Antibiotic prophylaxis for cardiac surgery in Australia

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ABSTRACT

Objective: To evaluate national practice for antibiotic prophylaxis in cardiac surgery with respect to the use of protocols, agent selection and duration of administration.

Design, setting and participants: Two point-prevalence surveys of intensive care units in 24 public and 27 private hospitals performing cardiac surgery in Australia, conducted in 2004 and 2008, using a structured telephone questionnaire of the attending senior intensive care clinician in each unit.

Main outcome measures: Existence of a protocol in the unit for antibiotic prophylaxis, specific antibiotic agents used and their duration of administration.

Results: Between 2004 and 2008, reported protocol use increased from 58% to 80% ($P = 0.02$), while concordance with version 13 of the Australian *Therapeutic guidelines: antibiotic* for both choice of agent and timing (duration of administration) remained around 10%. Use of multiple agents was common, as was continued antibiotic administration after completion of surgery. Over 4 years, the proportion of cardiac surgical units reporting vancomycin administration for routine valve surgery prophylaxis doubled to 62% ($P < 0.001$).

Conclusion: Despite an increase in reported protocol use for antibiotic prophylaxis in cardiac surgery, concordance with national antibiotic guidelines remained low, with duration of antibiotic administration deviating most from recommendations. Prophylactic vancomycin use appears to have increased substantially in recent years. Clinical implementation of recommended perioperative cardiac surgical antibiotic prophylaxis may not occur until supported by evidence from either a large prospective randomised study or standardised national surveillance of cardiac surgical site infection rates.

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Internationally, recommendations and practice differ regarding choice of agent and duration of administration of prophylactic antibiotics for cardiac surgery.[1] The current Australian *Therapeutic guidelines: antibiotic* (version 13) recommend either cephalothin or cephazolin or the co-administration of flucloxacillin and gentamicin at the time of induction of anaesthesia before surgery (Box 1).[2] Notably, the guidelines recommend against ongoing administration of antibiotic agents after completion of surgery. Although routine use of vancomycin is discouraged, this important agent is recommended for patients likely to be infected or colonised with methicillin-resistant *Staphylococcus aureus* (MRSA), as well as for patients requiring cardiac valve reoperation (return to theatre or revision) or in patients hypersensitive to penicillins or cephalosporins.

We aimed to document Australian practice over a recent 4-year period with respect to antibiotic prophylaxis for cardiac surgery, noting in particular the prevalence of departmental antibiotic protocols, the choice of agents and the duration of their administration in comparison with current Australian guidelines. Analysis of the pattern of vancomycin use was of central interest.

METHODS

Public and private hospitals performing cardiac surgery were identified based on information provided by the Australasian Society of Cardiac and Thoracic Surgeons, supplemented by preliminary telephone enquiries to all capital city intensive care units. Recruitment into the study occurred after the attending senior intensive care clinician on each of the 2 days of survey, in 2004 and 2008, agreed to answer the structured telephone questionnaire concerning individual unit antibiotic practice. Data collected in each of the 2 years included annual unit caseload, number of affiliated surgeons, whether the unit currently had an antibiotic protocol for cardiac surgery, the specific antibiotic agents used and their typical duration of use.

Paired proportions were compared across time within each surgical unit using McNemar's test for matched categorical data. Vancomycin usage data were first dichotomised ("any use within or outside Australian guidelines" or "no use") for the 45 units that had one-to-one matched data across 2004 and 2008, then summarised in 2×2 contingency tables and assessed using the exact McNemar's χ^2 test. Expansion of these binary data to three discrete levels of vancomycin use ("according to Australian guidelines", "outside Australian guidelines", or "no use") produced 3×2 contingency tables, which were assessed using exact symmetry tests. All analyses were performed using Stata, version 11.0 (StataCorp, College Station, Tex, USA).

The Melbourne Health Research Directorate reviewed the study design and approved the project as a quality assurance survey of clinical practice for which formal ethics committee review was not required.

RESULTS

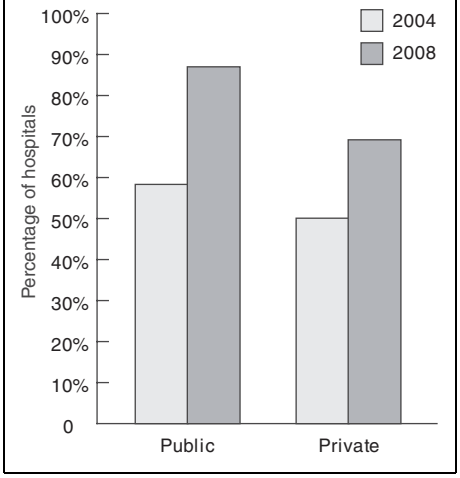
Fifty intensive care units were surveyed in 2004, and 49 units in 2008. Two of the units surveyed in 2004 had discontinued cardiac surgery by 2008, while one unit had commenced cardiac surgery after 2004. These changes, and missing data on antibiotic protocol use, meant that paired comparisons were based on 45 (21 public, 24 private) of the 51 separate surgical units recorded at least once in the surveys.

1 Australian guidelines for antibiotic prophylaxis in cardiac surgery[2]

Cephalothin 2 g (child: 50 mg/kg up to 2 g) intravenously, at the time of induction of anaesthesia
OR
Cephazolin 1 g (adult ⩾ 80 kg: 2 g; child: 25 mg/kg up to 1 g) intravenously, at the time of induction
OR THE COMBINATION OF
Di/flucloxacillin 2 g (child: 50 mg/kg up to 2 g) intravenously, at the time of induction
PLUS
Gentamicin 2 mg/kg intravenously, at the time of induction.
If there are indications for using vancomycin:
Vancomycin 25 mg/kg up to 1.5 g (child aged < 12 years: 30 mg/kg up to 1.5 g) intravenously, ending the infusion just before the procedure (slow infusion required)
PLUS
Gentamicin 2 mg/kg intravenously, at the time of induction. ◆

The median reported cardiac surgical caseloads across all surveyed units were 400 (range, 75–2000) patients per year in 2004 and 400 (range, 50–1500) in 2008. The

2 Reported use of antibiotic prophylaxis protocols in 2004 and 2008, by hospital funding type



3 Number of units using prophylactic antibiotics, by surgical type and year*

	CAGS alone		Valve surgery ± CAGS	
Antibiotic	2004	2008	2004	2008
Di/flucloxacillin	7	7	6	3
Vancomycin				
Routine	4	7	13	16
Specific indication	2	12	2	13
Surgical request	0	2	0	2
Teicoplanin	2	1	2	1
Ticarcillin–clavulanate	1	1	1	1
Cephazolin	12	25	10	21
Cephalothin	26	13	22	12
Ceftriaxone	0	6	1	6
Cefotaxime	2	0	2	0
Gentamicin (with flucloxacillin)	4 (1)	7 (3)	12 (1)	13 (1)
Cephalexin	1	0	1	0

CAGS = coronary artery graft surgery. * Columns sum to greater than the overall number of units due to frequent use of multiple antibiotics. Categories of antibiotic use are shown for all units rather than the subset of 45 units for which paired results for both 2004 and 2008 were available. ◆

median number of attending surgeons per unit was four in both years (range, 1–10 in 2004; 2–8 in 2008).

Across all units, an antibiotic protocol was reportedly used for cardiac surgery patients in 13/26 private hospital units (50%) and 14/24 public hospital units (58%) in 2004, compared with 18/26 (69%) and 20/23 (87%), respectively, in 2008 (Box 2). In paired comparisons, protocol use increased from 26/45 units (58%) in 2004 to 36/45 (80%) in 2008 ($P = 0.02$, McNemar's test). Of the 36 units using protocols in 2008, 13 were not in 2004. Three units that were using protocols in 2004 no longer were in 2008.

The numbers of units using categories of prophylactic antibiotics in 2004 and 2008 are shown in Box 3. Routine antibiotic prophylaxis consisted exclusively of a first-generation cephalosporin or the co-administration of flucloxacillin and gentamicin for coronary artery graft surgery (CAGS) in 34/50 units (68%) in 2004 and 29/49 (59%) in 2008 (data not shown). Antimicrobial agent administration was more variable for valve surgery (with or without coronary grafting), with the same combination used for this purpose by 21/50 units (42%) in 2004 and 21/49 (43%) in 2008.

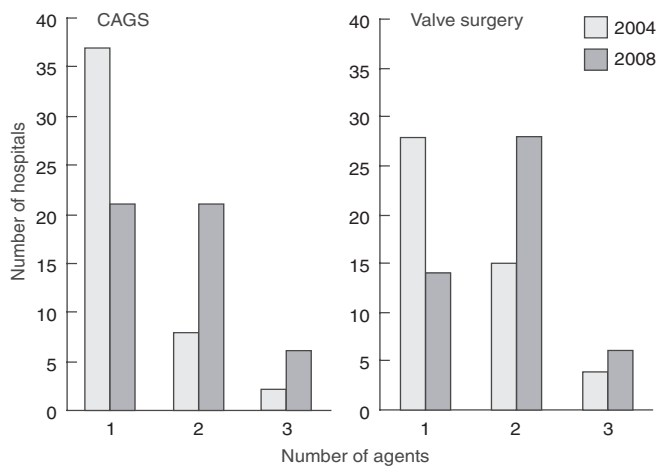
In 2004, the most common practice was use of a single agent for prophylaxis. By contrast, an increase in the use of two or three agents in combination was noted in 2008 (Box 4).

The duration of antibiotic dosing is summarised in Box 5. Surgical units that described continuation of antibiotics until removal of surgical drains rather than to a specific time were included in the count at postoperative Day 1 (24 h), and units continuing antibiotics until removal of intravascular catheters were included in the count at Day 2 (48 h).

The Australian therapeutic guidelines for drug choice *and* duration were followed by 5/50 units (10%) for CAGS and 2/50 units (4%) for valve surgery in 2004. In 2008, 6/49 (12%) and 4/49 units (8%), respectively, were in full compliance with these guidelines.

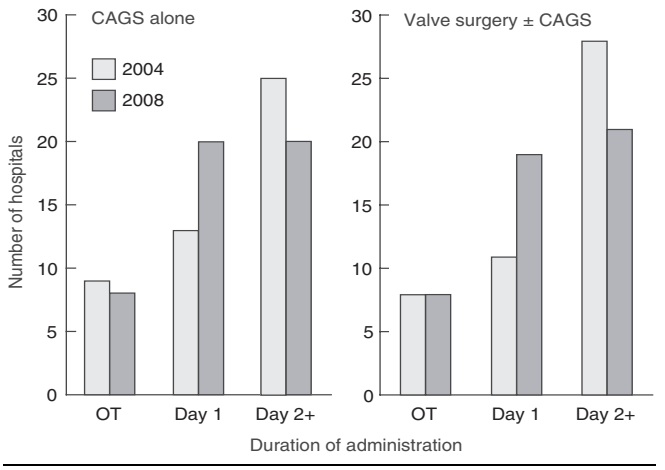
A notable change over time, shown in Box 3, was an increased frequency of administration of glycopeptides. While teicoplanin use remained low (two units in 2004, and one in

4 Number of antibiotic agents used for prophylaxis in 2004 and 2008, by surgical type



CAGS = coronary artery graft surgery. ◆

5 Duration of antibiotic administration for prophylaxis in 2004 and 2008, by surgical type



CAGS = coronary artery graft surgery. OT = antibiotics administered in operating theatre only. ◆

2008), vancomycin use as part of CAGS prophylaxis increased from 6/45 units (13%) in 2004 to 20/45 units (44%) in 2008 ($P < 0.001$, exact McNemar's test). Of the 20 sites using vancomycin for CAGS in 2008, 15 were not in 2004. This vancomycin usage, considered in relation to antibiotic prescribing guidelines, showed evidence of a shift in overall prescription patterns ($P = 0.002$, exact symmetry test). The largest contribution to this shift in usage was due to 10/45 units (22%) changing from no vancomycin use in 2004 to vancomycin use that was classified as "outside guidelines" in 2008, while only one surgical unit changed from use outside guidelines to no use of vancomycin.

Similar marked changes were also seen for valve surgery, where vancomycin use increased from 14/45 units (31%) in 2004 to 28/45 (62%) in 2008 ($P < 0.001$, exact McNemar's test). Of the 28 units using vancomycin for valve surgery in 2008, 14 were not in 2004. When considered in relation to antibiotic prescribing guidelines, this vancomycin usage also showed strong evidence of a shift in overall prescription patterns ($P < 0.001$, exact symmetry test). The largest contributions to this shift in usage were due to 10/45 units (22%) changing from no vancomycin use in 2004 to vancomycin use "outside guidelines" in 2008, and a further 4/45 units (9%) changing from no vancomycin use in 2004 to vancomycin use "within guidelines" in 2008. No surgical unit changed in the opposite direction.

DISCUSSION

A number of recent changes were observed in the antibiotic prophylaxis used for cardiac surgery in Australia. First, the overall use of antibiotic protocols seems to have increased, being slightly but consistently greater in public than private hospitals. Second, an apparent increase was observed between 2004 and 2008 in the administration of multiple classes of antibiotic rather than a single agent, with these agents being administered for surgical prophylaxis mostly as multiple doses over time rather than a single preoperative dose. Third, the observed decrease in popularity of single-agent antimicrobial prophylaxis was accompanied by a substantial increase in the use of vancomycin in both isolated CAGS and in valve surgery with or without concurrent CAGS.

Concordance with the current Australian *Therapeutic guidelines: antibiotic* recommendation[2] for antibiotic prophylaxis in cardiac surgery was found to be low, especially in the context of valve surgery, mainly due to the practice of ongoing postoperative administration of antibiotics in the intensive care unit, the prevalence of which appeared stable over the 4-year period sampled.

Numerous international studies in cardiac surgery have demonstrated that it is relatively common for timing, selection or duration of administration of antimicrobial prophylaxis to be judged as inappropriate or excessive when compared with local guidelines.[3-7] Recent Australian research reported a level of 73% concordance with national guidelines for cardiac surgical antibiotic prophylaxis for drug choice, and 45% concordance with guidelines for both drug choice and timing.[4]

Such widespread disparity between guidelines and practice suggests an underlying conflict between a perceived clinical benefit to the individual patient and a theoretical long-term risk to the wider community from reduced antimicrobial sensitivity patterns. This conflict is unlikely to be resolved without an appropriately powered randomised prospective study demonstrating the adequacy of current guidelines to the satisfaction of cardiac surgeons. An alternative source of evidence may be national surveillance of surgical site infections across all Australian cardiac surgical units, with analysis comparing these with antibiotic usage profiles.

Limitations of clinical practice guidelines include the potential for bias when based on expert opinion in the absence of randomised controlled trials, and inadequate flexibility in the presence of complex interpatient variability. However, full compliance with surgical antibiotic prophylaxis guidelines appears to be associated with low rates of postoperative infectious complications.[8] Notably, data from the Victorian Hospital Acquired Infection Surveillance System (VICNISS) seem to indicate stable low rates of cardiac surgical site infections in Victoria over the 4-year period examined in our survey: surgical site infection rates remained around 5% despite apparent differences in antibiotic prophylaxis regimens between cardiac surgical units (unpublished data, VICNISS Coordinating Centre, Melbourne, Vic, 2009).

In summary, this survey of Australian cardiac surgical antibiotic use demonstrated wide variation in national practice and marked deviation from existing national guidelines, despite an increased prevalence of unit protocols for antibiotic prophylaxis. An increasing number of antibiotic agents, including vancomycin, were being administered as routine prophylaxis, and these tended to be continued for longer than recommended. Improving the evidentiary basis for the existing guidelines may require either standardised national epidemiological surveillance or a randomised study adequately powered to demonstrate the efficacy of single-dose preoperative versus prolonged perioperative cardiac surgical antibiotic prophylaxis. Either approach would be a very large undertaking, but until such data exist, improved compliance with current guidelines seems unlikely.

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COMPETING INTERESTS

None identified.

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