Information Graphics
in
Health Technology Assessment

Submitted by William Marck Stahl-Timmins of the Peninsula Postgraduate Health Institute to the Universities of Exeter and Plymouth as a thesis for the degree of Doctor of Philosophy in the visual presentation of health technology assessment data and information, January 2011.

I certify that all material in this which is not my own work has been identified and that no unchanged or acknowledged material has previously been submitted and approved for the award of a degree by this or any other university.

Signed:

(Will Stahl-Timmins)

Preface

Initial navigation and reference sections. Please use the coloured tabs that can be seen on the right-hand edge of the book to navigate to and from these sections as necessary.

Chapter 1: Introduction

Introduces the terms 'information graphics' and 'health technology assessment'. This chapter also sets the research questions for the rest of the thesis.

Chapter 2: Methodology

A discussion of the methods used in the research domain of the thesis.

Chapter 3: Context

Examines the current use of, and needs for, information graphics in HTA.

Chapter 4: Design

Shows practical examples of the specification and development of information graphics, for use in HTA.

Chapter 5: Prototype test 1 (GOfER)

An empirical study to evaluate GOfER, a systematic review overview graphic, specified in Chapter 4.

Chapter 6: Prototype test 2 (SOC)

A second graphic, SOC, for time-based overview of a Markov model, is evaluated using similar research methods to those in Chapter 5.

Chapter 7: Discussion

Ties together results of preceding chapters, offering conclusions drawn from combined findings of all studies in the thesis.

Chapter 8: Appendices

Supporting material such as interview scripts and transcripts, as well as multiple-page information graphics which would disrupt the flow of the text. A methodological study is also recorded here, which informed the development of this thesis, but the results of which are not essential to understand the arguments herein.

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0.3 Abstract

This thesis addresses the question of the design, production and use of information graphics in health technology assessment (HTA). Drawing on previous research in both information design and health policy, it describes a comprehensive design process for creating new visual presentations that can inform health policy-makers.

The thesis begins by introducing, and functionally defining the terms 'information graphics' and 'health technology assessment' in Chapter 1. It then offers a methodological discussion of how research can be performed at the intersection between these two diverse fields. This discussion forms Chapter 2 of the thesis.

The context of use is surveyed in two studies, which are presented in Chapter 3. These assess the current use of information graphics in HTA, and the information needs of health policy decision-making bodies. This enables a needs-based approach to the design of 10 information graphics, that could be used in HTA. These are shown in Chapter 4.

Finally, two of these information graphics are empirically tested with two further research studies, forming Chapter 5 and Chapter 6.

The thesis is aimed at giving practical advice to those wanting to produce graphical presentations of information in HTA, and to provide the foundation for further original research in information design and HTA. Chapter 7 draws together the research from the rest of the thesis, to make recommendations in light of the combined findings.

0.4 Thanks

This PhD thesis is not the work of one person, but of many. Without the assistance of the following people, the volume would be much diminished:

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External contacts

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Peter Jones	and the other staff and students at Plymouth's BA (Hons) Graphic Communication with Typography course, for giving me a platform to begin to develop my teaching skills. I found even a small quantity of teaching support exhausting but enormously rewarding. I was very pleased to be able to play a tiny part in the creative development of such engaging and interesting young minds.
The participants in my studies: **The NICE technical advisors** **The researchers at PenTAG and ScHARR** **The hundreds that took part in the online study**	I wish that I could name you all without breaching the terms of my ethical research permission from the university. Without your input, I would have no research on which to base this PhD. Thank you for offering your time, insight, encouragement, suggestions and expertise.
HTA researchers worldwide	You do challenging, sometimes misunderstood, but greatly important work. I feel privileged to have come to understand a little about your field.
Information designers	Lastly on this list, but in no way last in my mind, I would like to thank those that have taken it upon themselves to inform and explain using visual communication. Thank you for helping to make my life colourful, fascinating, and full of beautiful information graphics.

0.5 Author's declaration

The six original research studies presented this thesis, in Chapters 3.1, 3.2, 4, 5 6, and Appendix A, are all my own work. Two studies have been published as joint works, which require a statement of my involvement in the research:

Pitt, M., Stahl-Timmins, W., Anderson, R., & Stein, K. 2009, *Using information graphics in health technology assessment: Toward a structured approach,* International Journal of Technology Assessment in Health Care, vol. 25, no. 04, pp. 555–563.

The content analysis research for this study was performed by myself at an early stage of my PhD. All data collection, analysis and visual presentation of data were performed by me. The idea for the study was, however, that of my Director of Studies, Dr Martin Pitt. He also produced the original draft of the paper, using sections from a report on the study written by myself. The other two authors and myself each made comments on the draft before submission.

Stahl-Timmins, W., Pitt, M., Peters, J., Stein, K. & Anderson, R. 2010, *Graphical presentation of data for health policy decisions: An exploratory online decision task experiment to measure effectiveness,* Information Design Journal, vol. 18, no. 3.

The research study was designed, programmed and analysed entirely by myself. Statistical work and graphical presentation of results were also carried out by me. I also drafted the paper, which the other authors were kind enough to comment on and edit. Dr Peters checked the statistical work, but did not make any major revisions.

0.6 Definitions

Appraisal Committee (NICE) – The meeting at which guidance on the use of a health technology in the UK's national health service is discussed.

Arm – This term is used both in relation to mathematical modelling and clinical trials. The arms of a Markov model are different simulations which are run so that they can be compared with each other. The arms of a clinical trial relate to different groups of participants, who would usually be given different interventions, so that they can be compared.

Confounder – A factor that influences the results of a trial, and potentially introduces bias, such as having flawed randomisation.

Confidence interval – A statistical measure, giving a range of values and a stated degree of certainty. Commonly, this range represents an area within which there is 95% probability that the true population mean may be found, as estimated from a sample of this population (Field, 2005).

Cycle – The unit of time into which a Markov model is separated, commonly a week or a month in HTA.

Discrete event simulation – A way of producing a mathematical model, in which simulated patients are represented individually.

EVPI (expected value of perfect information) analysis – A calculation of the amount you would be willing to pay for perfect information (if that were possible).

Forest plot – A graphical presentation specifically developed for presenting meta-analyses. These charts give a summary of the weight and direction of scientific evidence (see Chapter 4.2.8.1).

Hazard ratio – A statistical measure of the hazard, or risk of an event, with reference to an explanatory variable – such as the risk of death with reference to which of two interventions was received.

Health technology – "The drugs, devices, and medical and surgical procedures used in medical care, and the organizational and supportive systems within which such care is provided." (Office of Technology Assessment 1978)

Intervention – A health intervention can be a drug, device, surgical procedure, screening programme, public health campaign or organisational change.

Markov model – A mathematical modelling technique commonly used in HTA. In this technique, cohorts of people are simulated, allowing transitions between health states to be represented by flows between states.

Model (modelling, modeller) – In HTA, a mathematical model is a simulation of a cohort of imagined people, used to extend the length of trials.

Parallel coordinates – A way of showing data with many attributes on a single set of axes. See Chapter 4.2.3: Graphic 3 – Parallel coordinates for probabilistic sensitivity analysis.

Scalability – In information visualisation literature, this term refers to whether a visual presentation would be suitable for a much larger or more complex data set than the example with which it is presented.

State – A state in a Markov model is a grouping of units that fulfil particular criteria. In HTA, simulated people commonly move between states when experiencing different health events, such as undergoing surgery, disease progression or death.

Systematic review – A way of giving an overview of an area of research, by systematically searching databases of published scientific evidence. See Chapter 1.2.1 – A brief history of HTA.

Technology (as in context of 'health technology assessment') – See *Health technology.*

Vector-based files – Vector-based files, such as PDFs, can be enlarged and resized, as they are recorded as a series of mathematical functions, rather than on a pixel-by-pixel basis, as in bitmap (or raster) file formats such as JPEG and TIFF).

0.7 Abbreviations

EBM – Evidence–based medicine

GOfER – Graphical Overview for Evidence Reviews

HTA – Health technology assessment

INAHTA – International Network of Agencies for Health Technology Assessment

ISPOR – International Society for Pharmacoeconomics and Outcomes Research

MCV – Multiple Coordinated View (a method of linking interactive displays together and presenting them on the same screen)

NHS – National Health Service (UK)

NICE – National Institute for Health and Clinical Excellence (UK)

TAR – Technology assessment report (UK HTA)

OTA – Office of Technology Assessment (USA)

PSA – Probabilistic Sensitivity Analysis

SOC – State Occupancy Chart

UK – United Kingdom (of Great Britain and Northern Ireland)