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Is scorpion antivenom cost-effective as marketed in the United States?

Edward P. Armstrong [a, b, *], Maja Bakall [c], Grant H. Skrepnek [a, b], Leslie V. Boyer [b]

[a] Department of Pharmacy Practice and Science, College of Pharmacy, University of Arizona, Tucson, AZ, USA
[b] Venom Immunochemistry, Pharmacology and Emergency Response (VIPER) Institute, College of Medicine, University of Arizona, Tucson, AZ, USA
[c] Department of Pharmaceutical Sciences, University of Arizona, Tucson, AZ, USA

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ABSTRACT

Purpose: The purpose of this study was to analyze the cost-effectiveness of scorpion antivenom compared to no antivenom, in the United States, using a decision analysis framework.

Methods: A decision analytic model was created to assess patient course with and without antivenom. Costs were determined from the perspective of a health care payer. Cost data used in the model were extracted from Arizona Medicaid. The probability of clinical events occurring with and without antivenom was obtained from the published literature, medical claims obtained from Arizona Medicaid, and results of recent clinical trials. Patients that became so ill that mechanical ventilator support was necessary were considered treatment failures. A Monte Carlo simulation was run 1000 times and sampled simultaneously across all variable distributions in the model.

Results: The mean success rate was 99.87% (95% CI 99.64%–99.98%) with scorpion antivenom and 94.31% (95% CI 91.10%–96.61%) without scorpion antivenom. The mean cost using scorpion antivenom was $10,708 (95% CI $10,556 – $11,010) and the mean cost without scorpion antivenom was $3178 (95% CI $1627 – $5184). Since the 95% CIs do not overlap for either the success or cost, use of the scorpion antivenom was significantly more effective and significantly more expensive than no antivenom. Cost-effectiveness analysis found that the scorpion antivenom was not cost-effective at its current price as marketed in the United States.

Conclusion: The scorpion antivenom marketed in the United States is extremely effective, but too costly to justify its use in most clinical situations. Formulary committees should restrict the use of this antivenom to only the most severe scorpion envenomations.

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1. Introduction

The availability of antivenom for treatment of scorpion envenomation in Arizona has varied greatly over time (Boyer, 2013). Recently, a new scorpion antivenom has become available in the United States (Boyer, 2013). Although this antivenom has been found to be clinically effective (Boyer et al., 2009), as an orphan drug it is so expensive that its market viability is uncertain (Anonymous, 2013; Carroll and Staton, 2012), raising the question of whether it should be used in all cases or only those involving severe envenomations. Cost-effectiveness analysis incorporates both clinical outcomes data and cost data.

* Corresponding author. College of Pharmacy, University of Arizona, 1295 N Martin Avenue, Tucson, Arizona 85737, USA. Tel.: +1 520 626 5764.

E-mail address: armstrong@pharmacy.arizona.edu (E.P. Armstrong).

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At the basis of all economic evaluations is the concept that resources are scarce, and that choices must be made among a range of possible options. A full economic evaluation takes into account both costs and clinical or humanistic outcomes associated with at least two alternative activities (Drummond et al., 2005). Within healthcare, the demand for services and treatments is almost unlimited, and the resources available can never meet all the demands. A cost-effectiveness analysis may be useful in decision-making by including structured information about the costs and outcomes associated with treatment alternatives, and it is a way to decide which alternative may provide the greatest outcome for the money invested. Resource allocation decisions may be enhanced using information indicating what treatments provide the greatest benefit to patients for the resources available when providing care to patients. Economic evaluations may be useful to provide analysis of treatment alternatives in terms of their clinical outcomes as well as their costs (Drummond et al., 2005).

An incremental cost-effectiveness analysis examines the difference in costs divided by the difference in clinical outcome between two treatments (Skrepnek, 2005). This provides evidence for the difference in costs to achieve an improvement in outcomes between two treatments.

The purpose of this study was to analyze the cost-effectiveness of scorpion antivenom compared to no antivenom in the Arizona population, using a decision analysis framework and applying costs for the United States.

2. Material and methods

2.1. Cost-effectiveness framework

A decision analytic model was created in the TreeAge Pro software program. The structure of the model is summarized in Fig. 1. The model compared use of the scorpion antivenom to no antivenom. The model used a probabilistic sensitivity analysis to include both first and second order uncertainty. Beta distributions were used for probabilities since this constrains the variables between 0 and 1.0. Gamma distributions were used for costs since health care costs are typically skewed to the right and are not negative. This analysis was approved by the University of Arizona Human Subjects Protection Program.

2.2. Cost data

Costs were determined from the perspective of a health care payer. Cost data used in the model were extracted from Arizona Medicaid cost data from June 1, 2005 and June 1, 2006. During this time period there was a severe shortage of scorpion antivenom available in Maricopa County (Riley et al., 2006). Patients admitted to hospitals in Maricopa County were treated primarily with palliative and supportive care during this time and thus represented a suitable study population for the costs of scorpion envenomation in pediatric patients treated in the absence of antivenom.

Administrative medical and pharmacy claims were obtained from Arizona Medicaid. Inclusion criteria were as follows: 1) a medical claim for scorpion envenomation (defined as a diagnosis code of E9052), age up to 18 years, care provided in Maricopa county, and dates of service between June 1, 2005 and June 1, 2006. All medical and pharmacy claims data were collected for patients meeting these criteria. The data provided patient diagnoses, treatments, and place of services. Next, the cost data paid by Arizona Medicaid identified in the database were adjusted for inflation to 2012 using the medical Consumer Price Index. The cost data were stratified into the following cost centers: inpatient hospital services, intensive care units stays, emergency room visits, and helicopter ambulance transportation to a specialized tertiary care facility. The mean, median, and standard deviations of paid amounts were calculated. Additionally, a cost estimate for ventilator support was used based on published literature (Dasta et al., 2005). This cost was also inflated to 2012 using the medical Consumer Price Index. Table 1 summarizes the variable inputs in the model. The cost of the scorpion antivenom was $3500 per vial (the average wholesale price of the marketed product during 2012) and the dose was assumed to be three vials for all patients, based on the manufacturer's recommended dosing.

2.3. Effectiveness data

The probability of clinical events occurring with and without antivenom was obtained from the published literature as well as the medical claims obtained from Arizona Medicaid (Boyer et al., 2009; O'Connor and Ruha, 2012), with supplemental data derived from the Arizona clinical trials database currently in process of separate publication (Boyer et al., 2013a,b Toxicon, A and B). These data determined the probabilities for air ambulance transport, intensive care unit admission, and requirement of mechanical ventilation and are summarized in Table 1.

2.4. Definition of treatment success and failure

Cost-effectiveness analysis compares the costs of treatment alternatives in monetary terms to the clinical outcomes they provide. In this cost-effectiveness analysis we chose to consider a successfully treated patient as one that was well after scorpion envenomation and who did not experience severe complications that required mechanical ventilation. Therefore, both patients treated in the emergency department alone or admitted to a hospital, but not requiring mechanical ventilation were considered treatment successes. However, patients that in the course of envenomation became so ill that mechanical ventilator support was necessary were considered treatment failures.

Cost effectiveness was calculated using TreeAge Pro using a probabilistic sensitivity analysis. The Monte Carlo simulation was run 1000 times and the computer sampled simultaneously across all variable distributions. The analysis provided means, SDs, and 95% CIs for both treatment strategies. Scatterplots and cost-effectiveness acceptability curves were created to further assess the results.

3. Results

Table 2 summarizes the key results. The mean success rate was 99.87% (95% CI 99.64%–99.98%) with scorpion

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