Bibliography

Teaching Pack: Building Decision Trees

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KEY CHAPTERS IN DECISOIN ANALYSIS TEXTBOOKS

Hunink MGM et al. **Decision Making in Health and Medicine: Integrating Evidence and Values**, 2nd Edition. Cambridge University Press 2014.

- **Chapter 3: Choosing the Best Treatment.** Hunink MGM et al. Decision Making in Health and Medicine: Integrating Evidence and Values, 2nd Edition. Cambridge University Press 2014: 53-77.

Weinstein MCW et al. **Clinical Decision Analysis.** W.B. Saunders Company 1980.

- **Chapter 2: Structuring Clinical Decisions Under Uncertainty.** Weinstein MCW et al. Clinical Decision Analysis. W.B. Saunders Company 1980: 12-36.
- **Chapter 3: Probabilities and Clinical Decisions.** Weinstein MCW et al. Clinical Decision Analysis. W.B. Saunders Company 1980: 37-74.

Sox HC et al. **Medical Decision Making**, 2nd Edition. Wiley-Blackwell 2013.

- **Chapter 6: Expected Value Decision Making.** Sox HC et al. Medical Decision Making, 2nd Edition. Wiley-Blackwell 2013: 143-169.

Haddix AC et al, eds. **Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation**, 2nd Edition. Oxford University Press 2003.

- Goldie SJ, Corso PS. **Chapter 7: Decision Analysis.** Haddix AC et al, eds. Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation, 2nd Edition. Oxford University Press 2003: 103-126.

Edwards W et al, eds. **Advances in Decision Analysis: From Foundations to Applications.** Cambridge University Press 2007.

- Winterfeldt D, Edwards W. **Chapter 6: Defining a Decision Analytic Structure.** Edwards W et al, eds. Advances in Decision Analysis: From Foundations to Applications. Cambridge University Press 2007: 81-103.

SELECTIONS ON USE OF DECISION ANALYSIS MODELING

How Modeling Can Inform Strategies to Improve Population Health: Workshop Summary. National Academies of Sciences, Engineering, and Medicine 2016. https://www.nap.edu/catalog/21807/how-modeling-can-inform-strategies-to-improve-population-health-workshop
Open access
In April 2015, the Institute of Medicine convened a workshop to explore the potential uses of simulation and other types of modeling for the purpose of selecting and refining potential strategies, ranging from interventions to investments, to improve the health of communities and the nation's health. Participants worked to identify how modeling could inform population health decision making based on lessons learned from models that have been, or have not been, used successfully, opportunities and barriers to incorporating models into decision making, and data needs and opportunities to leverage existing data and to collect new data for modeling. This report summarizes the presentations and discussions from this workshop.

Owens et al. Use of Decision Models in the Development of Evidence-Based Clinical Preventive Services Recommendations: Methods of the U.S. Preventive Services Task Force. Annals of Internal Medicine 2016; 165 (7): 501-508. https://doi.org/10.7326/M15-2531
The U.S. Preventive Services Task Force (USPSTF) develops evidence-based recommendations about preventive care based on comprehensive systematic reviews of the best available evidence. Decision models provide a complementary, quantitative approach to support the USPSTF as it deliberates about the evidence and develops recommendations for clinical and policy use. This article describes the rationale for using modeling, an approach to selecting topics for modeling, and how modeling may inform recommendations about clinical preventive services.

Decision and Simulation Modeling in Systematic Reviews. Agency for Health Care Research and Quality 2013. https://effectivehealthcare.ahrq.gov/topics/methods-decision-simulation-modeling/research
Open access
The purpose of this study is to provide guidance for determining when incorporating a decision-analytic model alongside a systemic review would be of added value for decision making purposes. The purpose of systematic reviews is to synthesize the current scientific literature on a particular topic in the form of evidence reports and technology assessments to assist public and private organizations in developing strategies that improve the quality of health care and decision making. However, there is often not enough evidence to fully address the questions that are relevant for decision makers. Decision models may provide added value alongside systematic reviews by adding a formal structure, which can be informed by the evidence.

Kim SY, Goldie SJ. Cost-Effectiveness Analyses of Vaccination Programmes: A Focused Review of Modelling Approaches. PharmacoEconomics 2008; 26 (3): 191-215. https://doi.org/10.2165/00019053-200826030-00004
Evaluating cost effectiveness, taking into account the relevant biological, clinical, epidemiological and economic factors of a vaccination program, generally requires use of a model. This review examines the modelling approaches used in cost-effectiveness analyses (CEAs) of vaccination programs. After overviewing the key attributes of models used in CEAs, a framework for categorizing theoretical models is presented. Categories are based on three main attributes: static/dynamic; stochastic/deterministic; and aggregate/individual based.

DECISION TREES IN MEDICINE AND HEALTH

Detsky AS al. **Primer on Medical Decision Analysis: Part 2 - Building a Tree.** Medical Decision Making 1997; 17: 126-135. https://www.researchgate.net/publication/14109714_Primer_on_medical_decision_analysis_Part_2--Building_a_tree
This part of a five-part series covering practical issues in the performance of decision analysis outlines the basic strategies for building decision trees. The authors offer six recommendations for building and programming decision trees. Following these six recommendations will facilitate performance of the sensitivity analyses required to achieve two goals. The first is to find modeling or programming errors, a process known as "debugging" the tree. The second is to determine the robustness of the qualitative conclusions drawn from the analysis.

Richardson WS, Detsky AS. **Users' Guides to the Medical Literature. VII. How to Use a Clinical Decision Analysis. A. Are the Results of the Study Valid?** Evidence-Based Medicine Working Group. Journal of American Medical Association 1995; 273: 1610-1613. https://jamanetwork.com/journals/jama/article-abstract/388593
CLINICAL SCENARIO: You are the attending physician on an inpatient service where a 51-year-old man is admitted with congestive heart failure of recent onset. You find he has a dilated cardiomyopathy, the cause of which remains unknown after a thorough evaluation. He is in sinus rhythm. The team's resident asks you whether the patient should be anticoagulated with warfarin, enough to keep his international normalized ratio from 2.0 to 3.0, in order to prevent systemic emboli, even though his echocardiogram does not show left ventricular thrombus. You are not sure about the evidence concerning this issue, so you admit your shared knowledge gap and resolve to search together for the relevant information.

Weinstein MC. **Risky Choices in Medical Decision Making: A Survey.** Geneva Papers on Risk and Insurance 1986; 11: 197-216. https://doi.org/10.1057/gpp.1986.16
Open access
Economic models of decision making under uncertainty presume five features of a decision- making situation. The first is a set of well-defined alternatives from which to choose. The second is uncertainly in the relation between the chosen alternative and the actual consequence. The third feature is a set preferences held by the decision maker and applied to the possible outcomes. Fourth, one or more constraints may limit the set of available alternatives. Finally, and most importantly, the decision must be made; to postpone a decision or to preserve the status quo is itself a decision with its attendant consequences. While these features are shared by many economic decisions under uncertainty, such as in purchasing insurance or in assembling an investment portfolio - and it was surely these sorts of decisions that von Neumann and Morgenstern (1947) had in mind when they developed their now classical theory of economic choice under uncertainty—these are features also shared by many decisions that arise in clinical medicine and public health.

Podgorelec V et al. **Decision Trees: An Overview and Their Use in Medicine.** Journal of Medical Systems 2002; 26 (5): 445-463. https://doi.org/10.1023/A:1016409317640
In medical decision making (classification, diagnosing, etc.) there are many situations where decision must be made effectively and reliably. Conceptual simple decision making models with the possibility of automatic learning are the most appropriate for performing such tasks. Decision trees are a reliable and effective decision making technique that provide high classification accuracy with a simple representation of gathered knowledge and they have been used in different areas of medical decision making. In the paper we present the basic characteristics of decision trees and the successful alternatives to the traditional induction approach with the emphasis on existing and possible future applications in medicine.

EARLY EXAMPLES OF DECISION ANALYSIS IN CLINICAL MEDICINE

Kassirer JP et al. **Decision Analysis: A Progress Report.** Annals of Internal Medicine 1987; 106: 275-291.
https://doi.org/10.7326/0003-4819-106-2-275
Since its introduction into medicine 15 years ago, decision analysis has been applied to difficult clinical problems. Several important advances have made the process more practical and acceptable: computer programs that eliminate the need for burdensome calculations, improved techniques for designing analytic models, the ability to carry out sensitivity analyses over several dimensions simultaneously, and the elaboration of clinically relevant measures of utility. Using these techniques, analysts have addressed many important clinical issues including screening for and prevention of disease, tradeoffs among tests and treatments, and the interpretation of clinical data under conditions of uncertainty. Problems with the approach remain and applications have not been extensive, but decision analysis is evolving as a powerful clinical tool and gradually is gaining acceptance in medical practice.

Thornton JG et al. **Decision Analysis in Medicine.** BMJ 1992; 304: 1099-1103.
http://doi.org/10.1136/bmj.304.6834.1099
Open access
For many straightforward medical problems any well trained doctor will make a good decision. Some- times the correct course of action is unclear, however, and without help doctors and patients may make poor decisions because of a failure to consider probabilities correctly or to recognize the range of patients' values and weigh these correctly. Wrong decisions are made as a result of well recognized biases, and one way of avoiding these biases and clarifying the problem is decision analysis. Decision analysis is a method for breaking complex problems down into manageable component parts, analyzing these parts in detail, and then combining them in a logical way to indicate the best course of action. In North America decision analysis is taught in most undergraduate medical courses but it is rarely used in the United Kingdom and was omitted from a BMJ series on logic in medicine in 1987. With more emphasis than ever before being put on patient choice in the NHS the time is ripe for a change of heart on decision analysis and we hope to go some way to remedy this national neglect in this article.

Pauker SG, Kassirer JP. **Decision Analysis.** The New England Journal of Medicine 1987; 316: 250-258.
http://www.nejm.org/doi/full/10.1056/NEJM198701293160505

DECISION ANALYSIS IN CLINICAL DECISION MAKING

Best M et al. **Making the Right Decision: Benjamin Franklin's Son Dies of Smallpox in 1736.** Quality and Safety in Healthcare 2007; 16 (6): 478-480. http://dx.doi.org/10.1136/qshc.2007.023465
Open access
Benjamin Franklin in his autobiography said: "In 1736 I lost one of my sons, a fine boy of four years old, by the smallpox taken in the common way. I long regretted bitterly and still regret that I had not given it to him by inoculation. This I mention for the sake of the parents who omit that operation, on the supposition that they should never forgive themselves if a child died under it; my example showing that the regret may be the same either way, and that, therefore, the safer should be chosen." Good medical care requires making the right decisions—to test, treat or do nothing—in the face of uncertainty.2 Franklin came to believe he made the wrong decision to forgo smallpox inoculation for his son in 1736. We have enough information about Franklin's decision, made over a quarter of a millennium ago, to evaluate his choice.

Rochau U et al. **Decision-Analytic Modeling Studies: An Overview for Clinicians Using Multiple Myeloma as an Example.** Critical Reviews in Oncology/Hematology 2015; 94 (2): 164-178.
https://doi.org/10.1016/j.critrevonc.2014.12.017
The purpose of this study was to provide a clinician-friendly overview of decision-analytic models evaluating different treatment strategies for multiple myeloma (MM). We performed a systematic literature search to identify studies evaluating MM treatment strategies using mathematical decision-analytic models. We included studies that were published as full-text articles in English, and assessed relevant clinical endpoints, and summarized methodological characteristics (e.g., modeling approaches, simulation techniques, health outcomes, perspectives). Eleven decision-analytic modeling studies met our inclusion criteria. Five different modeling approaches were adopted: decision-tree modeling, Markov state-transition modeling, discrete event simulation, partitioned-survival analysis and area-under-the-curve modeling. Health outcomes included survival, number-needed-to-treat, life expectancy, and quality-adjusted life years. Evaluated treatment strategies included novel agent-based combination therapies, stem cell transplantation and supportive measures.

Sears ED, Chung KC. **Decision Analysis in Plastic Surgery: A Primer.** Plastic and Reconstructive Surgery 2010; 126 (4): 1373-1380.
http://journals.lww.com/plasreconsurg/Fulltext/2010/10000/Decision_Analysis_in_Plastic_Surgery__A_Primer.31.aspx
Open access
Decision analysis modeling can help plastic surgeons systematically evaluate competing strategies in complex clinical decisions. The aim of this paper is to introduce the decision analysis technique and discuss its essential components in an effort to apply best available evidence for modeling treatment decisions. The following components of the decision analysis technique are discussed in detail: 1) the clinical question is designed; 2) a model is created to incorporate possible treatment strategies and relevant outcomes; 3) probabilities and outcome values are assigned to the model; 4) the model is analyzed and the best strategy is identified; and 5) sensitivity analysis is performed to test the robustness of the model. In the era of evidence-based medicine, decision analysis is an important tool for plastic surgeons to become familiar with.

Chen NC et al. **A Primer on Use of Decision Analysis Methodology in Hand Surgery.** The Journal of Hand Surgery 2009; 34 (6): 983-990. http://dx.doi.org/10.1016/j.jhsa.2009.03.005
Decision analysis is a method of probabilistic reasoning and decision-making under conditions of uncertainty. These methods are being used increasingly in hand surgery and medicine in general. It is important for hand surgeons to understand these techniques and how to interpret the results from these studies. Performing a decision analysis involves (1) defining a specific question, (2) creating a model to frame the question, (3) assigning value to outcomes in the model, (4) assigning probabilities to chance events in the model, (5) identifying the best strategy within the model, (6) sensitivity analysis, and (7) model refinement. It is important to recognize the limitations inherent in decision analysis but also to understand its value in overcoming clinical uncertainty by employing a practical technique of modeling choices and outcomes.

DECISION ANALYSIS IN HEALTH AND ENVIRONMENT

von Winterfeldt D. **Bridging the Gap Between Science and Decision Making.** Proceedings of the National Academy of Sciences of the United States of America 2013.
http://www.pnas.org/content/110/Supplement_3/14055.full
Open access
All decisions, whether they are personal, public, or business-related, are based on the decision maker's beliefs and values. Science can and should help decision makers by shaping their beliefs. Unfortunately, science is not easily accessible to decision makers, and scientists often do not understand decision makers' information needs. This article presents a framework for bridging the gap between science and decision making and illustrates it with two examples. The first example is a personal health decision. It shows how a formal representation of the beliefs and values can reflect scientific inputs by a physician to combine with the values held by the decision maker to inform a medical choice. The second example is a public policy decision about managing a potential environmental hazard. It illustrates how controversial beliefs can be reflected as uncertainties and informed by science to make better decisions. Both examples use decision analysis to bridge science and decisions. The conclusions suggest that this can be a helpful process that requires skills in both science and decision making.

Marcot BG et al. **Recent Advances in Applying Decision Science to Managing National Forests.** Forest Ecology and Management 2012; 285: 123-132. http://dx.doi.org/10.1016/j.foreco.2012.08.024
Management of federal public forests to meet sustainability goals and multiple use regulations is an immense challenge. To succeed, the authors suggest use of formal decision science procedures and tools in the context of structured decision making (SDM). SDM entails four stages: problem structuring (framing the problem and defining objectives and evaluation criteria), problem analysis (defining alternatives, evaluating likely consequences, identifying key uncertainties, and analyzing tradeoffs), decision point (identifying the preferred alternative), and implementation and monitoring the preferred alternative with adaptive management feedbacks. The authors list a wide array of models, techniques, and tools available for each stage, and provide three case studies of their selected use in National Forest land management and project plans. Successful use of SDM involves participation by decision-makers, analysts, scientists, and stakeholders.