Reply to “Modeling the national pediatric vaccine stockpile: Supply shortages, health impacts and cost consequences”

The article “Modeling the national pediatric vaccine stockpile: Supply shortages, health impacts and cost consequences” by Shrestha, Wallace, and Meltzer (Vaccine 28 (2010) 6318–6332) addresses the very important and timely public health issue of determining the optimal number of doses that the U.S. National Pediatric Vaccine Stockpile (NPVS) must maintain to attenuate the impact of vaccine supply interruptions. Translating vaccine stockpile shortages into mortality and morbidity rates is useful for measuring their public health value. However, the proposed model has a number of weaknesses that can result in recommendations based on underestimated impacts. Additionally, the paper erroneously refers to the results of two studies published in 2006.

Shrestha et al. [1] propose a prescriptive spreadsheet model to evaluate the health and cost impacts of a finite set of vaccine shortage scenarios under a setting of high and low stockpile levels. The proposed model is designed to assist NPVS decision-makers to understand the impact of not fully stocking the stockpile at the six month level. However, it does not address the more salient question of determining the optimal vaccine stockpile levels. Given the increasing number of vaccines in the NPVS (especially combination vaccines), the use of descriptive models to exhaustively evaluate all the stockpile levels for the many scenarios under which supply interruptions could occur is impractical, lengthy, and potentially misleading. Most importantly, the purpose of a stockpile system is to create a supply buffer to mitigate the uncertainty in product demand or in its supply. In the paper, when estimating vaccine shortages, the authors do not adequately consider the duration of unexpected supply interruptions, whose lengths are uncertain and may often extend well over a year. In fact, the amount of doses demanded during a vaccine supply interruption results in what engineering and industry refer to as lead time demand, which is indispensable for designing inventory and stockpile systems of products in multiple industries. Technically, one can afford not to consider lead time demand only when both the length of the supply interruption and the product demand rate are known or have small variability, which is clearly not the case for vaccines. By not including the lead time demand in its analysis, the paper may result in health and cost impacts that are lower than their true values.

The paper also states that there are no available models that can help NPVS decision-makers to evaluate the health and financial impact of decisions regarding the stockpile target levels. However, in two previous studies published in Vaccine [3] and Health Care Management Science [2], we introduce a prescriptive optimization model to determine the optimal vaccine stockpile levels. Our model considers unexpected supply interruptions of stochastic duration, and also the capacity of the system to restore the vaccine supply. Shrestha et al. [1] erroneously describe the conclusions of our studies, in which we conclude that the current recommendation of holding enough vaccines to satisfy a 6-month demand is only valid for attenuating shortages lasting up to 6-months, and that given that the typical vaccine supply interruptions have lasted longer than that, the current stockpile recommendations are inadequate. In our work, we also characterize the risk of vaccine shortage as the probability of failing to cover a desired proportion of the population during a supply interruption, and show that even for interruptions lasting six months, the current stockpile levels result in a significant shortage risk. Consequently, we propose a methodology to determine stockpile levels that will result in an acceptable risk of a shortage.

Our study in this area suggests that public health decision-makers are best situated to focus their attention on the use of prescriptive optimization models that consider the multiple interests they want to accommodate through the stockpiles, the random nature of supply interruptions, and the morbidity and mortality of infectious diseases as inputs, in addition to the actual vaccine stockpile levels. In a recent article published in the Journal of Industrial and Management Optimization [4], such a model is proposed. This model demonstrates that depending on the preferential behavior of the decision-makers, the resulting vaccine stockpile should not be viewed as a passive repository of vaccines, but rather as an active repository of opportunities to ensure adequate vaccination coverage.

References


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