VALUE IN HEALTH 14 (2011) 768–776

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HEALTH POLICY ANALYSIS

# Development of a Transparent Interactive Decision Interrogator to Facilitate the Decision-Making Process in Health Care

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A B S T R A C T

**Background:** Decisions about the use of new technologies in health care are often based on complex economic models. Decision makers frequently make informal judgments about evidence, uncertainty, and the assumptions that underpin these models. **Objectives:** Transparent interactive decision interrogator (TIDI) facilitates more formal critique of decision models by decision makers such as members of appraisal committees of the National Institute for Health and Clinical Excellence in the UK. By allowing them to run advanced statistical models under different scenarios in real time, TIDI can make the decision process more efficient and transparent, while avoiding limitations on pre-prepared analysis. **Methods:** TIDI, programmed in Visual Basic for applications within Excel, provides an interface for controlling all components of a decision model developed in the appropriate software (e.g., meta-analysis in WinBUGS and the decision model in R) by linking software packages using RExcel and R2WinBUGS. TIDI's graphical controls allow the user to modify assumptions and to run the decision model, and results are returned to an Excel spreadsheet. A tool displaying tornado plots helps to evaluate the influence of individual parameters on the model outcomes, and an interactive meta-analysis module allows the user to select any combination of available studies, explore the impact of bias adjustment, and view results using forest plots. We demonstrate TIDI using an example of a decision model in antenatal care. **Conclusion:** Use of TIDI during the NICE appraisal of tumor necrosis factor-alpha inhibitors (in psoriatic arthritis) successfully demonstrated its ability to facilitate critiques of the decision models by decision makers.

***Keywords:*** bias adjustment, decision model, interactive, meta-analysis, RExcel, software, TIDI



## Introduction

Decision-making systems in health care are increasingly designed in such a way to ensure equity of access and to optimize the use of limited health care resources, and this approach has been adopted now in many countries. To aid the decision-making process, health technology assessments (HTAs) are performed that evaluate both the effectiveness and cost-effectiveness of new technologies compared to existing technologies, resulting in guidance to national health care services. A significant component of HTAs is the economic evaluation that often relies on the development of elaborate decision analytic models [1,2]. Such models require a large number of inputs (related to cost, clinical effectiveness, natural disease history, and/or quality of life), some of which may be obtained from primary data collection, but more often rely on the re-analysis of published or other secondary data [3].

Historically, a two-part approach to HTA has been adopted, where individual parameter estimates are first obtained either directly or by conducting preliminary analyses (e.g., a meta-analysis where multiple sources of evidence exist) and then extracted and input into a decision model, often assuming independence and parametric distributions [4]. More recently an integrated one-step approach has been advocated [4,5] that unifies the two stages described above where all preliminary analyses and the decision model are conducted within a single analytical framework. The main advantages of this integrated approach over a two-stage approach include relaxing the assumptions of independence and parametric distributions, and the facilitation of transparency, sensitivity analysis, and updating. To date this has been achieved by programming all analysis components and evaluating them within a single statistical program. Markov Chain Monte Carlo simulation, as implemented in the WinBUGS package [6], provides an ideal environment for this. However, despite the advantages of such an approach, limitations include 1) lack of a user-friendly interface, and 2) very limited numerical and graphical output facilities. This makes it very difficult for models constructed in this way to be interrogated and fully appraised by non-technical experts including decision makers.

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1098-3015/$36.00 – see front matter Copyright © 2011, International Society for Pharmacoeconomics and Outcomes Research (ISPOR). Published by Elsevier Inc.

doi:10.1016/j.jval.2010.12.002

Decision making on new health care technologies in England and Wales is conducted by the National Institute for Health and Clinical Excellence (NICE). Health technology appraisal documents are produced both by independent academic teams and manufacturers, for consideration by NICE appraisal committees. Having carefully appraised these documents, the committees have to make decisions based on their own informal judgments about the evidence, uncertainty, and assumptions made [7,8]. Often the appraisal documents contain decision analytic models that are probabilistic in nature and thus reflect parameter uncertainty to some degree. However, usually uncertainties exist beyond those quantified in this way (e.g., parameters for which no data exist, structural uncertainties in the decision models). Hence, sensitivity analysis is an important part of the decision-making process and is used to investigate the robustness of the model results across different scenarios. This usually entails analysts anticipating, running, and reporting all possible scenarios that might be of interest to decision makers prior to their discussions. However, where all scenarios of interest have not been anticipated, this can lead to an inefficient process of repeated evaluations as analysts respond to sequential requests from decision makers (or decisions are made without the opportunity to formally conduct the relevant analyses). Therefore, it would be advantageous to allow decision makers, such as the appraisal committees of NICE, to run analyses under different scenarios, ideally in real-time during actual committee discussions.

In this report we introduce the framework concept of a transparent interactive decision interrogator (TIDI) together with an illustrative example implementation. This enhances the integrated one-stage approach discussed above, by incorporating a user interface to control many aspects of the modeling (i.e., preliminary analyses and evaluation of the decision model). It has been designed to help to overcome problems of interpretation, clarity and transparency in the decision process by facilitating critiques of the model structure, assumptions and uncertainty by a broad spectrum of people ranging from the analysts themselves when developing the model through to non-technical decision makers and other stakeholders. TIDI has been developed to be used in real-time by committees such as those at NICE during their deliberations. Hence, TIDI can make the process of evaluating uncertainty more transparent, faster, and more efficient; while at the same time avoiding arbitrary limitations of pre-prepared analyses of a restricted number of scenarios that might compromise its validity. A further technical advancement made possible by this approach is a relaxation of the need for all components of the modeling to be conducted in a single piece of code using MCMC methods. As we describe in more detail below, the TIDI interface can control multiple separate modeling components conducted in packages such as (but not restricted to) R and WinBUGS and coordinate them in such a way to maintain a one-step approach to analysis. This allows the utilization of the strengths of each package while overcoming their individual limitations.

The remainder of this article will 1) describe how TIDI works at a conceptual level; 2) introduce a range of features that can be implemented through an illustrative example decision model; and 3) provide a brief account of our experience piloting the interface at a real NICE technology appraisal committee meeting. The discussion will provide some closing remarks.

While we don't intend this article to present a software tutorial on "how to program a TIDI interface," we do provide all code developed for the illustrative example. The instructions on how to use the interface and how to install necessary software are included in Appendix A, which can be found at doi:10.1016/j.jval.2010.12.002.

## Methods

### *Developing TIDI*

There are a number of software packages available to implement health economic models. Although Excel (Microsoft Corporation, Redmond, WA) is mostly accessible and known to a wider community of nonexperts, decision models designed using Excel spreadsheets tend to be incomprehensible by the nature of the way they are constructed on an underlying spreadsheet. There have also been reports of Excel built-in statistical functions and procedures being faulty [9] or based on nonstandard rules of operator precedence [10]. Hence, we wished to keep the familiarity of Excel and the flexibility it allows for developing graphically appealing and intuitive "point and click" front-end control panels, while implementing the decision model and any subsidiary analyses (such as meta-analyses, modeling of individual level data sets, etc) in packages more suited for these tasks. Thus, TIDI's decision models have been developed in the specialized statistical packages R [11] and/or WinBUGS [5] as we believe these are clearer, more flexible, transparent, and computationally efficient, as well as allowing analysis methods not possible in Excel such as network meta-analysis [12]. However, the use of these specialized packages is entirely "behind the scenes": the Excel-based user interface allows decision makers to have access to features of all components of a decision model developed in R and WinBUGS without a need of knowledge of these software packages. This Excel front-end not only makes it possible to change the assumed values or distributions of the model parameters and re-run models under different scenarios in real time, but can also provide a control over the model assumptions. TIDI can also provide interactive access to supplementary analyses, for example influence analysis that can help to establish which of the parameters have the most impact on the cost-effectiveness estimates, and the meta-analyses carried out to estimate the efficacy parameters. A specific meta-analysis module of TIDI can enable interactive inclusion/exclusion of studies as well as bias adjustment [13] in real time for any such analyses contributing to decision model parameter estimation.

An Excel-based interface, programmed in Visual Basic for applications (VBA; Microsoft Corporation) [14,15], is at the center of TIDI. This allows a range of assumptions to be changed by using graphical controls set out on the Excel spreadsheet. RExcel [16,17], which is an add-in to Excel, provides communication between Excel and R. All data used by the model components can be stored in the Excel spreadsheets and transferred to the R workspace and various actions, for example execution of the decision model or its components, can also be activated using controls located on the Excel spreadsheet. Results of the decision model are then transferred from R back to Excel via RExcel. R also has powerful and flexible graphical capabilities, and output can be represented graphically in Excel using custom plots created "on the fly" in R (a tutorial on how to construct a simple Excel interface linked to R code can be found in the RExcel manExcel interface linked to R codeual with "demo" examples provided by the authors of RExcel with the download of the software).

Having this possibility of running programs developed in R from Excel allows the user to take this further and to execute (from Excel) additional model components, including complex evidence syntheses developed in WinBUGS [18]. This is achievable by using the R2Winbugs package available in R [19]. R2WinBUGS provides additional R commands that make it possible to specify (in the R code) all data and parameters necessary for the WinBUGS code to run. In this way, using RExcel, data required to run WinBUGS code can be passed from the Excel spreadsheet to the R workspace from which R code (run from Excel via RExcel) sends it to WinBUGS together with the instructions on how to process these data. This framework for the transfer of data and commands between different pieces of software