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Review article

Tolerance of uncertainty: A systematic review of health and healthcare-related outcomes

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ABSTRACT

Background: Uncertainty tolerance (UT) is thought to be a characteristic of individuals that influences various outcomes related to health, healthcare, and healthcare education. We undertook a systematic literature review to evaluate the state of the evidence on UT and its relationship to these outcomes.
Methods: We conducted electronic and bibliographic searches to identify relevant studies examining associations between UT and health, healthcare, or healthcare education outcomes. We used standardized tools to assess methodological quality and analyzed the major findings of existing studies, which we organized and classified by theme.
Results: Searches yielded 542 potentially relevant articles, of which 67 met inclusion criteria. Existing studies were heterogeneous in focus, setting, and measurement approach, were largely cross-sectional in design, and overall methodological quality was low. UT was associated with various trainee-centered, provider-centered, and patient-centered outcomes which were cognitive, emotional, and behavioral in nature. UT was most consistently associated with emotional well-being.
Conclusions: Uncertainty tolerance is associated with several important trainee-, provider-, and patient-centered outcomes in healthcare and healthcare education. However, low methodological quality, study design limitations, and heterogeneity in the measurement of UT limit strong inferences about its effects, and addressing these problems is a critical need for future research.
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1. Introduction

Uncertainty is an important problem in medicine, pervading nearly every activity of healthcare, from health promotion and disease prevention, to disease treatment, to palliative and end-of-life. In all of these activities uncertainty of one type or another—*e.g.*, diagnostic, prognostic, therapeutic—arises in the minds of patients, clinicians, and trainees, and influences their thoughts, feelings, and actions [1]. Responding to these uncertainties in an adaptive way is one of the most important challenges faced by each of these parties [2,3].

The critical importance of uncertainty and people's responses to it has long been recognized; however, it has received increasing attention over the past several years [4,5]. The phenomenon of "uncertainty tolerance" (UT) and its relationship to various health and healthcare-related outcomes has become the focus of an expanding body of empirical research. Searching PubMed reveals substantial growth in published papers citing uncertainty and tolerance as key words, from less than 10 in 1980; to over 200 in 2016. UT has been defined and measured in various ways in this research; although in a recent conceptual review and analysis of the phenomenon we argued that existing understandings of UT can be subsumed by an overarching; integrative definition: *the set of negative and positive psychological responses—cognitive*; *emotional*; *and behavioral—provoked by the conscious awareness of ignorance about particular aspects of the world* [6]. This definition acknowledges the breadth of different potential responses to uncertainty; which can be both negative (*e.g.*; thoughts and feelings of vulnerability; information and decision avoidance) and positive (*e.g.*; thoughts and feelings of opportunity and hope; information seeking and decision-making). An individual's "tolerance" of uncertainty is the balance between these responses; and may thus be more negative (tending towards more negatively valenced responses) or positive (tending towards more positively valenced responses). Our integrative definition also acknowledges that UT can represent either a state induced by a particular situation; (consisting of a particular pattern of cognitive; emotional; or behavioral responses to uncertainty); or a trait (consisting of an individual's *propensity* towards a particular pattern of responses). We have previously put forth an integrative conceptual model of UT (Fig. 1); aimed at guiding future efforts to measure and understand its mechanisms and outcomes [6].

Many past studies of UT have treated it as a trait-level propensity or characteristic of individuals and have explored its extent among patients, health care providers, and trainees, as well as the association between UT and outcomes related to health, healthcare, and healthcare education. They have utilized a number of measures of UT and have examined several settings and populations. These studies have produced potentially important findings; however, findings have been inconsistent [7–13]. Existing heterogeneity in the methods and findings of past studies of UT makes it difficult to draw conclusions about its extent and influence upon health- and healthcare-related outcomes, and raises the need for a comprehensive appraisal of the state of the evidence.

To meet this need, we conducted a systematic literature review, aimed at identifying existing empirical studies of UT in healthcare, describing their quality and areas of focus, and summarizing their main findings and limitations. We aimed to be as inclusive as possible, surveying studies measuring UT in different ways and examining a broad range of outcomes related to health, healthcare, and healthcare education. Here we present the findings of this analysis and discuss implications for future research.

2. Methods

2.1. Study design

Our study protocol was developed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as well as guidelines provided by the Cochrane Collaboration [14,15]. The review was registered with the PROSPERO international prospective registry of systematic reviews, registration #CRD42015032449.

2.2. Search strategy

Studies were considered for inclusion if they reported original research in the English language peer-reviewed literature focused on at least one of the following concepts: tolerance or intolerance of uncertainty in medicine; or tolerance or intolerance of—or

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