

# An Assessment of Vancomycin Use in 2 Tertiary Care Hospitals

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## ABSTRACT

**Background and Objective:** The emergence of vancomycin resistance among gram-positive organisms over the past 10 years has raised serious health concerns worldwide. In response, several government organizations have developed recommendations for the appropriate use of vancomycin. The goal of this study was to assess the appropriateness of vancomycin use at 2 tertiary care teaching hospitals in relation to a set of modified guidelines.

**Methods:** All adult patients receiving vancomycin at the Health Sciences Centre and St Boniface General Hospital in Winnipeg, Manitoba, between October 1 and November 30, 1999, were eligible for prospective or retrospective chart review. Patients were identified during order entry and by means of the pharmacy information system. Each patient's vancomycin therapy was assessed according to modified Centers for Disease Control and Prevention and Laboratory Centre for Disease Control guidelines.

**Results:** A total of 199 courses of vancomycin therapy were assessed. Vancomycin was started for prophylaxis in 54 (27%) cases, empiric use in 116 (58%) cases, and documented infections in 28 (14%) cases (indication was unknown in one case). Vancomycin use was inappropriate in 89 (45%) of 199 courses of therapy. Inappropriate empiric use (52 courses) and prophylactic use (27 courses) accounted for the majority of these inappropriate cases (58% and 30%, respectively).

**Conclusions:** Vancomycin was prescribed inappropriately in almost half of all cases in these 2 institutions. These results are comparable to previously reported assessments of vancomycin use. Despite availability of guidelines on vancomycin use, it appears that clinician education, improved  $\beta$ -lactam allergy workup, and vigilance are warranted, even in the absence of vancomycin resistance.

**Key words:** vancomycin, vancomycin-resistant enterococcus, drug use evaluation

## RÉSUMÉ

**Historique et objectif :** L'émergence de bactéries Gram-positives résistant à la vancomycine au cours des dix dernières années a soulevé de sérieuses préoccupations pour la santé partout dans le monde. Nombre d'organisations gouvernementales ont réagi en mettant de l'avant des recommandations sur l'utilisation appropriée de la vancomycine. L'objectif de cette étude était d'évaluer, à partir de lignes directrices modifiées, la pertinence de l'utilisation de la vancomycine dans deux hôpitaux universitaires de soins tertiaires.

**Méthodes :** Tous les patients adultes du *Health Sciences Centre* et de l'*Hôpital général St-Boniface de Winnipeg*, au Manitoba, qui ont reçu de la vancomycine entre le 1er octobre et le 30 novembre 1999, étaient admissibles à l'étude prospective et rétrospective de leurs dossiers médicaux. Les patients ont été identifiés lors de la saisie des ordonnances et à l'aide du système d'information de la pharmacie. Pour chacun des patients, le traitement à la vancomycine a été évalué en fonction des lignes directrices modifiées des Centers for Disease Control and Prevention et du Laboratoire de lutte contre la maladie.

**Résultats :** Au total, 199 traitements à la vancomycine ont été évalués. La vancomycine a été prescrite comme traitement prophylactique dans 54 (27 %) cas, comme traitement empirique dans 116 (58 %) cas et dans 28 (14 %) cas documentés d'infections (aucune indication n'était spécifiée dans un des cas). L'utilisation de la vancomycine était inappropriée dans 89 (45 %) des 199 traitements. Cinquante-deux traitements empiriques et 27 traitements prophylactiques représentaient la plupart de ces cas inappropriés (respectivement 58 % et 30 %).

**Conclusions :** La vancomycine a été prescrite de façon inappropriée dans près de la moitié des cas dans ces deux établissements. Ces résultats sont comparables à ceux d'études antérieures sur l'utilisation de la vancomycine. Malgré la disponibilité de lignes directrices sur l'utilisation de la vancomycine, il semble que l'éducation des cliniciens, de meilleurs tests d'allergie aux  $\beta$ -lactamines et la vigilance s'imposent, même en l'absence de résistance à la vancomycine.

**Mots clés :** vancomycine, entérocoques résistant à la vancomycine, évaluation de l'utilisation des médicaments

Can J Hosp Pharm 2004;57:150-7

## INTRODUCTION

The emergence of antibiotic resistance over the past 20 years has raised serious health concerns in the medical community and the lay press worldwide. The identification of vancomycin-resistant enterococci (VRE) over the past decade is of particular concern. Enterococci, gram-positive bacteria responsible for infections such as endocarditis, urinary tract infections, and bacteremia, represented the third most common group of nosocomial pathogens between 1992 and 1999.<sup>1</sup> Enterococcal infections have traditionally been treated with penicillin, usually in combination with an aminoglycoside. Vancomycin, a glycopeptide antibiotic, is commonly employed in the treatment of enterococcal and other gram-positive infections in situations where the isolate is resistant to  $\beta$ -lactam antibiotics or the patient is allergic to  $\beta$ -lactam antibiotics.<sup>2</sup>

VRE was first isolated in 1988 by Uttley and others.<sup>3</sup> Over the period 1989 to 1997, the Centers for Disease Control and Prevention (CDC) Nosocomial Infections Surveillance System reported a substantial increase in the incidence of nosocomial VRE infections among patients not being cared for in an intensive care unit (ICU), from 0.3% to 15.4%.<sup>4</sup> VRE is a major problem because few treatment options exist for such infections, VRE infection is associated with a high mortality rate, and vancomycin resistance may be transferred from enterococci to other bacteria, including *Staphylococcus aureus* and *Staphylococcus epidermidis*.<sup>5-12</sup> Therefore, inappropriate use of vancomycin and the potential for development of resistance are of great concern.

VRE colonization has been associated with the use of oral and parenteral forms of this glycopeptide.<sup>13-17</sup> VRE has also been isolated from patients receiving cephalosporins and antianaerobic antimicrobials.<sup>14,18-20</sup> Other risk factors associated with colonization and infection by VRE are admission to an ICU, immunosuppression (e.g., in patients undergoing transplantation or in hematology and oncology patients), chronic renal failure requiring dialysis, and presence of an indwelling urinary or central venous catheter.<sup>21,22</sup>

In response to these problems and risk factors, the Hospital Infection Control Practices Advisory Committee (HICPAC) of the CDC<sup>23</sup> and the Laboratory Centre for Disease Control (LCDC) of Health Canada<sup>21</sup> developed guidelines for the appropriate use of vancomycin. In addition, the CDC has recommended that all institutions, even those without documented cases of VRE, perform an audit of vancomycin use to assess adherence with CDC guidelines.<sup>23</sup> Available data suggest that a large proportion of vancomycin use is inappropriate.<sup>24-27</sup>

As is the case for many centres in Canada, endemic VRE is virtually nonexistent in Winnipeg. The majority of cases have involved patients previously colonized with VRE (i.e., VRE imported from institutions in other cities). As a result, the CDC and LCDC recommendations have not been promoted or followed, nor has vancomycin use been reviewed at the Health Sciences Centre (HSC) or St Boniface General Hospital (SBGH), 2 tertiary care teaching hospitals associated with the University of Manitoba. Despite the increase in vancomycin use at both institutions over the past decade, physicians have remained complacent regarding the threat of VRE and the overuse of antibiotics. This study was undertaken to assess the appropriateness of vancomycin use in adult patients at both HSC and SBGH in relation to a set of guidelines developed from the CDC and LCDC recommendations. In addition, it was of interest to determine if patients receiving vancomycin at these institutions had risk factors for the acquisition of VRE.

## METHODS

The study was conducted at the HSC (800 beds) and SBGH (500 beds) in Winnipeg, Manitoba. Vancomycin use was not restricted at either institution before or during this study. Guidelines for appropriate vancomycin use published by the CDC<sup>23</sup> were modified and adopted by the HSC Antibiotic Subcommittee in 1995. These guidelines were subsequently modified, on the basis of LCDC guidelines,<sup>21</sup> for this vancomycin review to define several additional indications as appropriate: prophylactic use before surgery or empiric use for suspected infection in individuals with type I anaphylactic  $\beta$ -lactam allergy, empiric use in patients with previous infection with methicillin-resistant *S. aureus*, empiric use for treatment of infection of a burn wound, and empiric use for treatment of infection of an indwelling prosthesis (see Appendix 1). In this study, vancomycin use was assessed as appropriate or inappropriate in relation to these modified guidelines for vancomycin use.

All adult patients older than 18 years of age for whom vancomycin was prescribed at the HSC or SBGH between October 1 and November 30, 1999, were eligible for inclusion in the study. Eligible patients were identified from computer-generated lists, during the order entry process, and by means of pharmacy prescription records. Patient charts were arbitrarily chosen for retrospective or prospective audit. Data were collected primarily from the patient chart, but the study coordinator also collected information from the medical team and from the patient when this was feasible.

Data extracted included demographic characteristics, descriptions of  $\beta$ -lactam allergy, prescriber information, indication for vancomycin use, risk factors for VRE acquisition, and culture and sensitivity results. Data were entered directly into a Microsoft Access database prepared for data storage and analysis. Selected cases were reviewed with an infectious diseases specialist to ensure uniform interpretation of vancomycin appropriateness.

## RESULTS

### Patient Characteristics

Vancomycin was prescribed for a total of 261 patients during the 2-month period, 148 at HSC and 113 at SBGH. Vancomycin therapy was audited for 192 patients. Data for the remaining 69 patients were not reviewed because the chart was not available or

because of investigator time constraints. Thirteen patients received 2 courses of vancomycin therapy during this period, so a total of 205 courses of therapy were identified. Of these, 199 courses (97% of the total) in 187 patients were reviewed; information for the remaining 6 courses was not available. Sixty-three (32%) of the 199 courses were followed prospectively (i.e., data were collected, but there were no interventions) and 136 courses (68%) were assessed retrospectively.

$\beta$ -Lactam allergy was reported in 78 (42%) of 187 patients (Table 1). Of these 78 cases, type I reactions occurred in 22 (28%) and rash or gastrointestinal intolerance was reported in 43 (55%).

The average number of VRE risk factors per patient ( $\pm$  standard deviation [SD]) was  $1.8 \pm 1.1$ ; presence of a central venous catheter was the most common risk factor (Table 2).

**Table 1. Characteristics of 187 Patients Receiving Vancomycin Therapy at 2 Winnipeg Hospitals**

Characteristic*	Institution; No. (and %) of Patients†					
	HSC (n = 111)		SBGH (n = 76)		Overall (n = 187)	
No. of men	54	(49)	30	(39)	84	(45)
No. of women	57	(51)	46	(61)	103	(55)
Mean age $\pm$ SD (years)	57 $\pm$ 16		65 $\pm$ 15		60 $\pm$ 16	
Comorbid condition	106	(95)	74	(97)	180	(96)
$\beta$ -Lactam allergy reported	32	(29)	46	(61)	78	(42)
<b>Nature of allergic reaction‡</b>						
Anaphylaxis or angioedema	6	(5)	3	(4)	9	(5)
Urticaria	4	(4)	4	(5)	8	(4)
Laryngospasm	3	(3)	1	(1)	4	(2)
Rash	12	(11)	20	(26)	32	(17)
Unknown (not specified)	8	(7)	11	(14)	19	(10)
Adverse effect (e.g., nausea)	3	(3)	9	(12)	12	(6)

HSC = Health Sciences Centre, Winnipeg, Manitoba; SBGH = St Boniface General Hospital, Winnipeg, Manitoba; SD = standard deviation.

\*Cases were also screened for hemolytic anemia and serum sickness, but no cases were identified.

†Except where indicated otherwise.

‡Some patients had more than one reported reaction.

**Table 2. Risk Factors for Vancomycin-Resistant *Enterococcus***

Risk Factor	Institution; No. (and %) of Patients					
	HSC (n = 111)		SBGH (n = 76)		Overall (n = 187)	
Patient in ICU	24	(22)	9	(12)	33	(18)
Transplant or oncology patient	21	(19)	5	(7)	26	(14)
Indwelling urinary catheter present	36	(32)	41	(54)	77	(41)
Central venous catheter present	68	(61)	25	(33)	93	(50)
Previous vancomycin use	3	(3)	1	(1)	4	(2)
Previous broad-spectrum antibiotic use*	38	(34)	20	(26)	58	(31)
Dialysis patient	37	(33)	16	(21)	53	(28)

HSC = Health Sciences Centre, Winnipeg, Manitoba; SBGH = St Boniface General Hospital, Winnipeg, Manitoba; ICU = intensive care unit.

\*Defined as patient having received at least one dose of a third-generation cephalosporin, imipenem, flouroquinolone, aminoglycoside, or antianaerobic antibiotic during the current hospital admission.



**Table 3. Indications for Vancomycin Use**

Indication	Institution; No. (and %) of Courses					
	HSC (n = 118)		SBGH (n = 81)		Overall (n = 199)	
<b>Prophylactic Use</b>						
<i>Major procedure</i>						
Prosthetic joint	2	(2)	20	(25)	22	(11)
Heart valve	1	(1)	1	(1)	2	(1)
Vascular graft	5	(4)	8	(10)	13	(7)
CSF shunt	1	(1)	0		1	(1)
Other	1	(1)	1	(1)	2	(1)
Subtotal	10	(8)	30	(37)	40	(20)
<i>Routine procedure</i>						
Endocarditis	1	(1)	0		1	(1)
Other prophylactic use	1	(1)	0		1	(1)
Total	18	(15)	36	(44)	54	(27)
<b>Empiric Use*</b>						
Sepsis	37	(31)	12	(15)	49	(25)
Infection of indwelling prosthesis	14	(12)	12	(15)	26	(13)
Febrile neutropenia	9	(8)	1	(1)	10	(5)
Meningitis	5	(4)	1	(1)	6	(3)
Osteomyelitis	3	(3)	2	(2)	5	(3)
Endocarditis	2	(2)	3	(4)	5	(3)
Peritonitis	1	(1)	4	(5)	5	(3)
Other	11	(9)	3	(4)	14	(7)
Total	80	(68)	36	(44)	116	(58)
<b>Documented infection</b>	20	(17)	8	(10)	28	(14)
<b>Unknown indication</b>	0		1	(1)	1	(1)

HSC = Health Sciences Centre, Winnipeg, Manitoba; SBGH = St Boniface General Hospital, Winnipeg, Manitoba; CSF = cerebrospinal fluid.  
 \*For some courses of empiric therapy at each institution, there was more than one indication; therefore, the total number of courses is less than the sum of courses by indication.

### Patterns of Vancomycin Use

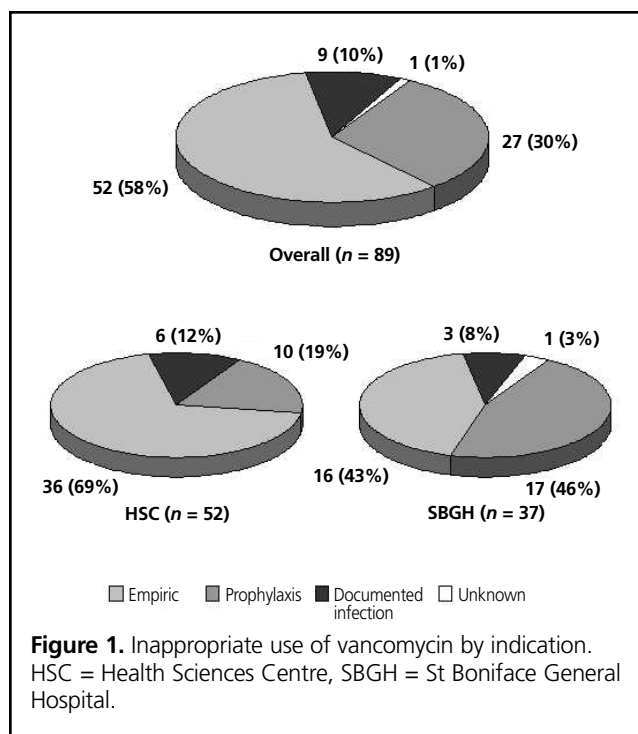
Of the 199 courses of vancomycin therapy, the drug was started for prophylaxis in 54 cases (27%), for empiric use in 116 (58%), and for treatment of documented infection in 28 (14%) (Table 3); the indication could not be determined in one case. Vancomycin was used more often for surgical prophylaxis at SBGH than at HSC (44% [36/81] versus 15% [18/118]), whereas it was used more often for empiric treatment of infection at HSC than at SBGH (68% [80/118] versus 44% [36/81]) (Table 3). In 95 (82%) of the courses of therapy for empiric use, culture results indicated a gram-positive organism. The most common organisms isolated were *S. epidermidis* (in 34% of cases), coagulase-negative *Staphylococcus* (in 22%), *S. aureus* (in 20%), enterococcal species (in 13%), *Enterococcus faecalis* (in 7%), *Enterococcus faecium* (in 4%), and nonhemolytic streptococcus (in 2%).

A similar proportion of courses were initiated for documented infections at HSC and SBGH (17% [20/118] versus 10% [8/81]) (Table 3). Overall the medical service

(115 courses [58%]) and the surgical service (80 courses [40%]) were primarily responsible for vancomycin prescribing, with the obstetric and gynecology service contributing the remainder. The infectious diseases service was consulted in 60 (30%) of the cases (39 [33%] of those at HSC and 21 [26%] of those at SBGH).

### Adherence with Guidelines

According to the modified guidelines (Appendix 1), vancomycin use was deemed inappropriate in 89 (45%) of the 199 courses. Inappropriate empiric use, defined as inappropriate initial selection or inappropriate continuation of therapy once culture and sensitivity results were known, accounted for 52 cases (58%) of inappropriate use (Figure 1). Inappropriate use for prophylaxis and documented infection accounted for 27 (30%) and 9 (10%) of all cases of inappropriate use, respectively; the course for which the indication could not be determined was also deemed inappropriate. The average duration ( $\pm$  SD) of an inappropriate course of therapy was  $8 \pm 11$  days, and the average number of doses was  $9 \pm 14$ .



### Prophylactic Use

In 25 (93%) of the 27 inappropriate prophylactic courses, a  $\beta$ -lactam allergy was reported on the patient chart, but the reaction did not meet the criteria of a type I allergic reaction. Inappropriate prophylactic use accounted for 10 (19%) of the 52 inappropriate courses at HSC and 17 (46%) of the 37 inappropriate courses at SBGH.

### Empiric Use

Inappropriate selection of initial therapy accounted for 21 (40%) of the 52 inappropriate courses of empiric therapy. Inappropriate continuation of vancomycin therapy after culture and sensitivity results became available accounted for another 21 (40%) of inappropriate empiric courses. In the remaining 10 (19%) inappropriate empiric courses, both the initial selection and continued use after culture and sensitivity results became available were deemed inappropriate. Indications other than those listed in the guidelines accounted for 11 (35%) of the 31 cases in which the initial choice of vancomycin was inappropriate. Inappropriate empiric use accounted for 36 (69%) of the 52 inappropriate courses at HSC and 16 (43%) of the 37 inappropriate courses at SBGH.

### Documented Infection

In 4 (44%) of the 9 inappropriate courses for documented infection, the organisms were sensitive to

antibiotics other than vancomycin; 3 (33%) of the 9 courses were inappropriate because the patient did not have a type I allergy to  $\beta$ -lactam antimicrobials. In 2 cases (22%), vancomycin use did not meet criteria for oral use for the treatment of antibiotic-associated colitis. Inappropriate use for documented infections accounted for 6 (12%) of the 52 inappropriate courses at HSC and 3 (8%) of the 37 inappropriate courses at SBGH.

### Service Prescribing Vancomycin

Of the 89 inappropriate courses, 52 (58%) were initiated by the medical service and 37 (42%) by the surgical service. The infectious disease service was consulted in 20 (22%) of these inappropriate courses.

### DISCUSSION

In almost 50% of all courses of vancomycin therapy at these 2 institutions, use of this drug was considered inappropriate according to the modified guidelines. This rate of inappropriate use is comparable to rates reported from other audits of vancomycin (33% to 64%).<sup>24-28</sup>

Several hospitals in Canada and the United States have evaluated the appropriateness of their vancomycin use in relation to CDC guidelines or modified versions of those guidelines. Johnson and others<sup>24</sup> completed a chart review for 135 patients to assess the appropriateness of vancomycin use according to the CDC guidelines. Vancomycin use was deemed inappropriate in 60% of the patients. As well, 21% of the patients continued to receive vancomycin even though culture results and susceptibility data suggested appropriate alternative antibiotics to streamline therapy. Wright and Wrenn<sup>25</sup> assessed the appropriateness of vancomycin use in patients presenting to their emergency department before and after publication of the CDC guidelines in 1995. Using a modified version of the CDC guidelines, the investigators found that vancomycin use had been appropriate in 44% of patients before publication of the CDC guidelines, in 62% of patients the year after publication, and in 71% the year after that. Another study assessed adherence to CDC guidelines after implementation of a restriction policy requiring approval of the infectious diseases service to continue vancomycin therapy longer than 72 hours.<sup>28</sup> Despite the restriction policy, vancomycin use was deemed inappropriate in 33% of courses. In other studies, the incidence of inappropriate vancomycin orders, according to CDC or institution guidelines, was 61% and 64%.<sup>26,27</sup>



Several patient groups, such as those undergoing dialysis, those receiving critical care, and hematology or oncology patients, have been identified as being at risk of VRE colonization and infection.<sup>21,22</sup> Although VRE is not endemic within the 2 Winnipeg institutions studied, the mean per-patient number of risk factors for colonization or infection with VRE was almost 2. Because many of these risk factors cannot be modified, the importance of appropriate antibiotic use is crucial in minimizing the emergence of VRE.

Several patterns of use were noted. At HSC vancomycin was prescribed primarily by the medical service, whereas at SBGH the drug was prescribed primarily by the orthopedic and vascular surgery services. The reason for this difference is unknown. Both hospitals perform orthopedic and cardiovascular surgery. In addition, sampling techniques should have captured surgical use for these indications at HSC. One possible explanation may be that patients receiving dialysis on an outpatient basis were not included in the pharmacy database at SBGH.

This study identified 3 major areas of concern with respect to vancomycin use: unnecessary initial empiric use, prolonged empiric use despite cultures indicating other appropriate antibiotic choices, and unnecessary prophylactic use.

Inappropriate empiric courses accounted for over half of all cases of inappropriate use, mostly because of inappropriate selection of vancomycin for the indication but also because of a failure to streamline therapy once culture and sensitivity results were available. In a large number of cases, patients continued to receive vancomycin even when their culture and sensitivity results showed *S. epidermidis* and *S. aureus* sensitive to  $\beta$ -lactam agents. Hospital staff must become better educated about institution-specific guidelines for appropriate vancomycin use to decrease this inappropriate empiric use.

Inappropriate prophylactic use was primarily due to failure to recognize the nature of  $\beta$ -lactam allergy in patients for whom an allergy was reported. In many cases the allergy was described as a rash or gastrointestinal intolerance. Most of the patients who received vancomycin because of a reported allergy were receiving prophylactic therapy before an elective orthopedic or cardiovascular surgical procedure. To improve vancomycin use in these 2 institutions, improvements are needed in allergy charting mechanisms, so that intolerance to  $\beta$ -lactam antibiotics can be easily differentiated from anaphylaxis; in addition, penicillin skin testing should be investigated as

a tool to help identify patients with a reported penicillin allergy who could safely receive a  $\beta$ -lactam antibiotic. Although Phillips and others<sup>29</sup> found that preoperative penicillin skin testing was associated with significant cost, this strategy might decrease the pressures selecting for vancomycin-resistant organisms and therefore reduce long-term costs.

There are several limitations to this project. First, the study was primarily retrospective and therefore relied heavily on information in the patients' charts. Second, the data gathered were descriptive, which means that the investigators can only speculate about the significance of certain observations related to vancomycin use and its appropriateness at both hospitals. Finally, because of the study design, the results are generalizable only to large teaching institutions.

Nevertheless, this study highlights continuing concerns about the use of vancomycin. Interventions to promote the rational use of vancomycin, such as reinforcement of existing guidelines with staff, must be pursued. In addition, key pharmacists and physicians should be identified and asked to intervene in cases of apparent inappropriate use.

Pharmacist and physician vigilance in assessment and documentation of a patient's medication and allergy history is a critical step in promoting appropriate vancomycin use. Ideally, the record of the patient's allergy status, in both the chart and the hospital computer system, should include not only the list of medications to which the patient is allergic, but also when any reactions happened, the time course of reactions, the specific symptoms, how the reactions were managed, whether the patient has received the drug (or drugs) since the reaction, and if allergy testing has been done since the reaction. Access to a complete allergy history would facilitate more appropriate antibiotic use by clinicians.

Absence of endemic VRE, along with decreasing acquisition costs for vancomycin over the past decade, has resulted in complacency in Winnipeg, such that the appropriate use of vancomycin has not been adequately emphasized at the 2 institutions evaluated here. The recent pharmacist shortage and a focus on high-cost and high-volume drug items (e.g., erythropoietin and low-molecular-weight heparins) have limited the institutions' ability to conduct interventions on certain antimicrobial agents. With the low prevalence of VRE, good infection control procedures and surveillance programs have become the primary approach for detecting and controlling VRE in Canadian hospitals.

In conclusion, this study represents a good sample of vancomycin use at 2 large teaching hospitals. The results suggest that vancomycin use at these tertiary care institutions is similar and that most of the inappropriate use of vancomycin relates to empiric use of this agent for infection. Although the percentage of appropriate courses of vancomycin therapy was similar to that of other institutions, vancomycin use at both of these institutions must be improved. Interventions such as clinician education, improved  $\beta$ -lactam allergy workup, and vigilance appear warranted even in the absence of vancomycin resistance.

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**Appendix 1.** Audit Criteria for Vancomycin Use at Health Sciences Centre and St Boniface General Hospital, Winnipeg, Manitoba (Based on Published Recommendations<sup>21,23</sup>)

For the purposes of this document a type I allergy to beta lactam antimicrobials (BLAs) is defined as the history of anaphylaxis/angioedema, or urticaria, or laryngospasm.

**Situations in which the use of vancomycin is appropriate or acceptable:**

**A. Prophylaxis**

In patients with a reported type I or unknown allergy to BLAs who require:

1. Endocarditis prophylaxis prior to a surgical procedure
2. Prophylaxis for surgical implantation of a prosthetic joint, heart valve, vascular graft, or CSF shunt
3. Routine surgical prophylaxis

**B. Empiric Use for the Treatment of:**

1. A febrile neutropenic episode, if one of the following applies:
  - a. Inflamed central venous exit site
  - b. Fever persists longer than 72 hours after the initiation of empirical treatment without vancomycin and the patient has a central venous catheter
2. Sepsis, if one of the following applies:
  - a. Presence of a central venous catheter
  - b. Patients with a reported type I or unknown allergy to BLAs
  - c. Patients that have had previous colonization with MRSA
3. Endocarditis, if one of the following applies:
  - a. Prosthetic valve
  - b. Patients with a reported type I or unknown allergy to BLAs
  - c. Patients that have had previous colonization with MRSA
4. Meningitis, if one of the following applies:
  - a. Post-neurosurgery/head trauma
  - b. Patient has an indwelling CSF shunt
  - c. Patients with a reported type I or unknown allergy to BLAs
  - d. Patients that have had previous colonization with MRSA

5. Osteomyelitis, if one of the following applies:
  - a. Patients with a reported type I or unknown allergy to BLAs
  - b. Patients that have had previous colonization with MRSA
6. A burn wound infection.
7. Peritonitis, if one of the following applies:
  - a. Patient has an indwelling peritoneal catheter
  - b. Patients with a reported type I or unknown allergy to BLAs
8. An infection of an indwelling prostheses (e.g., pacemaker, central venous catheter, vascular graft, joint)

Once culture and sensitivity results are known, therapy should be streamlined and if vancomycin is continued its appropriateness should be reassessed as follows:

The continuation of vancomycin is appropriate only if one of the following applies:

1. For the treatment of infections due to beta-lactam resistant gram-positive microorganisms
2. For the treatment of infections due to gram-positive microorganisms in patients with a reported type I or unknown allergy to BLAs.

**Note:** If culture results are negative or inconclusive yet clinical signs still indicate infection, then the patient must meet the empirical criteria for use of vancomycin in order for its use to be considered appropriate.

**C. Therapeutic Use for the Treatment of:**

1. Infections due to beta-lactam resistant gram-positive microorganisms
2. Infections due to gram-positive microorganisms in patients with a reported type I or unknown allergy to BLAs
3. Antibiotic-associated colitis (AAC) that has failed to respond to oral metronidazole therapy or is severe and potentially life-threatening.

CSF = cerebrospinal fluid, MRSA = methicillin-resistant *Staphylococcus aureus*.

