



REVIEW

Cost-effectiveness decision modelling in social care: exploring the why, the how, and the what next

[version 1; peer review: 2 approved with reservations]

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Abstract

Context

In social care research economic evaluation has had limited impact, in contrast to other health related areas. However, increasing research funding and policy interest is occurring, including regarding the role of cost-effectiveness decision modelling.

Objectives

We explore why cost-effectiveness decision modelling is informative in a social care setting, how it can and has previously been implemented, and what next steps are needed to ensure consistent, robust, and informative models are produced to inform social care decisions.

Method

This paper consists of an overview of the theoretical added value of cost-effectiveness decision modelling in a social care setting, alongside a literature search summarising the key features of decision models in the current published and grey literature.

Findings

Cost-effectiveness decision modelling in social care is relatively undeveloped with only a few examples identified and minimal methodological research in the area. These studies varied greatly in

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the approaches taken but demonstrate the practicality and value of decision modelling.

Limitations

The pragmatic approach to the literature review may have missed some existing decision models but we consider the findings to be appropriate.

Implications

Cost-effectiveness decision modelling has the potential to play an important role in informing effective, consistent, and transparent decision-making processes in social care. However, methodological developments are needed to standardise the approaches taken.

Plain Language Summary

This article focuses on a method called "cost-effectiveness decision modelling," which can help improve decision-making in social care. Social care provides essential services to people who need help with daily activities due to age, illness, or disability. Even though economic evaluation is common in other areas of health, it hasn't been widely used in social care, where the need for thoughtful use of limited resources is just as important. Recently, however, there's been more interest in using cost-effectiveness models to inform decisions about which services provide the best value for the resources spent.

In this article, we explore why decision modelling is important for social care, how it has been used in the past, and what needs to happen to make it a more reliable and useful tool. Decision modelling brings together information from different sources, like research studies and expert opinions, to help predict the costs and benefits of different services. By comparing different care options, decision modelling can show which services deliver the best outcomes for individuals and the community.

Our review of existing research found that decision modelling in social care is still quite limited, with only a small number of examples available. The studies we found used different approaches, which makes it difficult to compare their results. However, these models show the potential of decision modelling to improve how resources are allocated in social care.

To make this tool more effective, further research is needed to standardize the methods used and ensure that models are robust and reliable. With these improvements, decision modelling could play an important role in helping policymakers and practitioners make better, more informed decisions about social care services.

Keywords

Social care, social care data, economic evidence, decision modelling

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Introduction

The most that can be expected from any model is that it can supply a useful approximation to reality: All models are wrong; some models are useful (Box et al., 2005).

Social care, also known as 'long term care' outside of the UK, provides social work, personal care, protection and social support services to children and adults who are deemed to be in need or at risk due to illness, disability, frailty, or poverty. As well as supporting service users or clients, it can support informal unpaid carers, such as family members of the service user. In the UK, social care receives funding through the statutory (public) sector, however supply is limited and need for care is routinely means tested, resulting in many users self-funding. The voluntary, community, and social enterprise as well as the private sector are important partners for statutory health and social care agencies in providing social care, meaning that public, private, and third sectors are all part of the delivery of social care.

The objectives of adult social care in England, and responsibilities of local authorities in relation to social care, are set out in the Health and Social Care Act (Glover-Thomas, 2013). Key objectives of social care include supporting individuals to remain independent in the community, supporting their dignity, personal choice, and control over their daily lives, as well as supporting social-care related quality of life and safety. More broadly, social care supports the health care system with its role in prevention and reducing health care service use. Alternative outcome measures relevant to social care, such as the Adult Social Care Outcomes Toolkit (ASCOT), ICECAP-O, and ICECAP-A, provide valuable metrics for capturing the broader impacts of social care interventions beyond traditional health outcomes.

The primary purpose of this paper is to identify further research needs in the field of economic evaluation within social care and to provide comprehensive guidance for researchers and practitioners interested in the methodologies of social care interventions. By addressing these areas, the study aims to bridge existing gaps and enhance the robustness and applicability of decision modelling in social care settings.

Cost-effectiveness analysis, the summation of the costs and effects of alternative courses of action, is considered an informative component in the development of National Institute for Health and Care Excellence's (NICE) guidance related to best social care provision in England (NICE, 2014). By seeking to estimate the value gained from resources used to implement an intervention or policy, cost-effectiveness analysis aims to determine the best alternative use of limited resources, and the benefits that would have been gained from taking the alternative course of action.

The challenges of conducting robust cost-effectiveness analysis in social care, in contrast to the other areas such as health technology assessment, have previously been defined and discussed (Bauer et al., 2021; El-Banna et al., 2021;

Suh & Holmes, 2022; Weatherly et al., 2017). The challenges include: defining the objectives of the intervention and services, and relatedly, the complexity of outcomes of interest, the range of stakeholders in the public, private, and third sectors, complexity of interventions, and availability of research and data. These challenges are especially evident when compared to the evaluation of new pharmaceuticals, for which the methodological approaches to conduct such evaluations were originally developed and for which the consideration of health maximisation subject to costs borne by the public healthcare system are considered sufficient (Drummond et al., 2015). Furthermore, reviews of cost-effectiveness analyses of social care interventions (Bauer et al., 2021; Weatherly et al., 2017) reveal that an increasing number are being undertaken in the social care field but with heterogeneity in methodological approaches used, raising the question of limited standardisation of evaluative methods.

Establishing the cost-effectiveness of an intervention, broadly employs one of two approaches with which to generate findings: empirical data analysis from a single study and decision modelling (Drummond et al., 2015). The use of empirical data relies on evidence generated from sources such as clinical trials and observational and routinely collected data. In contrast, in decision modelling the pathways of care are simulated, and multiple data sources used to impute costs and benefits as they are assumed to occur at different decision-making points or key events (Briggs et al., 2006). This method allows extrapolating costs and effects beyond the time-period of an experimental study.

This paper explores *why* cost-effectiveness decision modelling has the potential to be informative in a social care setting, *how* it can and has previously been implemented, and *what next* steps are needed to ensure consistent, robust, and informative models are produced to inform social care decisions. To do so we first introduce decision modelling as an approach, exploring its distinctive features and aims and its conceptual value to informing decision making in social care. Through a purposeful review of existing published models, we consider how decision modelling has been operationalised in social care to date, and finally seek to define a route forward to increase the usefulness and application of decision modelling in social care.

Why cost-effectiveness decision modelling has a role in social care

To evaluate the effectiveness and cost-effectiveness of a commissioning decision it is necessary to understand what the aims and objectives are of all relevant stakeholders and consider how the cost and outcomes of interest to each are impacted by different available commissioning decisions (Drummond et al., 2015). Given the potential for social care interventions to have multiple decision makers, sectors, objectives, and budgets, this can be challenging. Decision modelling can address many of the conceptual and logistical challenges of conducting cost-effectiveness analyses of complex, real-world interventions. Decision, or 'economic' modelling, is a broad term to describe

the use of mathematical analysis to simplify the complexity of real-world situations. In health economics decision modelling has been defined as the use of such analyses to estimate a series of possible health outcomes and resource use implications which would result from alternative interventions (Briggs *et al.*, 2006).

In practice, decision models are created by conceptualising and simplifying a complex reality in which interventions exist, focussing on the areas where a demonstrable difference exists between the alternative course of action. This simplification focuses on a limited number of definable states in which the individual can exist. These may be health states, e.g. pre-frail, frail, and dead, or service states, e.g. living at home, admitted to care home, admitted to hospital. Movement between these states, and the impact of each mode of care being evaluated on these transitions is then estimated, with the outcomes of interest and resource use implications of each state reported. The model can then be 'run' over the time-period considered relevant, and the sum of the outcomes and resource use implications estimated and compared for the competing modes of care.

The approach is commonly implemented to inform the deliberations of a national commissioner of health services where the quality adjusted life years (QALYs) of the treated individual are the primary outcome of interest (Briggs *et al.*, 2006). While a healthcare QALY based model may not be of primary interest in social care commissioning deliberations, a social care QALY based model might do (Stuttard *et al.*, 2021). Decision modelling as an approach is flexible so long as it is possible to conceptualise and estimate the relevant states individuals may occupy, the costs and outcomes associated with their membership, how they transition between them, and the impact of competing modes of care.

Decision modelling approaches can be argued to have five key benefits in informing deliberations in any setting:

- 1) Bringing information together from multiple sources
- 2) Extrapolating over the longer term, and more specifically into the future
- 3) Making comparisons across relevant interventions – making more efficient use of data
- 4) Characterising and evidencing uncertainty
- 5) Informing multiple stakeholder perspectives

In this section we explore the role of each of these elements related to social care decision making.

Bringing information together from multiple sources

A substantial challenge of conducting cost-effectiveness analysis in social care is the limited availability of evidence which can be considered robust in isolation, although this is improving (Tinelli *et al.*, 2020) Moreover, in social care, evidence is often fragmented across different agencies and

sectors, with data collected independently and for varying purposes. Decision models allow the integration of these disparate sources, including qualitative data, expert judgment, and observational studies, into a unified evaluative framework. This is particularly crucial in cases where traditional health-related metrics (e.g., QALYs) are insufficient to capture the full breadth of social care outcomes. However, decision modelling provides a framework to both synthesise evidence from a disparate range of sources but also to test the sensitivity of the conclusion to changes in the informative data.

Such data may include trial data but could also include routinely collected data, expert opinion, or exploratory scenario analysis where little is currently known about the value of a parameter. Data suitable to inform cost-effectiveness analysis are currently less common in social care, with evidence on best practice having developed in unstructured ways that are experience-based rather than experiment-based (Gould & Kendall, 2007; Shields & Elvidge, 2020; Suh & Holmes, 2022). Furthermore, some have argued that as a field of research social care is not sufficiently developed to meaningfully develop what could be considered unbiased estimates through approaches such as RCTs, necessitating the use of alternative sources of evidence (Rosten, 2020). However, the social care economic evidence base is expanding (Tinelli *et al.*, 2020), more administrative data is available, and methods such as expert elicitation have been developed to inform the necessary structures and parameters of decision models which can be applied to a social care setting (Bojke *et al.*, 2021).

Extrapolating over the longer term, and more specifically into the future

Many of the reasons for providing a service, be it social care or health care, are to improve longer-term outcomes. This may be to strengthen an individual's activities of daily living over the next month, or to improve their chance of being robust to frailty in a decade's time. Decision modelling allows this bridge between intervention today and outcomes over the longer-term to be made explicit, and for any necessary conditions for outcomes to be achieved, made clear. While in social care many of the interventions are designed to deal with immediate care needs, such as personal care, areas of intervention such as home adaptation and reablement services entail intervention now, to support living independently within the community and to improve potential outcomes in the future. While their aim may be to reduce the risk of catastrophic deterioration (requiring hospitalisation or institutional care) rather than any curative intent as is often applied in a health care setting, consideration of effect beyond the initial intervention period represents an important element in considering the value of a service. Social care can also delay access to more intensive services such as residential homes and may facilitate earlier discharge from hospital.

Making comparisons across relevant interventions

Cost-effectiveness analyses which only include a limited set of the full range of competing modes of care risk drawing

inefficient or erroneous conclusions by potentially recommending one option as cost-effective when better options may be available but were excluded from the analysis (NICE, 2013) for example in a two-armed trial which omits other relevant comparators. Decision modelling provides a framework to overcome these challenges through its ability to draw from multiple sources of evidence directly or use methodological approaches such as scenario analysis and meta-analysis.

While not unique to the area, one of the challenges of social care is that it represents a complex set of modes of care, especially compared to pharmaceutical interventions which can easily be characterised into the medication and doses provided. Relevant to this, the NICE Social Care Guidance (NICE, 2013) recommends that all modes of care 'routinely delivered by the public and non-public social care sector' should be incorporated in any economic evaluation. Coupled with the challenges of conducting trial analysis in this setting such a requirement typically would necessitate the use of decision modelling.

Characterising uncertainty

An important strength of cost-effectiveness analysis is its ability to inform decision makers about the level of uncertainty in conclusions drawn. Decision modelling facilitates this through probabilistic and deterministic sensitivity analyses. These approaches draw on information beyond the expected average costs and benefits of the relevant interventions to demonstrate the uncertainty around the conclusion of the evaluation. This uncertainty can be expressed in several ways including the probability of the decision being incorrect, the impact of such a wrong decision, and whether the cost and delay of additional research can be justified to reduce our uncertainty. Evidence to inform such analyses can be drawn from the primary source, for example a trial, wider evidence, or exploratory scenarios. The comparatively limited level of research evidence and level of complexity regarding causal pathways of care evident in social care implies the consideration of uncertainty is of importance.

Inform multiple stakeholder perspectives

To be useful in the decision-making process, cost-effectiveness analysis must reflect the needs of the key stakeholders (Williams & Calnan, 1991). However, defining who the key stakeholders of an evaluation are in social care can be difficult, potentially spanning all sectors of the economy. Social care-related services are delivered by a range of providers, including various public sector agencies, commercial providers, the voluntary and community sector, and unpaid carers. Furthermore, services may be provided in-house or externally contracted, for example with the commissioning of vision rehabilitation services by local authorities (Longo *et al.*, 2020). The costs are also borne by various public sector agencies, service users and their families. As a result, the payer-provider matrix is complex and differs across the range of social care services available; some social care is funded by the local authority, others by service users or a mixture of both, and some social care is provided by carers or volunteers. This is further complicated by often strong correlations between health and

social care activities, for example the lack of social care provision may delay discharge of individuals from hospitals.

By explicitly conceptualising the movement of an individual through a finite number of states and estimating the payoffs as these transitions occur, decision modelling allows the analysis to be re-run from different perspectives. For example, costs borne from a health care perspective can be recorded separately from a social care or a private individual payer's perspective.

How has decision modelling previously been implemented in social care

In England, since 1999, NICE has provided national guidance on the promotion of good health and the prevention and treatment of ill health. Under the Health and Social Care Act 2012 NICE was given additional responsibility to develop guidance and quality standards for social care, making it the first health technology agency internationally to do so. As part of its remit NICE developed a reference case for the economic evaluation of interventions with a social care focus, a generalisable specification of the methods considered appropriate (NICE, 2014). The reference case has been summarised elsewhere, a key finding of which is that compared to HTA guidance, economic evaluation methods guidance for use in social care is much less prescriptive and the range of suggested methods much broader (Bauer *et al.*, 2021; Weatherly *et al.*, 2017). Published systematic reviews have shown that over recent years more economic evaluations of social care interventions have been undertaken, but that the scale is still limited (Tinelli *et al.*, 2020; Weatherly *et al.*, 2017).

The latest general NICE reference case provides some guidance regarding the appropriate approach to conducting decision modelling to inform cost effectiveness analysis (NICE, 2014) and there are existing good practice guides when conducting decision modelling informed cost-effectiveness analysis which have focussed on health technology assessment (Briggs *et al.*, 2006). However, the extent to which these are generalisable to social care is unclear, therefore with the aim of exploring the scale and scope of decision modelling studies in social care we conducted a purposeful review of the literature. The review, conducted between August and November 2023, focussed on published studies, either in peer reviewed journals or research reports, or are listed in the ESSENCE Toolkit (Tinelli *et al.*, 2020).

The ESSENCE Toolkit is a comprehensive repository of economic evaluations and decision models in social care, which enabled us to identify studies directly aligned with our research objectives. It allowed us to focus on decision modelling methods most relevant to social care, particularly in addressing key methodological trends and gaps. Since our goal is to provide insights specific to decision modelling in social care, rather than conducting a broad review of all available research, a purposeful review was sufficient for capturing the most relevant and impactful studies without the need for a full systematic review.

The literature selected are those that met the following criteria:

- 1) Conducted economic evaluations of social care interventions, using the NHS England definition of social care as practical support provided because of illness or disability (NHS, 2021). The broader term of 'economic evaluation' was used to ensure any relevant models which conducted similar analyses such as cost-benefit or cost-consequence were also included; and
- 2) employed decision modelling methods such as decision trees, Markov decision processes, or simulated modelling to estimate the performance of the programme.

We are aware that there is also a literature describing the use of agent-based modelling in social care to, for example, predict social care demand (Gostoli & Silverman, 2019; Gostoli & Silverman, 2022) however these do not extend to cost-effectiveness analyses, nor do they evaluate specific interventions and thus for brevity were excluded from this review. However, they are informative when considering available methodological approaches to decision modelling in this setting. Future research should explore integrating agent-based models to capture the multifaceted nature of social care interventions.

This approach identified 55 studies from an initial search of the titles by criteria 1), with eight being considered relevant to the aims of this paper (Bauer *et al.*, 2010; Bauer *et al.*, 2017; Dixon *et al.*, 2014; Mavranzouli *et al.*, 2014; McDaid *et al.*, 2017; Public Health England, 2018; Tong *et al.*, 2017), one of which contained six independent models (McDaid *et al.*, 2017). The purposeful nature of this review implied pragmatic inclusion and exclusion criteria but broadly the aim was to identify economic evaluations of social care interventions which incorporated some element of a clearly described decision model. We extracted data on key aspects such as the type of decision model used, perspective adopted, time horizon, data sources, measures of effect, uncertainty analysis, headline results, and identified challenges. This systematic extraction process ensured consistency and comprehensiveness in capturing relevant information from each study. The majority of the 55 studies identified as economic evaluations did not incorporate a decision modelling element, consisting of estimates of cost and benefits from primary data sources, for example trials. While not a complete description of the published decision models in social care we consider these eight studies to be an indication of the state of play in the discipline sufficient for the aims of this paper. We conducted a quality assessment of the included studies using the Drummond's criteria to evaluate the robustness of their decision modelling approaches. Despite the purposeful nature of this review, incorporating a quality assessment helps mitigate potential biases and provides a more comprehensive understanding of the existing literature. A summary of the models produced is available in Supplementary Table 1 (Refer extended data)

Supplementary Table 1 demonstrates that there is a wide range of approaches taken to modelling in social care, despite the relatively small number of available studies. Approaches range from relatively simple decision trees exploring outcomes over a short time horizon (Bauer *et al.*, 2010) to individual/client level simulations over the lifetime of the individual (Tong *et al.*, 2017). In general, many of the decision models considered a short time horizon, for example a year, focussing on the period of intervention, with most limiting their horizon to five years or less. This was consistent with the model design and nature of the intervention being evaluated, with the case made that the costs and benefits would only occur over the short term, e.g. support at home services (Dixon *et al.*, 2014) and falls prevention (Public Health England, 2018).

The models included evidence from a wide range of sources, primarily the published literature but also evidence from trials (Cottrell *et al.*, 2018; Mavranzouli *et al.*, 2014), observational data (Dixon *et al.*, 2014), and hypothetical values (Dixon *et al.*, 2014) were used. Most model parameters were drawn from published literature or relevant trial data.

While the more complex models reviewed included extensive uncertainty analysis, including probabilistic and scenario-based sensitivity analyses (Bauer *et al.*, 2017; Cottrell *et al.*, 2018; Tong *et al.*, 2017) the majority of the models focussed on a single base-case analysis. Where it was presented, uncertainty was only explored in terms of impact of the headline results of the analysis with no exploration of advanced modelling approaches such as value of information methodologies or distributional cost-effectiveness analysis, methods which seek to estimate the value of investing in addition research and the differential impact of interventions by socio-economic factors respectively (Weatherly *et al.*, 2017). Additionally, distributional cost-effectiveness analysis, a relatively novel approach in health economics, has begun to gain traction and offers a way to account for equity considerations in social care decision-making. Although not widely adopted yet, its potential to capture the distributional impacts of social care interventions should not be overlooked.

Overall, the published decision models demonstrate the lack of availability of a single appropriate reference case to apply when deciding the optimal decision modelling approach, with a wide range of approaches taken to conduct economic evaluation but importantly no clear logic as to why the different approaches were selected. While reference was made to the complexity of social care decision making in some of the studies (e.g. McDaid *et al.* (2017) and Public Health England (2018)), few attempts were made to reflect this complexity in the decision model, with the focus most often on costs falling on the public sector, specifically NHS and personal social services, and benefits to the intervention recipients. In some cases, a broader perspective was additionally defined as a secondary analysis (Tong *et al.*, 2017), however, the lack of any widely agreed approach to incorporating the wider implications

of social care beyond the public sector cost and health implications makes the extension of any decision model challenging. However, incorporating broader economic evaluation methods such as cost-benefit analysis or cost-consequence analysis could provide a more comprehensive understanding of the multifaceted impacts of social care interventions.

Discussion: what is next for decision modelling in social care?

Economic evaluation is increasingly being applied in social care settings to provide valuable insights to inform the effective and cost-effective use of limited resources. Decision modelling represents a valuable tool to synthesise and analyse data for economic evaluation as it facilitates the incorporation of evidence from multiple sources, the extrapolation of evidence over a longer period than may be directly available, comparisons across all relevant interventions, and the characterisation of uncertainty.

Modelling has been employed in social care programs with examples of highly complex models (Tong *et al.*, 2017) and attempts to incorporate the complex set of stakeholders and relevant outcomes evident with social care delivery in England (McDaid *et al.*, 2017). However, as demonstrated by our review, the overall scale of such models is limited, with only eight separate studies being identified as having implemented decision models relevant to a social care setting. There are many potential reasons for this lack of scale, but key challenges facing decision modelling in this setting can be considered in three elements: contextual, methodological, and evidential (Squires *et al.*, 2016).

In addition to the challenges facing economic evaluation of social care more broadly, and discussed elsewhere (Bauer *et al.*, 2021; Weatherly *et al.*, 2017), the contextualisation of the decision problem and care pathway represents a key challenge for decision modelling in this area. The wide variation in the form of intervention and real-world service provision makes summarising the decision problem in a robust way in the form of a decision model much more challenging in social care, with the risk being the issue is over simplified.

While a key strength of decision modelling techniques is the ability to draw information from a range of sources including trial, observational, and expert elicited data, the complexity of the evidence requirement and relatively limited history of data collection in social care settings, limits the opportunity to conduct meaningful decision modelling in this setting. Efforts are, however, being made to better report and make available routine data in social care (e.g. The Catalogue of Social Care Data (CPEC, 2023)) and to increase the level of funding of research for example by NIHR in the UK (NIHR, 2022).

In recent years there has been significant progress made in methodological developments related to conducting economic evaluation in more complex areas of health and social care provision, for example Skivington *et al.* (2021) provide a framework for developing and evaluating complex interventions

and economic considerations are considered core in determining the comparative resource and outcome consequences of the interventions for those people and organisations affected. They suggest that broad economic approaches to evaluation such as cost-consequence analysis or cost-benefit analysis might be relevant to capture the full range of non-health as well as health costs and benefits across different sectors, and NICE (2013) (2014) also supports use of these economic evaluation approaches of complex intervention. Squires *et al.* (2016) have produced a similar framework when conducting decision modelling applied to public health. However, there are still numerous areas still requiring methodological development including the modelling of impacts across different sectors and spillover effects (e.g. accounting for the network of support including family and friends), the incorporation of social care specific outcome measures into decision modelling, and the relevant opportunity cost threshold in social care.

While these are all issues that have contributed to the limited application of decision modelling in social care it is evident that it is not the fundamental nature of decision modelling to which they apply, rather to the broader challenges of conducting robust evaluations in a social care setting. As the models identified in the pragmatic review demonstrate, the use of decision modelling in social care is both possible and informative to the setting. Modelling is well used in these studies to highlight the potential costs and benefits of interventions and importantly identify where data is lacking (Dixon *et al.*, 2014).

In terms of '*what next for decision modelling in social care*', our review has demonstrated that a range of economic evaluation methods and modelling approaches are being used, applied to social care. The range of methods used is consistent with NICE methods guidance in social care. As a tool for undertaking cost-effectiveness analysis, models offer a flexible and somewhat creative approach to undertake rigorous analysis, using available data to best serve the needs of the relevant stakeholders. However, while the current flexibility in approaches has ensured relevance of each decision model to the setting in which it is applied, care is needed that this is not to the detriment of comparison across the findings of each model. Furthermore, understanding how local authorities interpret the results of cost-effectiveness analyses is crucial. Local authorities often focus on cost savings and resource allocation, which may influence the prioritization of interventions. Providing clear guidelines and training on interpreting CEA results can help mitigate potential misinterpretations and ensure informed decision-making.

Another area ripe for future development is the inclusion of equity and distributional considerations within decision models. Current approaches largely focus on average outcomes, but there is increasing recognition that social care interventions often benefit different population subgroups in varying ways. Incorporating distributional cost-effectiveness analysis into future models would allow for more nuanced conclusions about how benefits and costs are distributed across different

socio-economic groups, ensuring that decision-makers can account for equity when prioritising resources.

Conclusions

George Box's eponymous statement that 'all models are wrong; some are useful' could be argued to never have been as fitting as in the setting of decision modelling in social care, a setting in which complexity and immaturity of data and research combine to limit the ability to create robust decision models. However, as has been shown through the models that do exist in this setting, there is simultaneously significant potential for decision modelling approaches to provide clarity to evaluations in this setting. As increasing research funding (NIHR, 2022), policy interest, and routine data collection develops, decision modelling will represent an important tool in the conducting of economic evaluation.

Data availability statement

No data associated with this article.

Extended data

Figshare: Cost-effectiveness decision modelling in social care: exploring the why, the how, and the what next, DOI: <https://doi.org/10.6084/m9.figshare.27612558.v1> (Huo, 2024)

The project contains the following extended data:

- Literature Table - Summary of existing social care decision models

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

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? **Elizabeth Goodwin** 

University of Exeter, Exeter, UK

Thank you for the opportunity to review this interesting paper on the use of decision modelling in the context of social care. This is a relevant and timely discussion, given the increasing interest in how economic evaluation methods can be applied to complex interventions that may sit partially or wholly outside the traditional “health” arena, and the extension of the remit of NICE to encompass adult and children’s social care. The paper explores the potential role of decision modelling in the evaluation of social care interventions before presenting a review that aims to illustrate the current state of play. This forms the basis for a discussion of key challenges and areas for future research and methodological development. This is a clear and well-written paper, which offers a useful contribution to the growing literature in this area, however I do have some suggestions for improvement.

My primary concern is that there appears to be a mismatch between the content of the review and the rest of the paper; this is an issue that must be addressed to make the article scientifically sound. While the paper is framed throughout as focusing on social care interventions, this focus is not reflected in the studies included in the review. As a result of this, I have unfortunately concluded that the topic of the review has only partly been discussed in the context of the literature, and the conclusions drawn are only partly appropriate. The inclusion criteria for the review state that social care was defined as “practical support provided because of illness or disability”. In the UK, however, the working definition of social care is much more specific, and is typically limited to the types of interventions that may be commissioned or delivered by local authority social services departments. A number of the interventions included in this review, as described in Table 1 and in the original publications, do not meet this definition. For example, the six interventions reported by McDaid et al (2017) are *public health* interventions, the cognitive screening tests (Tong et al, 2017) are conducted by GPs in a *primary care* setting, and supported employment (Mavranzouli et al, 2014) is more likely to fall under the remit of the *Department for Work and Pensions*, eg via Job Centres. This is an important distinction, given that there are fundamental differences between social care and these other sectors in terms of their statutory responsibilities, primary intended outcomes, funding arrangements and evaluation guidelines. As such, it seems to me that this review covers the broader use of cost-effectiveness decision

modelling in the evaluation of complex interventions that sit either partially or wholly outside the health sector (although under this definition it remains difficult to justify the inclusion of the cognitive screening tests), rather than its more specific use in the evaluation of social care interventions. I suggest either reframing the stated aims and focus of the paper along these lines, or limiting the included studies to those evaluating interventions that fall within the generally accepted definition and remit of social care.

Other suggestions:

1. The methods employed to identify papers for inclusion in the review could be reported in greater detail. More information on search terms and strategies, and on the inclusion/exclusion criteria and how these were applied, would strengthen the paper. This could be provided as Supplementary Material.
2. The authors mention using the Drummond Checklist to assess the quality of the included studies, however the findings are not reported. A summary of this in the text would be informative, perhaps supported by an additional Supplementary Table.
3. There are several factual statements throughout the paper that are not supported by citations; please can these be added.

I have also had the benefit of reading the constructive and insightful review provided by our colleagues in Birmingham, and I support the points they have raised. Having said that, I've always been very fond of that George Box quotation, so for entirely non-scientific reasons I do hope that you keep it.

Is the topic of the review discussed comprehensively in the context of the current literature?

Partly

Are all factual statements correct and adequately supported by citations?

Partly

Is the review written in accessible language?

Yes

Are the conclusions drawn appropriate in the context of the current research literature?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Health economics; economic evaluation of complex interventions; measurement of health and wellbeing outcomes. Prior to my academic career, I worked in planning, performance and project management for a local authority social services department.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 16 Jun 2025

Dacheng Huo

Thank you for your constructive review and for acknowledging the relevance and contribution of our paper. Your comments have been very helpful in refining the clarity, scope, and positioning of our work. Below, we provide responses to each of your suggestions.

Scope of the review and definition of social care

Thank you for raising this important point. We agree that conceptual clarity around what constitutes "social care" is essential, especially given the boundaries between health, public health, and social care in the UK context.

In our review, we deliberately based the inclusion criteria on the scope of the ESSENCE Toolkit, a resource developed by the NIHR School for Social Care Research to support evidence-informed decision-making in adult social care. The Toolkit uses a broad but policy-relevant definition of social care derived from the National Audit Office (2018) framework, encompassing a range of services that provide practical support due to illness, disability, or age-related needs. This includes not only traditional local authority-provided care services, but also interventions related to housing, support, and community-based services that contribute to social care outcomes and resource use.

We chose to adopt this framework for two reasons:

- First, the ESSENCE Toolkit is a curated, peer-reviewed source specifically intended to inform adult social care policy and commissioning decisions in England, making it directly relevant to our research aims.
- Second, the definition used in ESSENCE reflects the operational reality of social care delivery, where services are often delivered in partnership with or overlap with other sectors (e.g. health, employment, housing). These interventions, while not always under local authority remit, are frequently commissioned to improve outcomes for social care service users.

We acknowledge that our original manuscript did not sufficiently explain this rationale. In the revised version, we have added a detailed description of the ESSENCE Toolkit and its inclusion criteria, and clarified our decision to use it as the foundation for our review. We have also made it clear that our objective was not to define or restrict "social care" narrowly in legal or administrative terms, but rather to examine the current state of modelling practice as it applies to interventions intended to inform social care-related decision-making.

We believe that this approach is methodologically appropriate and well aligned with the aims of our paper—to understand how decision modelling is being used (or underused) in the broader social care context, and to identify where future methodological work is most needed.

Response to Other suggestions:**1. Methods: search process and inclusion criteria**

Thank you for suggesting more detail on our study selection process. In response, we have expanded the methods section to specify that the review focused on UK-based studies, which used decision modelling methods in the context of adult social care. We also clarified our use of the ESSENCE Toolkit as the main source of included studies, and added further explanation of the search scope and rationale. Additional details on search terms and selection criteria are now provided in the supplementary material to ensure transparency.

1. Quality assessment reporting

We appreciate your suggestion to report the findings of the quality assessment. We have revised the manuscript accordingly. We added the quality result based on Phillips checklist, which is better suited to evaluating decision modelling studies. A summary of the quality assessment is now included in the main text, and a detailed table has been added to the supplementary materials.

1. Supporting citations

Thank you for highlighting the need to reference key statements. We have reviewed the manuscript and added appropriate citations throughout. In particular, we now reference relevant literature to support claims about the strengths of decision modelling—such as its ability to extrapolate long-term outcomes and to integrate evidence from multiple sources through approaches like scenario analysis and meta-analysis.

We are pleased to hear that you appreciated the inclusion of the George Box quotation. We have retained it in the revised version, as we agree it effectively captures the role of modelling in complex systems such as social care.

We hope the revisions and clarifications made in response to your comments are satisfactory. Your feedback has been instrumental in improving the quality, clarity, and focus of our manuscript, and we are sincerely grateful for your contribution.

Competing Interests: No competing interests were disclosed.

Reviewer Report 08 February 2025

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Ian Litchfield

University of Birmingham, Birmingham, England, UK

Melyda Melyda

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Thank you for the opportunity to review this paper on decision modelling in social care. The topic is particularly relevant given the increasing recognition of the need for robust economic evaluations in social care settings. The paper is well-structured and provides an overview of the role of decision modelling in economic evaluation for social care interventions. It highlights the methodological challenges, the current state of decision modelling in the field, and areas for future development.

While the paper is generally well-written and informative, there are a few areas where it could be strengthened.

1. Introduction: The opening quote, while insightful, does not clearly tie into the discussion that follows. Also, while the authors clearly state their objective—to "*....bridge existing gaps and enhance the robustness and applicability of decision modelling in social care settings*"—the

introduction does not clearly define what the current gap is. It would also be helpful to clarify how this review differs from existing reviews of cost-effectiveness analyses of social care interventions (Bauer et al., 2021; Weatherly et al., 2017) and what specific contribution it makes beyond these prior studies.

2. Page 5: The statement, "*While a healthcare QALY-based model may not be of primary interest in social care commissioning deliberations, a social care QALY-based model might do* (Stuttard et al., 2021)," would benefit from further elaboration. It is not entirely clear what the authors mean by a social care QALY-based model in this context and how it differs in application or relevance of the decision model. Would its use impact the decision model discussed in this section?
3. Several claims regarding the benefits of decision modelling require additional referencing. For instance:

On Extrapolating over the longer term, and more specifically into the future section - "*Decision modelling allows this bridge between intervention today and outcomes over the longer-term to be made explicit, and for any necessary conditions for outcomes to be achieved, made clear.*" (page 5)

On Making comparisons across relevant interventions - "*Decision modelling provides a framework to overcome these challenges through its ability to draw from multiple sources of evidence directly or use methodological approaches such as scenario analysis and meta-analysis.*" (page 6)

Providing supporting references for these statements would strengthen the paper.

1. The criteria for selecting the reviewed studies are not entirely clear. It is not specified whether only UK studies were included, what years were considered, or what types of social care interventions were reviewed. The paper also does not specify where the review search was conducted (e.g., databases used, search terms applied).
2. The authors review decision models using the Drummond checklist, but I think the recommended approach for decision models is the Phillips checklist (<https://www.nice.org.uk/process/pmg20/resources/appendix-h-appraisal-checklists-evidence-tables-grade-and-economic-profiles-pdf-8779777885>). I also wonder about the quality of those eight papers that were found.
3. **Page 7:** The statement, "*While reference was made to the complexity of social care decision-making in some of the studies (e.g. McDaid et al. (2017) and Public Health England (2018)), few attempts were made to reflect this complexity in the decision model, with the focus most often on costs falling on the public sector, specifically NHS and personal social services, and benefits to the intervention recipients,*" could benefit from further clarification. It is unclear what the authors mean by the **complexity of the model** in this context. How is complexity being defined, and what criteria are being used to assess it? Additionally, it would be helpful to elaborate on how the authors determine whether a model sufficiently captures the complexity of social care decision-making.
4. The authors frequently discuss social care outcomes but do not elaborate on the findings of the eight referenced papers. Unlike healthcare, where outcomes focus on clinical effectiveness (e.g., survival, QALYs), social care outcomes are broader and more complex, as shown in these studies. This might highlight the need for standardised metrics (e.g., ASCOT and ICECAP) to improve comparability and maybe consistency in decision models use in social care.
5. The review of existing decision models highlights the lack of a standardised approach, but the discussion does not fully explore how a more unified framework could be developed.

Given the variability in modelling techniques and perspectives, some discussion on how consensus might be achieved—perhaps through a core set of recommended methods or guidelines—would be valuable.

Is the topic of the review discussed comprehensively in the context of the current literature?

Partly

Are all factual statements correct and adequately supported by citations?

Partly

Is the review written in accessible language?

Yes

Are the conclusions drawn appropriate in the context of the current research literature?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Health Economics, Health Service Delivery

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Author Response 16 Jun 2025

Dacheng Huo

Thank you for your thoughtful and constructive review. We appreciate your recognition of the relevance and clarity of our manuscript. Your comments helped us refine the focus, improve the transparency of our methods, and strengthen the overall contribution of this review. Below we provide point-by-point responses.

1. Introduction and objective clarity

We have revised the introduction to more clearly define the gap addressed in this paper—specifically, the limited methodological development and inconsistent application of decision modelling in social care economic evaluation. The opening quote is now removed. We also clarified how this paper differs from existing reviews (e.g. Bauer et al., 2021; Weatherly et al., 2017) by focusing on the use of decision modelling itself, the challenges observed in practice, and potential directions for future development. The stated objective has been revised to better reflect this specific focus.

2. Clarification of the “social care QALY-based model”

We have revised this section to explain more clearly what is meant by a “social care QALY-based model.” Specifically, we now illustrate this using the example of the ASCOT tool, which captures domains such as independence, social connection, and control—outcomes that are highly relevant in social care contexts but not covered by conventional health-related quality of life measures. We also added a sentence explaining how decision

modelling approaches can accommodate such outcome structures, provided that relevant states, transitions, and consequences can be appropriately conceptualized.

3. Study selection criteria and use of the ESSENCE Toolkit

Our review solely relied on the ESSENCE Toolkit. In the revised manuscript, we now provide a fuller explanation of why this source was appropriate. ESSENCE offers a comprehensive, policy-relevant collection of economic evaluations in adult social care and is based on a broad yet systematic definition developed by the National Audit Office. We clarified that the review focused on UK-based studies and added further details on databases and search terms.

4. Quality assessment using the Phillips checklist

Following your recommendation, we replaced the Drummond checklist with the Phillips checklist, which is more appropriate for assessing decision-analytic models. We updated the methods section accordingly and added a summary of the quality assessment results in both the main text and supplementary material.

5. Clarifying the notion of “complexity” in models

We did not apply a formal criteria for complexity, as this was not the central focus of the review and may not be appropriate across such a diverse set of studies. However, we revised the discussion to more clearly describe the types of complexity relevant to social care modelling—such as cross-sector costs and benefits, long-term impacts, and the involvement of multiple stakeholders. These issues were considered when commenting on how models reflected the complexity of real-world decision-making.

6. Discussion on standardization and frameworks

We agree that a more unified modelling framework would be valuable. However, proposing or outlining such a framework was beyond the scope of this review. Our aim was to map current practices and identify methodological gaps, rather than to offer prescriptive guidance. We now clarify this intention in the revised discussion and note that future methodological work could build on our findings to support greater standardization in the field.

We hope that the revisions and clarifications we have made are in line with your suggestions. Your feedback has helped improve the clarity and focus of the manuscript, and we are sincerely grateful for your input.

Competing Interests: No competing interests were disclosed.