Three surveillance strategies for vancomycin-resistant enterococci in hospitalized patients: detection of colonization efficiency and a cost-effectiveness model


Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Three surveillance strategies for identifying carriers of vancomycin-resistant enterococci (VRE) were examined:

continuing the current screening practice, consisting of weekly screening of patients in high-risk areas, such as haematology-oncology unit, bone marrow and solid organ transplant unit, and surgical and medical intensive care units (CURRENT strategy);

screening the CURRENT patients plus those with history of renal disease (RENAL); and

screening CURRENT patients plus those with a hospitalisation in the 2 years prior (HOSP).

VRE was defined as Enterococcus faecium or E. faecalis resistant to vancomycin with a minimum inhibitory concentration greater than 6 microg/mL.

Type of intervention
Screening.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of hospitalised patients. The relevant group of targeted patients depended on the surveillance strategy.

Setting
The setting was a hospital. The economic study was carried out in Illinois, USA.

Dates to which data relate
Some effectiveness data were obtained from studies published from 1996 to 2003, while other clinical data were directly gathered from September to October 2000. Some resource use data were derived from studies published between 1995 and 2002. The price year was 2001.

Source of effectiveness data
The effectiveness evidence was derived from a single study, a synthesis of completed studies, and some assumptions.

Link between effectiveness and cost data
The costing was not carried out on the same sample of patients as that used in the effectiveness study.

**Study sample**
The authors stated that a routine surveillance programme was carried out weekly in high-risk areas. However, between September and October 2000, a sample of 200 stool specimens was screened for the presence of VRE at the authors’ institution. Medical records for all patients who were not residing in high-risk nursing units, and for whom a specimen was submitted to determine risk factors associated with VRE, were reviewed. Risk factors included patient's location at the time of specimen testing, where the patient resided prior to hospital admission, dates of any prior hospital admissions, reasons for health care contact, and past medical history.

**Study design**
The authors stated that an epidemiological study was carried out at the Northwestern Memorial Hospital in Chicago, Illinois. The patients were followed during their hospital stay. No patient was lost to the follow-up assessment.

**Analysis of effectiveness**
All of the patients included in the initial study sample were accounted for in the analysis of effectiveness. The outcome measures used were the results of the analysis of the 200 specimens. More specifically, the percentage of patients positive to VRE in high-risk patients, patient hospitalised in the 2 years prior and patients with renal impairment.

**Effectiveness results**
The analysis of the 200 specimens revealed that 81 specimens were from high-risk units and 119 were from non-surveillance units. Specimens from the latter (non-surveillance units) were collected from 94 patients, 5 of whom were found to be positive for VRE.

The routine surveillance programme of high-risk units identified 16 patients with VRE. Thus, 24% (5 of 21) of the patients with VRE were detected in non high-risk units. Of such patients, 3 (60%) had documented renal impairment, and all had at least one hospital admission in the prior 2 years.

Two of the 5 patients had never been seen at the authors’ institution. A medical record review of VRE-negative patients revealed that 14% (n=12) had a history of renal impairment and 48% (n=41) were hospitalised in the past 2 years.

Overall, 10.6% (n=5) of the 47 patients who had been hospitalised in the past 2 years were colonised with VRE.

The hospital database revealed that 3.1% of 30,507 adult inpatients had a diagnosis of renal disease and 28.5% had been hospitalised in the previous 2 years.

**Clinical conclusions**
The results of the epidemiological study were used to calculate the probability values used in the decision model.

**Modelling**
A probabilistic decision model was constructed to compare the costs and benefits of the three screening strategies examined in the study. The model relied on a decision tree, which was the same for the three options. Patients entered the model at the time of hospital admission and were followed until they were discharged or died. Patients who were screened could test either positive or negative for VRE and then could be either colonised or not. Colonised patients could develop active VRE or remain carriers without active infection. Patients not colonised entered an embedded Markov model that transitioned patients among five health states at daily intervals. The five health states were no VRE, VRE colonisation, VRE infection, discharge, and death. Most of the transition probabilities were assigned a specific probability distribution. Some fixed (non-probabilistic) estimates were also used. The cycle length of the Markov model was 1 day but the time horizon was not reported (a short time horizon appears to have been considered).
Outcomes assessed in the review
The outcomes estimates from the literature were:

the average length of stay (LOS),

increased LOS due to VRE,

the mortality rate associated with a VRE infection, and

the rate of VRE spread.

Study designs and other criteria for inclusion in the review
It was not stated whether a systematic review of the literature was undertaken to identify primary studies. No information on the design of the studies was given. One of the studies had been published by the authors’ institution.

Sources searched to identify primary studies
Not stated.

Criteria used to ensure the validity of primary studies
Not stated.

Methods used to judge relevance and validity, and for extracting data
Not stated.

Number of primary studies included
Four primary studies provided published evidence.

Methods of combining primary studies
The data from each study provided the parameters for the model distributions.

Investigation of differences between primary studies
Not stated.

Results of the review
The average LOS was 5.01 days.

VRE increased LOS by a factor of 2.1 (+/- 0.34).

The mortality rate associated with a VRE infection was 57.4% (95% confidence interval, CI: 43.2 - 70.8).

The rate of VRE spread was 8.9 patients per 100,000 patient-days.

Methods used to derive estimates of effectiveness
Some assumptions were made to derive key model inputs.
Estimates of effectiveness and key assumptions
The proportion of patients currently at high risk was 21.6% (range: 15 - 35).

The proportion of patients with a history of renal disease was 3.1% (range: 1 - 50).

The proportion of patients with prior hospitalisation was 28.5% (range: 10 - 50).

The proportion of other patients who tested positive for VRE was 5% (range: 0.5 - 10).

Measure of benefits used in the economic analysis
The summary benefit measure used was the survival rate. This was estimated using a modelling approach. No discounting was applied.

Direct costs
Discounting was not relevant since the costs were incurred during the patient's hospitalisation. The unit costs were presented separately from the quantities of resources used for most items. The economic evaluation comprised daily costs of gowns and gloves for patient isolation, the costs of other supplies for patients in isolation, laboratory costs for VRE tests, additional costs for extra testing on positive samples, labour (physicians and other health care workers) and hospitalisation. The cost/resource boundary of the health care organisation was adopted. The costs and resource use estimates came from the authors' institution and the literature. All of the costs were adjusted to 2001 values using the medical care component of the Consumer Price Index.

Statistical analysis of costs
The total costs were presented as mean values with CIs. The unit costs used in the decision model appear to have been treated deterministically, while distributions were applied to some resource use inputs (hospital LOS and VRE-increased LOS).

Indirect Costs
The indirect costs were not considered in the economic evaluation.

Currency
US dollars ($).

Sensitivity analysis
Sensitivity analyses were carried out to examine the robustness of the estimated costs and benefits to variations in the rate of VRE spread, the proportion of patients in each screening group, and the per diem cost of hospitalisation. A univariate sensitivity analysis was presumably performed. In the probabilistic model, a Monte Carlo simulation was carried out. This generated CIs for the costs and benefits.

Estimated benefits used in the economic analysis
The survival rate was 87.50% (95% CI: 87.37 - 87.62) with CURRENT, 87.41% (95% CI: 87.16 - 87.61) with RENAL, and 87.56% (95% CI: 87.47 - 87.63) with HOSP.

Cost results
The cost of screening per patient admitted was $1.88 with CURRENT, $2.15 with RENAL and $2.48 with HOSP. However, the additional cost of screening per patient with the HOSP strategy was more than offset by a reduction in the hospital costs. Thus, the total cost per patient was $4,544 (95% CI: 3,910 - 5,778) with CURRENT, $5,180 (95% CI:
4,119 - 7,394) with RENAL and $4,064 (95% CI: 3,687 - 4,874) with HOSP.

Considering a total of 1,000 hospital admissions, the HOSP strategy would lead to overall savings of approximately $480,000.

**Synthesis of costs and benefits**
The costs and benefits were not combined because the HOSP strategy dominated both CURRENT and RENAL, which were more expensive and slightly less effective. The probabilistic analysis showed that the HOSP strategy dominated CURRENT in 98.8% of simulations and RENAL in 98.9% of simulations.

The sensitivity analysis revealed that HOSP remained the most cost-effective strategy in several scenarios. In particular, increasing VRE spread made the HOSP strategy even more favourable.

**Authors’ conclusions**
A strategy expanding surveillance programmes for vancomycin-resistant enterococci (VRE) to include patients with a hospitalisation in the prior 2 years was a cost-effective screening option.

**CRD COMMENTARY - Selection of comparators**
The authors justified their choice of the comparators, which were appropriate for the context of the study. Two expanded surveillance systems were compared with the current screening strategy. You should decide whether they are valid interventions in your own setting.

**Validity of estimate of measure of effectiveness**
The effectiveness evidence came from several sources, which were not clearly distinguished. First, a sample of specimens was identified to assess some input variables that were used in the model. Characteristics of the sample and other information on the study were not reported. The authors noted that the sample size of the epidemiological study was quite small and represented a limitation of the study. Second, some published evidence was used but information on the design of the primary studies was not given. The authors stated that only clinical trials were used, which ensures the internal validity of the sources. However, it was unclear whether a review of the literature had been undertaken, or whether the primary studies were identified selectively. Some authors’ assumptions were also made. Owing to the uncertainty around all clinical inputs, a probabilistic sensitivity analysis was carried out.

**Validity of estimate of measure of benefit**
The summary benefit measure was specific to the study setting and is not comparable with the benefits of other health care interventions. It was derived from the decision model, which appropriately reflected the patterns of care.

**Validity of estimate of costs**
The economic analysis included only the direct medical costs, which was consistent with the perspective adopted in the study. Information on the unit costs, quantities of resources used, and price year was provided, which enhances the possibility of replicating the study and performing refllation exercises in other time periods and settings. The costs were treated deterministically in the base-case but CIs were determined for the total costs. Uncertainty around some resource use was investigated in the probabilistic sensitivity analysis. However, the cost estimates were specific to the study setting and only one category of costs was varied in the sensitivity analysis. The source of the data was not reported clearly for all items.

**Other issues**
The authors made few comparisons of their findings with those from other studies. In terms of the generalisability of the study results to other settings, the authors stated that the use of multiple sources for model inputs enhanced the
external validity of their results. Further, the use of a probabilistic sensitivity analysis strengthened the robustness of the conclusions.

**Implications of the study**
The study results supported the implementation of a surveillance policy including patients with a hospitalisation in the previous 2 years. The authors stated that health care institutions could expand their current screening policy to those patients who answer yes to a simple question on hospital admission: “Have you been hospitalised in the past 2 years?”

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**Other publications of related interest**


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