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.

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1   Introduction

Computational models have become essential tools for health 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 liberal permissions to access and re-use model source code [8]. However, to date actual implementations of OSHEMs are 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 limit the uptake of OSHEMs [11].

There is also a need to develop good practice recommendations for OSHEMs [13]. Adherence to explicit standards is as essential requirement for quality health economic model implementaion [1], but current guidance for OSHEMs is scarce and piecemeal. Guidelines on health economic model transparency were published ten years ago [14] and made recommendations on model documentation but notably not 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 [15] and Zenodo [16] as well

as the use of version control systems such as Git [17]. A coding framework for OSHEMs developed in the language R includes standardised approaches to directory structure and naming conventions[18].

We have consolidated and refined these and other recommended standards for OSHEMs 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 software toolkits we have developed to help meet each standard 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 [19,20]. Much of this burden is potentially avertable [21], but poorly financed and organised mental health systems are ill-equipped for this challenge[22,23]. The large and widespread additional mental health burdens recently observed during the COVID pandemic[24] and predicted as a potential future consequence of global heating [25], 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[26].

Computational modelling could play an important role in developing policies to improve population mental health 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 [27], with mental health economic models predominantly addressing issues relating to the affordability and value for money of individual programs [28]. 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, may be inadequate for the decision support needs of policymakers and service planners [29]. Multi-application or reference models [30] 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 [31]. However, as they are intended for multiple-purposes and because propagation errors may be more likely with more complex models [32] 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 [33]. 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 [34].

The mental health systems modelling field also face a number of challenges that require sustained action over the long term. There are significant gaps in our understanding of the systems in which mental disorder emerges and is treated [35] and the theoretical basis for understanding complex mental health systems is weak [36]. Strikingly, it remains unclear why increased investments in mental health care have yet to discernibly reduce the prevalence and burden of mental disorders[37]. The literature about how the requirements, characteristics and performance of mental health services are shaped by spatiotemporal context is underdeveloped [38]. 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 [39]. Modelling projects should be resourced to be routinely updated and refined as new evidence emerges and decision contexts change [40].

Open source approaches and common standards have the potential to provide more transparent, collaborative and sustained approaches to mental health system model development. Open source frameworks have been previously recommended for the development of mental health modelling field [27] but, as with health economics more generally, OSHEMs are rare. Currently there is only mental health related model (in Alcohol Use Disorder [41]) that is indexed in the Open Source Models Clearinghouse [9,42], though a Major Depressive Disorder reference model for the United States [43] is currently being developed as part of the Open Value Initiative [44].

2.2 readyforwhatsnext

We are currently developing an open source model of the systems shaping the mental health of young people in Victoria, Australia. The model is called readyforwhatsnext and development progress is reported on a project website [45]. The project aims to produce a reference model that can examine multiple potential population level strategies for prevention (in 0-25 year olds) and treatment (in 12-25 year olds) of mental disorders. Our approach to model development is to undertake a number of discrete modelling projects and progressively link them together by means of a common framework. Sub-projects we are currently engaged in include those to develop models of People (synthetic populations of interest describing relevant individual characteristics and their household relationships, choice models for predicting helpseeking behaviour and models to map health psychological measures to health utility), Places (models that synthesise geometry and spatial attribute data to characterise the geographic distribution of relevant demographic, environmental, epidemiological and service infrastructure features) and Platforms (a model to describe the operation of a complex primary youth mental healths service). We have previously undertaken scoping work reviewing economic evidence relating to youth mental helth Programs [46] and also aim to integrate this with the model at a future date.

This needs a framework so....

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

Shiny tutorial [47]

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