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Critical Reviews in Oncology/Hematology 94 (2015) 164–178

CRITICAL REVIEWS IN
Oncology
Hematology
Incorporating Geriatric Oncology

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Decision-analytic modeling studies: An overview for clinicians using multiple myeloma as an example

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Accepted 23 December 2014

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http://dx.doi.org/10.1016/j.critrevonc.2014.12.017

Abstract

Purpose: The purpose of this study was to provide a clinician-friendly overview of decision-analytic models evaluating different treatment strategies for multiple myeloma (MM).
Methods: 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).
Results: 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.
Conclusion: Overall, our review provides a comprehensive summary of modeling studies assessing treatment of MM and highlights decision-analytic modeling as an important tool for health policy decision making.

Keywords: Decision-analytic modeling; Multiple myeloma; Systematic overview; Cost–effectiveness analysis; Health economic modeling

1. Introduction

Multiple myeloma (MM) is a hematological neoplasm presenting with clonal proliferation of plasma cells, typically characterized by anemia, bone disease and renal failure, and an ultimately fatal outcome [1]. Recently, the therapeutic management of MM has evolved as new drugs have been introduced into routine clinical practice. These "*novel-agent-based"* therapies contribute to significant improvements in patient outcomes [2], and the establishment of new treatment regimens. Novel agents can be combined with steroids, conventional chemotherapy (CCT), as well as stem cell transplantation (SCT) and result in unique profiles with respect to the trade-offs in benefits, harms and costs compared to the previous standard of care. First-line treatments for patients who are not eligible for SCT usually involve combinations of cytostatic drugs and steroids (e.g., melphalan, prednisone) with one or two novel agents (e.g., bortezomib, thalidomide, lenalidomide). However, in addition to higher costs, the expected improvements in patient-relevant outcomes with the new treatment regimens may be associated with different adverse drug event (ADE) profiles.

Decision-analytic modeling studies can help guide clinical and health policy decisions by systematically evaluating expected outcomes of alternative treatment options by simultaneously considering benefit and harms, as well as the respective costs. These methods allow results from short-term randomized trials to be combined with data from long-term observational studies. Additionally, quality of life (QoL), which is often an important factor for clinical decision making and frequently underreported in clinical trials, can be formally incorporated using these methods [3]. Results from decision-analytic models can aid the physician–patient decision making process by identifying the therapy that maximizes the expected health benefit and minimizes harms (e.g., ADEs) for a given patient. Additionally, government agencies, health care and insurance providers can use decision-analytic modeling to conduct health economic evaluations to inform reimbursement decisions under constrained budgets. These analyses synthesize the available evidence on health effects and costs of alternative technologies to "*obtain a clear understanding of the relationship between incremental cost and effect in order to assess relative cost–effectiveness and to determine which interventions should be adopted given existing information"* [4]. The objective of this study was to provide a comparative overview of published decision-analytic models that evaluate alternative treatment strategies for patients with MM. With the intention of appealing to a clinically oriented audience, we highlight modeling concepts and characteristics, methodological approaches and their application in health economic evaluations.