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RESEARCH ARTICLE

Vancomycin vs teicoplanin in the treatment of Gram-positive infections: a pharmacoeconomic analysis in a Turkish University Hospital

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Abstract *Objective* The aim of this study was to estimate and compare the costs of vancomycin and teicoplanin in the treatment of Gram-positive hospital infections in Turkey using a cost minimisation analysis. *Setting* Hacettepe University Hospital, Ankara, Turkey. *Method* The health-care provider's perspective was considered within formal pharmacoeconomic assessment methodology. The records of 76 patients who had been hospitalised and treated for Gram-positive infections at Hacettepe University Hospital between 16 July 2003 and 22 November 2003 were retrospectively evaluated to obtain individual data on resources and associated costs. *Main outcome measure* From a cost minimisation perspective, hospital directors may consider teicoplanin to be a relevant option in addition to vancomycin. *Result* The estimated mean treatment cost per patient was 1,780 TRY (1,101 EUR) for teicoplanin and 1,429 TRY (884 EUR) for vancomycin, with statistical analysis failing to reveal any significant difference between the two drugs in terms of these total costs ($p = 0.33$). This cost minimisation analysis shows that the average costs of vancomycin and teicoplanin per patient observed did not differ significantly. *Conclusion* Other potential advantages of one drug over the other, as reported by other authors, such as differing safety profiles or advantages in administration, may ultimately decide which is preferred.

Keywords Cost minimisation analysis · Glycopeptide · Pharmacoeconomics · Teicoplanin · Turkey · Vancomycin

Impact of findings on practice

- Prices and costs are fundamentally different concepts. A cheaper drug can be a more costly alternative than an expensive one.
- Decision makers should not only take the costs of drugs into account when making treatment choices.

Introduction

Glycopeptide antibiotics have long been considered the gold standard for the treatment of documented or suspected life-threatening, multiresistant, Gram-positive bacterial infections [1, 2]. Vancomycin is the sole glycopeptide available in the USA, whereas teicoplanin is a widely available alternative in Europe [3].

The aim of this study was to estimate and compare the costs of vancomycin and teicoplanin for the treatment of Gram-positive hospital infections using cost minimisation analysis of data obtained in an observational setting from a health-care provider's perspective. Hospital data on patients who received teicoplanin or vancomycin for the

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treatment of a Gram-positive bacterial infection in the Internal Medicine Wards at Hacettepe University Hospital (Ankara, Turkey) were used for this pharmacoeconomic analysis. The cost minimisation framework is motivated by assuming the equal effectiveness of the two drugs.

Background information on vancomycin vs teicoplanin

As assessed in clinical trials, teicoplanin and vancomycin have similar clinical and bacteriological efficacy in the treatment of Gram-positive infections [4]. Pharmacologically, these glycopeptide antibiotics have comparable mechanisms of action on bacterial cell wall synthesis [5]. Yet vancomycin is poorly absorbed from the gastrointestinal tract, and should therefore not be given to patients orally. Moreover, intramuscular injection of vancomycin causes considerable local pain, and is not recommended [6, 7]. Vancomycin has a low therapeutic index, and a risk of nephrotoxicity and ototoxicity that complicates the drug therapy and necessitates strict therapeutic drug monitoring. The most common method employed for the therapeutic monitoring of vancomycin has been to measure peak and trough levels at steady state and then individualise the dose pharmacokinetically to achieve target levels [6, 8].

Anaphylactoid reaction to vancomycin (red-neck/red-man syndrome) is the most common adverse effect [9]. In addition, chemical thrombophlebitis can occur in patients with peripheral venous cannulas [10].

The advantages of the ease of administration and better overall tolerance, particularly with respect to administration-related adverse effects and renal toxicity [1, 11], make teicoplanin a valuable alternative to vancomycin [12, 13]. Furthermore, mainly as a result of a prolonged elimination half-life, teicoplanin (approximately 47 h after therapeutic serum concentration is reached) allows for once-daily dosing [14]. If teicoplanin is used at a standard dosage there is little indication to measure serum concentrations in non-severe infections, with the exception of a few particular patient groups, such as those with burns or intravenous drug users [15]. Dose-related nephrotoxicity, ototoxicity and the red-neck (red-man) syndrome appear to be much less of a problem than with vancomycin [4, 16].

Still, the acquisition costs of teicoplanin and vancomycin vary from country to country; vancomycin drug acquisition costs are generally less than those of teicoplanin because vancomycin is available in a generic form. However, cost minimisation studies conducted in Europe have demonstrated that while the acquisition costs per dose of teicoplanin were approximately twice those of vancomycin, the total costs of a 2-week treatment with either agent were similar [17, 18]. The objective of our current study was to reproduce such findings based on the data of observational retrospective patient files in an another local (Turkish) setting.

Patients and methods

The records of patients who received either teicoplanin or vancomycin for the treatment of Gram-positive bacterial infections while hospitalised in the Internal Medicine Wards at Hacettepe University Hospital between 16 July 2003 and 22 November 2004 were reviewed retrospectively. For data collection purposes, an original patient record profile was made. In filling out these patient record profiles, patient records, patient receipts, on-line discharge cards concerning the hospitalisation dates and specific forms were used. The latter were specifically directed at monitoring vascular catheter infections and the empirical therapies initiated in daily clinical practice. According to the information obtained during expert meetings with clinicians, we felt that we could validly assume that the choice of either one of the drugs was not directly related to patient characteristics that one would expect to highly influence the costs (patient severity, age etc.).

Patients whose records could not be obtained, in particular, if patient profiles and hospital bills were not available, were excluded from the study.

Pharmacoeconomic methodology

Vancomycin and teicoplanin were compared within a cost minimisation framework, where the difference between them is reduced to a comparison of costs. This cost minimisation design is justified by our plausible initial assumption, postulating the equal efficacy of the two drugs. The analysis was conducted from a health-care provider's perspective, in particular that of the Department of Internal Medicine at Hacettepe University Hospital. The direct medical costs taken into account were:

1. Drug costs: next to drug acquisition costs, the loading dose of teicoplanin was explicitly included in the analysis.
2. Preparation and administration costs: the preparation and administration costs taken into consideration for both drugs were the specific infusion solution (for example, 0.9% NaCl 100 ml PVC), the infusion system and the syringes used. The cost of nursing staff time was not included in the analysis. When teicoplanin was administered intramuscularly only the cost of the syringe was included.
3. Drug monitoring costs: unlike teicoplanin, vancomycin requires serum level monitoring, and therefore the laboratory test costs and the regular monitoring of serum levels were included.
4. Costs of the treatment of adverse effects: in particular, the costs of directly treating the adverse effect or of prophylaxis (for example, pheniramine to prevent allergic reactions) were taken into consideration.

5. Costs of treatment failure: in patients in whom treatment was discontinued due to an adverse effect, ineffectiveness of therapy or for any other reason, the costs associated with the next alternative drug used were attributed to the costs of the therapy with the initial drug of choice.

The daily unit costs shown in Tables 1 and 2 were used to calculate the treatment costs for each patient. The drug price list valid from 9 September 2005 issued by the General Directorate of Pharmacy and Pharmaceuticals was used for calculating drug acquisition costs. Furthermore, the costs of hospital days during glycopeptide therapy were calculated using the Financial Year Budget Application Directive for 2005.

Data evaluation

Study data were analysed using the SPSS (version 11.0; SPSS, Chicago, IL, USA) statistical package and specific routines in R (version 2.5.0; R, Vienna, Austria) were used to fit probability distributions to data on length of stay and costs [19]. Categorical data were compared using the Chi-squared test or Fisher's exact test when the frequencies expected were very small, whereas the independent sample *t* test was reserved for continuous data assuming normal distributions [20]. However, normality does obviously not always apply to continuous data; the distribution of costs and health-care resources are often right-skewed. This occurs due to low percentages of patients with relatively extreme high costs (e.g. medical complications, prolonged hospital stay or the occurrence of side effects). Therefore, we explicitly modelled the distributional form of the costs and the length of stay [21]. In particular, we fitted distributions of the family of the generalised *F* distribution, which comprises, for example, the log-normal distribution, but is broader and thus allows more flexibility [22]. We used the Akaike Information Criterion AIC $= -2 \times$ (maximum log likelihood) $+ 2\,k$, where k is the number of model parameters as a goodness-of-fit measure. We took into account the estimated parameters of the generalised *F* distribution combined with the values of the AIC to make inferences on the distribution that fits the data best. Subsequently, a parametric regression model was used to estimate the effect of the different treatment groups on the outcomes (i.e. costs or length of stay). Finally, we used the moments of the best fitted distribution to estimate the expected value and the variance.

Table 1 Unit costs for drugs and resources in Turkish liras (TRY)[a] and Euros (EUR)

	Unit costs	
	TRY	EUR
Trade name of drugs		
Vancomycin (generic 1) 500 mg i.v. vial	11.87	7.34
Vancomycin (generic 2) 500 mg i.v. vial	11.60	7.18
Teicoplanin 400 mg i.v./i.m. vial	81.41	50.37
Pheniramine 2 ml 45.5 mg 5 ampule	0.51	0.32
Medical devices used during administration		
Serum 0.9% NaCl 100 ml PVC	2.28	1.41
Intravenous infusion kite	0.57	0.35
Syringe/injector	0.20	0.12
Total administration cost per dose	3.05	1.89
Costs of drug monitoring		
Unit cost of drug monitoring for vancomycin	21.19	13.11

[a] Indicative exchange rates announced at 15:30 on 27 January 2006 by the Central Bank of Turkey (1 EUR = 1.6163 TRY)

Table 2 Specific daily costs of hospital room types in Turkish liras (TRY)[a] and Euros (EUR)

Room type	Daily costs	
	TRY	EUR
Sterile room	118.64	73.40
Intensive care unit	88.98	55.05
Standard-care room[a]	8.31–26.69	5.14–16.51

[a] Exact costs vary depending on the specific class of the room

Results

A total of 79 patients were treated for Gram-positive hospital infections. They were all treated with either vancomycin or teicoplanin. Three patients were excluded from the final analysis due to the lack of access to patient profiles, hospital bills and hospital discharge cards. Therefore, the number of patients included in this study was 76.

Patients' characteristics

Of the 76 patients, 43 (56.6%) were men and 33 (43.4%) were women. No significant difference was observed when patients in the vancomycin and teicoplanin groups were compared in terms of gender ($p = 0.936$). The patients were between 17 and 83 years of age, with a mean age of 48.72 ± 15.32 years. The median age was 50 for both the vancomycin and teicoplanin groups ($p = 0.903$). Patients' characteristics are summarised in Table 3.

Of the co-morbid diseases and conditions encountered among patients, haematological malignancies were foremost at 47.1%, followed by solid tumours and neurological disorders at 10.6% each. In terms of indications for treatment, nearly half of the patients (48.7%) were given a

glycopeptide for the treatment of catheter-associated infections, and 4 patients received treatment due to septicaemia. For both comorbidity ($\chi^2 = 5.706$, $p = 0.68$) and indications ($\chi^2 = 4.555$, $p = 0.473$) no statistically significant differences were found between the two groups.

Clinical drug use

Teicoplanin was selected as first-line therapy in 43 patients (57%), whereas 33 patients (43%) received vancomycin as the initial drug of choice, 9 of whom were eventually switched to teicoplanin. Only 2 patients who were initially given teicoplanin were switched to vancomycin.

Local samples were taken from a total of 42 patients. Of these patients, 18 received teicoplanin and 24 received vancomycin as initial drug therapy. In 18 local samples bacterial growth was observed. No statistically significant difference was observed as a result of a Chi-squared test between patients receiving teicoplanin and those receiving vancomycin in terms of bacteria reproduction in their local samples ($\chi^2 = 1.946$, $p = 0.163$). Also, blood samples were taken from a total of 48 patients. Of these patients, 26 received teicoplanin and 22 received vancomycin as first-line drug therapy. In 15 blood samples bacterial growth was observed. No significant difference was observed as a result of a Chi-squared test between patients receiving teicoplanin and those receiving vancomycin in terms of bacteria reproduction in their blood samples ($\chi^2 = 1.031$, $p = 0.310$). The rest of the patients were given teicoplanin or vancomycin as empirical therapy.

For all patients receiving vancomycin a standard dose of 1,000 mg twice daily was given. With teicoplanin, however, varying doses were employed, such as 400 mg once daily for 17 patients (40%), 300 mg every 72 h for 1 patient, and 300 mg in every 48 h for 1 patient. In 2 patients, teicoplanin was given intramuscularly, while for the remaining patients intravenous infusion was preferred.

A single loading dose was only applied in 13 patients out of 43 who had received teicoplanin as first-line drug therapy (30%). The loading dose was 800 mg for 5 patients and 700 mg for 3 patients. One patient each received either 1,000 mg, 950 mg, 840 mg, 720 mg or 600 mg. Similarly, of the 9 patients who were switched to teicoplanin after initially receiving vancomycin, 3 (33%) had received loading doses, 600 mg in 2 patients and 1,000 mg in 1 patient.

Five of the patients who were given vancomycin as first-line therapy underwent drug monitoring tests, once in 3 patients, twice in 1 patient and four tests in 1 patient. Therefore, the total number of drug monitoring tests taken into account calculating the costs was 9.

Table 3 Patients' characteristics

	Vancomycin ($n = 33$)	Teicoplanin ($n = 43$)	Total ($n = 76$)
Age			
Average	48.97 ± 13.28	48.53 ± 16.87	48.72 ± 15.32
Range	18–72	17–83	17–83
Gender			
Men/women	18/15	25/18	43/33
Baseline disease, *n* (%)			
Haematological malignancy	15 (44.1)	25 (49.0)	40 (47.1)
Solid tumour	4 (11.8)	5 (9.8)	9 (10.6)
Kidney disease	1 (2.9)	1 (2.0)	2 (2.3)
Heart disease	2 (5.9)	3 (5.9)	5 (5.9)
Lung disease	–	2 (3.9)	2 (2.4)
Diabetes mellitus	2 (5.9)	4 (7.8)	6 (7.1)
Collagen tissue diseases and vasculitides	–	2 (3.9)	2 (2.4)
Neurological disorders	6 (17.7)	3 (5.9)	9 (10.6)
Other	4 (11.8)	6 (11.8)	10 (11.8)
Total[a]	34 (100)	51 (100)	85 (100)
Reason for treatment with a glycopeptide, *n* (%)			
Catheter-associated infection	15 (45.5)	22 (51.2)	37 (48.7)
Abdominal infection	2 (6.1)	2 (4.7)	4 (5.3)
Skin and soft tissue infection	10 (30.3)	12 (27.9)	22 (29.0)
CNS infection	5 (15.2)	2 (4.7)	7 (9.2)
Lung infection	–	2 (4.7)	2 (2.6)
Septicaemia	1 (3.0)	3 (7..0)	4 (5.3)
Total	33 (100)	43 (100)	76 (100)

[a] Totals add up to more than the numbers of patients, as one patient may suffer from more than one baseline disease

A total of 9 adverse drug reactions (ADRs) developed in 8 of the 76 patients (10.5%) who had received vancomycin and/or teicoplanin. The total number of ADRs encountered during teicoplanin use is only 2 (clouded consciousness in 1 patient and an increase in the creatinine level plus tremor), whereas of the 9 ADRs, 7 were due to vancomycin use (red-neck/red-man syndrome, drug eruption, an increase in the creatinine level + tremor in only 1 patient each, and skin eruption and increase in creatinine level in 4 patients).

Length of hospital stay

Overall, the patients' length of hospital stay varied between 14 and 261 days. Patients' days of hospitalisation during their glycopeptide antibiotic therapy varied between 1 and 55 days. The distribution of the length of stay (on glycopeptide therapy) appeared to be clearly skewed to the right. Based on the estimated parameters of the generalised F distribution and the AIC, the log-normal and the generalised gamma distribution provided the best fit for the total length of stay and the length of stay on glycopeptide therapy respectively. The expected values and expected standard deviations are given in Table 4, which are the best estimates of the mean population and standard deviation. Using a parametric regression, no significant differences were found between the vancomycin and teicoplanin groups with regard to the total length of stay ($p = 0.93$) and the number of days spent in hospital on glycopeptide therapy ($p = 0.15$) respectively.

Table 4 Length of hospital stay for patients receiving glycopeptides

	First-line drug therapy		p
	Teicoplanin	Vancomycin	
Total length of stay[a]			
EV ± SD	75.54 ± 59.33	68.34 ± 40.90	0.93
Range	14–249	22–261	–
Median	59	62	–
Length of stay on glycopeptide therapy[b]			
EV ± SD	12.75 ± 9.42	15.43 ± 15.97	0.15
Range	2–37	1–55	–
Median	13	13	–

SD = standard deviation; EV = expected value, based on the best fitting distribution

[a] Log-normal distribution fitted best

[b] Gamma distribution fitted best

Costs

The results of statistical analyses comparing the total costs of vancomycin and teicoplanin when given as first-line drug therapy are summarised in Table 5. All the sample distributions of the different cost components are clearly right-skewed except for the distributions of the ADR costs and the monitoring costs. For the right-skewed data the log-normal or generalised gamma distribution provided the best fit based on the estimated parameters of the generalised F distribution and the AIC. As there were only 5 patients who generated monitoring costs and 2 patients who generated ADR costs, no formal statistical analyses were performed on those data. Figure 1 shows the histogram, and the fitted generalised gamma distribution, of the total costs for both groups. We note that the sum of the expected values of the separate cost categories does not fully correspond to the expected value of the total costs. Although the parametric distributions fit the data well, the discrepancies are due to the fact that the log-normal or generalised gamma distributions do not fit the data 100%.

The acquisition cost of teicoplanin was found to be considerably higher than that of vancomycin ($p < 0.05$), while on the other hand, the administration costs of vancomycin were higher than those of teicoplanin ($p < 0.001$). Furthermore, the difference between the total costs was not statistically significant ($p = 0.33$). Besides, the estimated mean treatment cost per patient was 1,780 TRY (1,101 EUR) for teicoplanin and 1,429 TRY (884 EUR) for vancomycin, with statistical analysis failing to reveal any significant difference between the two drugs in terms of these total costs ($p = 0.33$).

Discussion

The selection of the specific evaluation method for pharmacoeconomic analyses depends on the nature of outcomes and the context in which the choices need to be made [23]. As in several articles it is indicated that both vancomycin and teicoplanin have comparable effectiveness [4, 24, 25], we performed a cost minimisation analysis.

The retrospective nature of our study did not allow for any intervention in the physicians' preference for drugs and therapy duration. However, the fact that 43 of the 76 patients included in the study received teicoplanin as the first-choice drug suggests a preference of physicians for teicoplanin over vancomycin.

The dosages of vancomycin/teicoplanin administered were similar to those suggested in the literature [14, 26, 27], according to which more ADRs are encountered during the use of vancomycin. In a meta-analysis conducted by Wood, it was emphasised that teicoplanin was tolerated better than vancomycin in terms of ADRs and nephrotoxicity [4]. Furthermore, in a study carried out by Codina et al. [28], it was found that ADRs due to vancomycin use (20.4%) were more frequent than those encountered with teicoplanin use (1.6%). Finally, we note that in contrast to

Table 5 Total costs of first-line glycopeptide therapy (vancomycin or teicoplanin)

Costs	Therapy						*p*
	Teicoplanin ($n = 43$)			Vancomycin ($n = 33$)			
	Expected value		SD	Expected value		SD	
	TRY	EUR	TRY	TRY	EUR	TRY	
Acquisition costs[a]	1,138.24	704.23	1,149.197	819.77	507.19	1,009.34	<0.05
Administration costs[a]	51.55	31.90	57.89	187.31	115.89	112.47	<0.001
Monitoring costs	0.00	0.00	0.00	5.78	3.58	16.98	*
ADR costs	0.00	0.00	0.00	1.07	0.66	4.94	*
Hospitalisation costs[b]	367.70	227.49	463.08	431.67	267.07	670.50	0.93
Total costs[a]	1,780.28	1,101.45	1,259.853	1,429.23	884.26	1,362.97	0.33

*Excluded from statistical analyses, numbers for monitoring costs are averages taken from the sample data, whereas elsewhere, expected values from fitted distributions are shown

[a] Gamma distribution fitted best

[b] Log-normal distribution fitted best

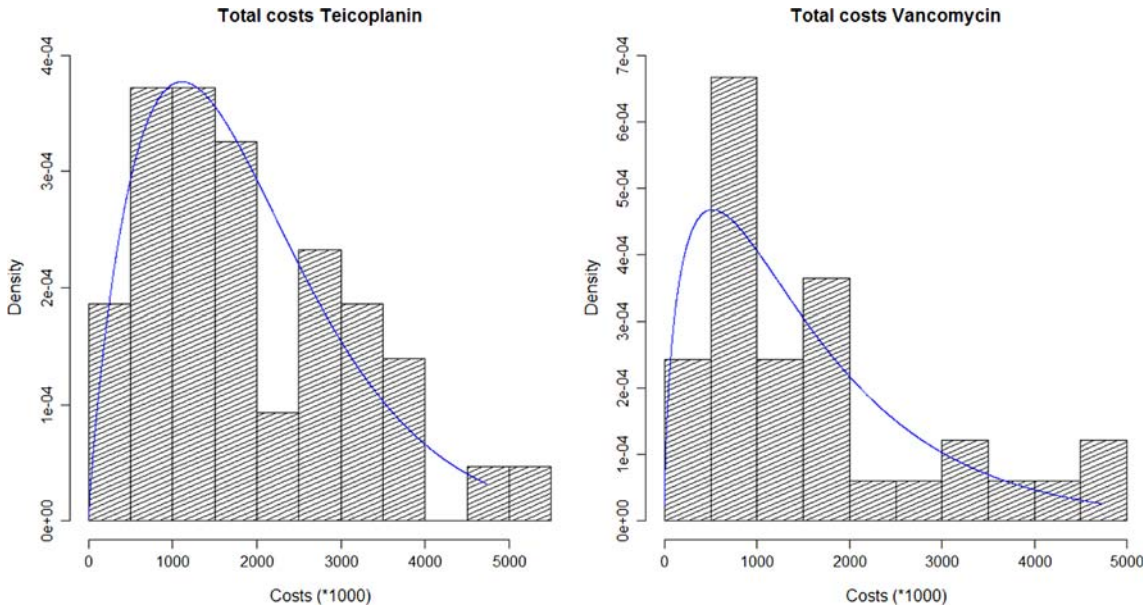

Fig. 1 Total costs observed and the fitted generalised gamma distributions

vancomycin use, the red-neck (red-man) syndrome is not a significant problem during teicoplanin use [29]. In our study it was observed that more ADRs occurred when vancomycin was selected and used in the patients. However, due to the low number of patients and ADRs in this study, it may be misleading to draw certain conclusions. The ADRs mentioned could be investigated in more detail in a larger patient group.

The average total therapy costs per patient were estimated at 1,780 TRY (1,101 EUR) and 1,429 TRY (884 EUR) for patients who received teicoplanin and vancomycin as first-choice therapy respectively. This difference was not statistically significant. Although the acquisition costs of vancomycin were significantly lower than those of teicoplanin, the administration costs of vancomycin were significantly higher ($p < 0.001$). For patients who received vancomycin as first-line therapy, the drug administration costs contributed 13% to the total therapy cost. This rate was 3% in patients who were given teicoplanin. Furthermore, teicoplanin as first-line therapy does not require the monitoring of serum levels of the drug. Our finding is also supported by another study carried out by Simoens et al. If vancomycin was preferred in the treatment of catheter-related infections, higher costs of laboratory tests as a result of more frequent monitoring of serum concentrations occurred [30].

Previously conducted European pharmacoeconomic analyses have already demonstrated that 2-week courses of either glycopeptide (teicoplanin or vancomycin) have similar overall costs, when acquisition, preparation, administration, and monitoring costs are included [17]. A retrospective cost analysis study conducted by Bucaneve et al. showed that despite the higher acquisition cost of teicoplanin in comparison to vancomycin, the lower incidence of adverse effects associated with teicoplanin and its ease of administration (a single daily dose) resulted in equivalent overall treatment costs of teicoplanin and vancomycin-containing regimens [31]. Vazquez et al. [24] demonstrated that teicoplanin and vancomycin could be administered in neutropenic haematologic patients eventuating in similar efficacy and direct costs. Furthermore, Menichetti compared the clinical and microbiological efficacy, cost per patient and tolerability of teicoplanin and vancomycin as empirical or second-line treatment for febrile neutropenic episodes in patients with haematological or solid malignancies. While in terms of efficacy and cost teicoplanin and vancomycin were found to be equivalent, teicoplanin was better tolerated and could be used effectively for out-patient treatment [25].

In contrast, a cost minimisation analysis study conducted by Abad et al. suggested that vancomycin was more efficient than teicoplanin for the treatment of infections caused by Gram-positive organisms in patients in Intensive Care Units, since the efficacy and the safety of vancomycin and teicoplanin seemed similar and the global treatment costs for vancomycin were lower [32]. In the prospective cost analysis study conducted by Davey et al. the mean daily costs were estimated at £52.40 (approximately 65.38 EUR) for teicoplanin and £31.13 (approximately 38.84 EUR) for vancomycin. Use of a loading dose of teicoplanin significantly increased the mean daily drug costs if the duration of treatment was less than 10 days. However, administration of teicoplanin via the intramuscular route would reduce the costs because i.v. cannulae would not be required [33]. Likewise, in a recent cost minimisation analysis conducted with a Delphi survey technique, the mean treatment costs amounted to 1,272 EUR with teicoplanin and 1,041 EUR with vancomycin. The findings do, however, indicate that the physicians administer higher loading doses of teicoplanin than recommended in the drug information leaflet [30].

A study assessing the economic impact of vancomycin use versus teicoplanin use as antibiotic prophylaxis for patients undergoing surgery for valve replacement and coronary artery by-pass procedures conducted by Codina et al. indicated that teicoplanin is the preferred option if the drug is administered in surgical wards, while vancomycin is the least costly option when administered in medical wards [28].

The outcomes of pharmacoeconomic evaluations may vary due to the specific design of each individual study and/or the perspective selected. However, we note that the results obtained in this study were generally comparable to those of most other country-specific studies that compared these glycopeptide antibiotics, i.e. the costs of vancomycin and teicoplanin treatment do not significantly differ in a situation where equal effectiveness is assumed. If this is the case, other potential advantages of teicoplanin over vancomycin as reported by others [1, 4, 11–13, 16, 28, 29], such as differing safety profiles or advantages in administration, may ultimately decide which should be preferred.

Our retrospective approach should be considered with caution. Some bias may have been introduced, for example, if physicians considered the clinical information of the patient in the decision whether to choose one drug or the other. Further research should be directed towards prospectively designing this type of investigation and ideally randomised settings should be chosen.

Conclusion

This cost minimisation analysis shows that the average costs per patient observed did not differ significantly whether vancomycin or teicoplanin was used. However, from a cost minimisation perspective, hospital directors may consider teicoplanin to be a relevant option in addition to vancomycin. Other potential advantages of teicoplanin over vancomycin as reported by others, such as differing safety profiles or advantages in administration, may ultimately decide which should be preferred. On the other hand, though, it seems that it is essential for decision-makers to estimate their own likely direct costs when making a decision on which antibiotic therapy to choose.

By taking into consideration a number of similar studies that have been conducted in various settings, and the level of evidence of the relative contributions of acquisition and/or monitoring costs in relation to these two antibiotics, there is a need for a large and prospective randomised trial.

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