Journal of Microbiology, Immunology and Infection (2016) 49, 46–51

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jmii.com

ORIGINAL ARTICLE

Estimating the cost-effectiveness of linezolid for the treatment of methicillin-resistant *Staphylococcus aureus* nosocomial pneumonia in Taiwan

Po-Chang Lin [a,h], Bruce C.M. Wang [b,h], Richard Kim [c], Andrew Magyar [d], Chung-Chih Lai [e], Ya-Wen Yang [e], Yhu-Chering Huang [f,g,*]

[a] *Department of Internal Medicine, China Medical University Hospital, Taichung, Taiwan*
[b] *Elysia Group, Taipei, Taiwan*
[c] *University of Washington, Seattle, WA, USA*
[d] *Alliance Life Sciences Consulting Group, Somerset, NJ, USA*
[e] *Pfizer Limited, Taipei, Taiwan*
[f] *School of Traditional Chinese Medicine, College of Medicine, Chang Gung University, Taoyuan, Taiwan*
[g] *Division of Pediatric Infectious Disease, Department of Pediatrics, Chang Gung Memorial Hospital, Taoyuan, Taiwan*

Received 11 March 2015; received in revised form 27 July 2015; accepted 4 August 2015
Available online 9 September 2015

KEYWORDS
health economics;
linezolid;
nosocomial pneumonia;
vancomycin

Abstract *Background/Purpose:* Methicillin-resistant *Staphylococcus aureus* (MRSA) nosocomial pneumonia (NP) is associated with higher resource utilization, increased hospital stays, and mortality. We present a health economics model to understand the impact of using linezolid as the first-line treatment of MRSA NP in Taiwan.
Methods: We developed a cost-effectiveness model to estimate the costs and clinical outcomes of using linezolid 600 mg b.i.d. versus vancomycin 15 mg/kg b.i.d. as the first-line treatment of MRSA NP in Taiwan. The model is a decision-analytic analysis in which a MRSA-confirmed patient is simulated to utilize one of the treatments, using data from a clinical trial. Within each treatment arm, the patient can or cannot achieve clinical cure. Regardless of whether the clinical cure was achieved or not, the patient may or may not have experienced an adverse event. The per-protocol results for clinical cure were 57.6% and 46.6% for linezolid and vancomycin, respectively.

* Corresponding author. Division of Pediatric Infection Disease, Department of Pediatrics, Chang Gung Memorial Hospital, 5, Fu-Shing Street, Kwei-Shan, Taoyuan 333, Taiwan.
E-mail address: ychuang@adm.cgmh.org.tw (Y.-C. Huang).
[h] These two authors contributed equally to this work.

http://dx.doi.org/10.1016/j.jmii.2015.08.002

Results: The total cost of linezolid was $376 more per patient than that of vancomycin. Drug costs were higher for linezolid than for vancomycin ($1108 vs. $233), and hospitalization costs were lower ($4998 vs. $5496). With higher cost and higher cure rates for linezolid, the incremental cost per cure was $3421.
Conclusion: This study projects linezolid to have higher drug costs, lower hospital costs, and higher overall costs compared with vancomycin. This is balanced against the higher clinical cure rate for linezolid. Depending on the willingness to pay for clinical cure, linezolid could be cost effective as the first-line treatment of NP in Taiwan.

Introduction

Hospital-acquired pneumonia or nosocomial pneumonia (NP) is characterized by the pneumonia that a patient acquires 2 days or 3 days after being admitted to the hospital. Methicillin-resistant *Staphylococcus aureus* (MRSA) is responsible for many cases of NP in Taiwan.[1] This disease is associated with higher resource utilization, increased hospital stays, and mortality.[2] A recent study in Taiwan suggests an excess 1-year mortality of 20.2% for patients with *S. aureus* health care-associated infections, as well as increased ventilator dependence and dialysis.[3]

Vancomycin, a glycopeptide antibiotic, has been the standard of care since the 1980s for treating NP in Taiwan. Typical treatment regimens include using vancomycin from empiric treatment through confirmation, but recent findings suggest that doing so may be suboptimal.[4] Not only is vancomycin associated with nephrotoxicity, but there have also been reports that vancomycin-nonsusceptible organisms are becoming more common.[5] Teicoplanin, a semisynthetic glycopeptide antibiotic, has also been used in a manner similar to vancomycin. Recently, linezolid, the first member of the oxazolidine class of drugs, has been recommended as one of the antibiotics of choice for treatment of MRSA pneumonia, both in the United States and in Taiwan.[6]

In this study, we present a health economics and outcomes research (HEOR) model to understand the impact of using linezolid as the first-line treatment of MRSA NP in Taiwan. HEOR provides a model framework to understand the tradeoffs between competing options—in this case, vancomycin versus linezolid. The tradeoffs include costs (e.g., hospital utilization, pharmacy costs, and laboratory tests) and outcomes (clinical cure) associated with treatment choices. HEOR models include cost-effectiveness studies, which estimate the value for money of new treatments on a per-patient basis using common units, such as clinical cure, progression-free survival, and life years. The output expresses the incremental cost-effectiveness ratio (ICER) of the competing treatments.

Health technology assessment (HTA) committees often consult HEOR studies in their evaluations. The ICERs from cost-effectiveness analyses can be used by HTA bodies to support inclusion or exclusion recommendations of new treatments in health systems. For example, HTAs may have ICER thresholds above which treatments are not considered to be cost effective and thus are not recommended for reimbursement. Some HTAs utilizing this type of analysis include the National Institute for Health and Clinical Excellence in the United Kingdom, Blue Cross Blue Shield's Technology Assessment Committee in the United States, and the Center for Disease Evaluation in Taiwan.[7] To evaluate new technologies, the Center for Disease Evaluation conducts systematic reviews of reports from other HTA agencies, but they also recommend studies based on local, Taiwanese data. The model presented in this study is a localized HEOR model for the treatment of MRSA NP in Taiwan.

Methods

Model overview

We developed a cost-effectiveness model in Microsoft Excel (Microsoft Inc., Redmond, WA, USA) to estimate the costs and clinical outcomes of using linezolid 600 mg b.i.d. versus vancomycin 15 mg/kg b.i.d. as the first-line treatment of NP in Taiwan. We based the analysis on the results of the ZEPHyR (Linezolid in the treatment of subjects with nosocomial pneumonia proven to be due to methicillin-resistant *Staphylococcus aureus*) clinical trial, a randomized, double-blind, multicenter study. Note that the trial was global, with patients being enrolled at various sites in the United States, Europe, Asia, South America, and other regions. For additional details on the patient demographics, we refer readers to the original trial publication.[8] The assessment was conducted from a payer's perspective, and the timeframe is the same duration of the end of study in the trial, 7—30 days after end of treatment.

The final output is the incremental cost per cure (ICPC), which measures the additional monetary cost of achieving a clinical cure in an additional patient.

The model is a decision-analytic model the structure of which mimics that of the ZEPHyR clinical trial design (Figure 1). An MRSA-confirmed patient is simulated to utilize one of the following treatments: linezolid 600 mg b.i.d. or vancomycin 15 mg/kg b.i.d. Within each treatment arm, the patient can or cannot achieve clinical cure; in line with the trial protocol, clinical cure was defined as the resolution of clinical signs and symptoms of pneumonia, improvement or lack of progression in chest imaging, and