to adoption include concerns about intellectual property, confidentiality, model misuse and the resources required to support open source implementations [8,12]. As many health economic models are owned by pharmaceutical companies and consultancies, commercial considerations may also be limiting uptake of OSHEMs [11].

There is also a need to develop good practice guidance for implementing OSHEMs [13]. Adherence to explicit standards is as essential requirement for health economic modelling [1], yet guidence for quality implementation of OSHEMs is currently scarce and piecemeal. Best practice guidelines on health economic model transparency were published ten years ago [14] and made recommendations on model documentation but notably did not include guidance on the sharing of model code and data. More recent and more general modelling guidance [1] does recommend the sharing of model code and data through existing repositories

such as GitHub and Zenodo as well as the use of version control systems such as Git across a project's development lifecycle. A coding framework for OSHEMs developed in the language R includes standardised approaches to directory structure and naming conventions[15].

We have consolidated and refined these and other recommended standards for OSHEMs and developed tools to help implement them as part of a framework for developing an open source model of youth mental health. In this paper, we describe our motivation for developing the framework, the rationale for each standard specified in the framework, the toolkits we have developed and a worked example of a modelling project developed with the framework.

2 Motivation

2.1 Why develop OSHEMs in mental health

Mental disorders impose high health, social and economic burdens worldwide [16,17]. Much of this burden is potentially avertable [18], but poorly financed and organised mental health systems are ill-equipped for this challenge[19,20]. The large and widespread additional mental health burdens recently observed during the COVID pandemic[21] and predicted as a potential future consequence of global heating [22], highlight the need to improve the resilience and adaptability of these systems. To help stem growing demand for mental health services, policymakers have also been encouraged to place greater emphasis on tackling the social determinants of mental disorder[23].

Realising significant improvements in population mental health may in part depend on gaining better understanding of the systems in which mental disorder emerges and is treated [24]. Computational modelling could play an important role in providing these insights, but this may require significant changes in the way mental health modelling projects are funded, conceptualised and implemented.

Currently, mental health simulation studies rarely explore the features and behaviours of complex systems [25], with mental health economic models predominantly addressing issues relating to the affordability and value for money of individual programs [26]. Major mental health reform programs will require the identification, prioritisation, sequencing, targeting and monitoring of multiple interdependent initiatives. Single purpose models that assume static systems, even when sufficiently robust to be formally incorporated into Government resource planning processes, are therefore likely to be inadequate for the decision support needs of policymakers and service planners [27]. Multi-application or reference models [28] that use dynamic systems modelling approaches can provide insights about inter-dependencies between candidate policies and the evolution of the mental health systems planning context [29]. However, as they are intended for multiple-purposes and because propagation errors may be more likely with more complex models [30] such models require greater investments in model transparency and validation [11,14].

The development, validation and maintenance of these more complex models may be simply too onerous a burden to remain the responsibility of a single modelling team. Developing networks of modellers working on common health conditions [13] and collaborations across multiple modelling teams that include the ability to re-use and extend each others work, can make complex modelling projects more tractable [31]. Similarly, more attention to developing partnerships between modellers and decision-makers across the life-cycle of a modelling project can help ensure models are appropriately conceptualised and implemented and improve their practical utility as decision aids [32].

Infrastructure and funding is required to support the mental health systems modelling field address some long-term challenges. The theoretical basis for understanding complex mental health systems is currently weak [33]. Strikingly, it remains unclear why increased investments in mental health care have yet to discernibly reduce the prevalence and burden of mental disorders[34]. The literature about how the requirements, characteristics and performance of mental health services are shaped by spatiotemporal context is underdeveloped [35]. There is insufficient evidence to identify the social determinants of mental disorders most amenable to preventative interventions, and for which population sub-groups such interventions would

be most effective [36]. Modelling projects should be resourced to be routinely updated and refined as new evidence emerges and decision contexts change [37].

Open source approaches and common standards, which have been previously recommended for the development of mental health modelling field [25], have the potential to help address the need for a more transparent, collaborative and sustained approach to mental health system model development.

2.2 readyforwhatsnext

3 Implementation

3.1 Standards

TIMELY

3.1.1 Transparent Models

3.1.2 Iterative Models

3.1.3 Modular Models

3.1.4 Epitomised Models

3.1.5 Yielding Models

3.2 Infrastructure

3.2.1 Technical platforms

3.2.2 Software Development Kit

3.3 Application

Worked example

4 Discussion

MH systems design is not a pharma led project - less concerns about commercial ownership

greater use of these types of models may require adaptation on the part of funders, modellers and decision-makers. T

Availability of data and materials

Ethics approval

Details on ethics approvals go here.

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Conflict of Interest

None declared.

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A Appendix