

**ANTIBIOTIC USE EVALUATION  
AT KALGOORLIE REGIONAL  
HOSPITAL**

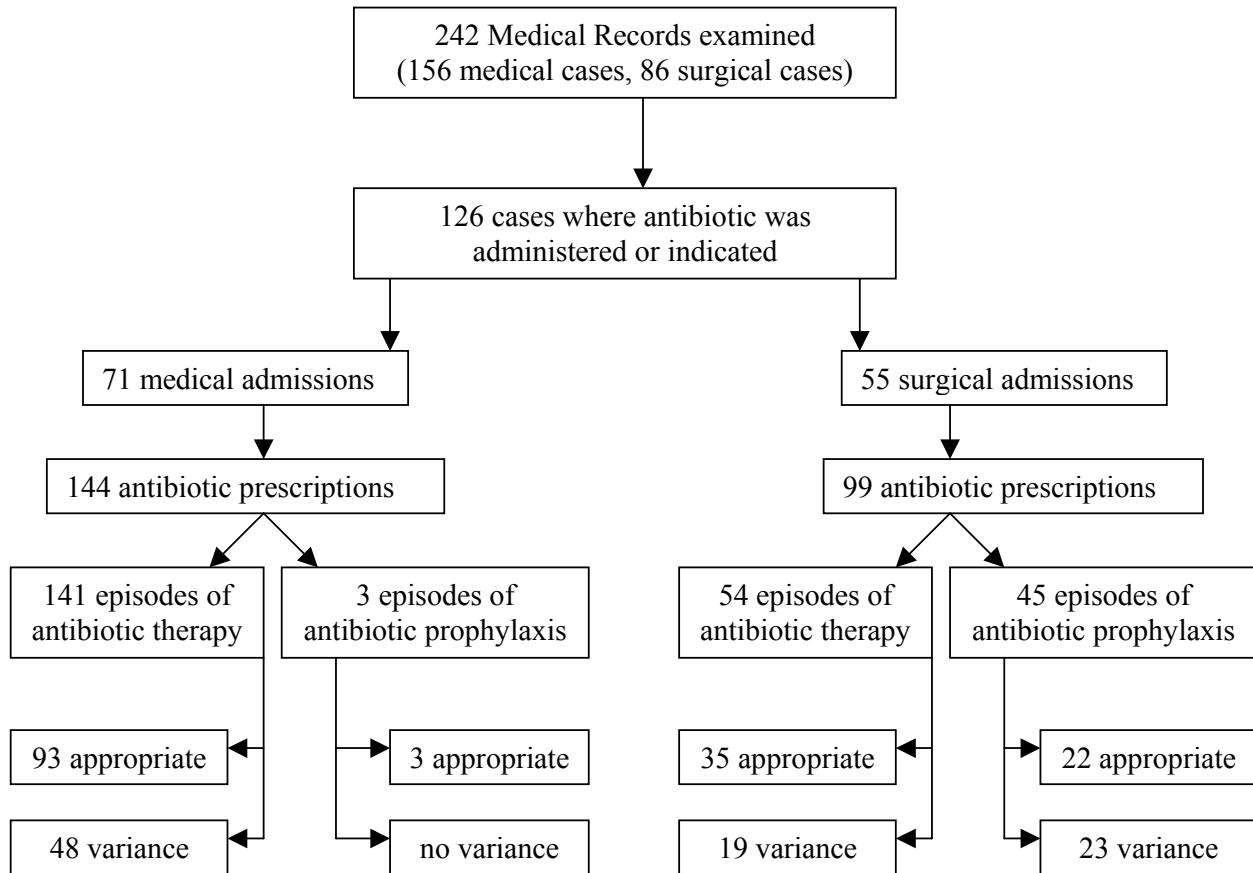
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## Summary

This report documents the third antibiotic use evaluation conducted by the Western Australian Drugs and Therapeutics Committee at Kalgoorlie Regional Hospital. Information for this report was collected in Kalgoorlie between 6<sup>th</sup> and 9<sup>th</sup> August 2001 from 242 medical records of admissions after 1<sup>st</sup> April 2001. From these records, detailed examination was made of 126 records showing use of one or more antibiotics (**Figure 1**). Therapeutic Guidelines: Antibiotic, Version 11 was used as the reference standard for assessing each antibiotic prescribing decision.



**Figure 1: Summary of antibiotic usage at Kalgoorlie Regional Hospital.**

In 126 admissions, antibiotics were administered for either prophylaxis (48 episodes) or therapy (195 episodes). Total episodes (243) includes 6 episodes where administration of antibiotic was omitted when indicated. Antibiotics were most often administered for the treatment of skin and wound infections (35%), followed by respiratory infections (29%), prophylaxis (15%) and urinary tract infections (11%). The antibiotic agents most frequently prescribed were flu(di)cloxacillin (42 episodes), amoxycillin plus clavulanate (Augmentin) (23), ceftriaxone (22), metronidazole (22), gentamicin (20) and roxithromycin (20).

Overall, appropriate antibiotic use was shown in 63% of episodes. Significant variance from the Guidelines occurred in 33% of medical and 42% of surgical admissions. Agents most often associated with variance were ceftriaxone (18 episodes), Augmentin (14) and cephalothin (12).

Episodes of variance were mainly associated with treatment of respiratory infections (31), prophylaxis (23), and treatment of skin (16) and abdominal (12) infections. Ceftriaxone was inappropriately used in respiratory tract infections (11) and abdominal infections (6), and Augmentin was also inappropriately used for respiratory infections (12). Variance associated with cephalothin occurred when this agent was used for post-operative prophylaxis (10). Another common cause of variance was co-administration of antibiotics with similar or overlapping activity when one of these agents would have been sufficient.

Previous evaluations have shown good antibiotic prescribing at Kalgoorlie Regional Hospital and this current study confirms that a generally high standard is being maintained.

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## 1. INTRODUCTION

The aim of this evaluation was to assess antibiotic prescribing at Kalgoorlie Regional Hospital according to the standards recommended in the Therapeutic Guidelines: Antibiotic, Version 11. These guidelines are endorsed by WADTC and are the recommended reference for antibiotic prescribing in Western Australian public hospitals.

## 2. METHODS

Data for this evaluation were gathered from medical records of 242 patients admitted after 1st April 2001, excluding paediatric, maternity, boarders and day patients.

Patient records were initially examined for documentation of antibiotic use, and where antibiotics were given the following details were recorded onto data sheets: age, gender and indigenous status; admission history (clinical division, specialty, length of stay, acute or elective admission status, diagnosis, existing comorbidity and relevant adverse reactions); antibiotic usage (agents used, dose, route, frequency, duration and total number of doses as well as supporting diagnostic evidence such as radiology, microbiology and other pathology). Information was coded using computer spreadsheet software. Each course of antibiotics or episode was compared to recommendations of the Guidelines. The presenting diagnosis as described in the case records was assumed to be accurate, and the appropriateness of antibiotic use was judged on this basis.

Demographic information was obtained from the Admission Registration Record, while clinical information was acquired from the Discharge Summary, Integrated Progress Notes and admission forms. Cases were categorised as either surgical or medical according to admission status. Surgical cases were divided further into specialties on the basis of the procedure performed and the specialty of the surgeon.

Each antibiotic episode was assessed in relation to the recommendations in the Guidelines, and categorised according to the following criteria,

Significant Variance - when the preferred drug was not used or when the antibiotic that was used was not indicated;

Minor Variance - differences in dose, route or frequency of administration;

Appropriate Use – prescribing practice equivalent to the Guidelines.

Variance was determined by objective comparison of documented prescribing with the recommendations of the Guidelines. Variations that were reasonably substantiated were usually considered appropriate, and doubts were generally resolved in favour of prescribers to avoid bias.

This evaluation was conducted by Clin Prof J. A. Millar (Chairman) and Mr D. Lyon (Research Officer) on behalf of the WADTC, with the consent of the management and staff of Kalgoorlie Regional Hospital.

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### 3. RESULTS

#### 3.1 General

We examined 242 patient files (156 medical, 86 surgical) and found 126 cases (52%) in which antibiotic therapy was either initiated or indicated (**Table 1**). Eighty five medical and 31 surgical cases showed no evidence of antibiotic use and were eliminated from further examination. The remaining 71 medical and 55 surgical admissions were given antibiotics, and form the basis of this study. There were 243 prescribing episodes consisting of 195 courses of antibiotic therapy, and 48 episodes of antibiotic prophylaxis. In the latter group, surgical antibiotic prophylaxis was administered in 43 episodes and omitted in 5 episodes. Antibiotic therapy was omitted when indicated in 1 episode.

**Table 1.: Summary information of records examined at Kalgoorlie Regional Hospital, 2001.**

RECORDS (Number of patient files examined)	242
CASES (Number of files showing antibiotic use)	126
EPISODES (Number of antibiotic courses)	243
Frequency of Antibiotic Use (Cases as a percent of Records)	52%
Average Antibiotic Episodes per Case	1.9

episodes where antibiotic was inappropriately omitted (6 cases) are included

#### 3.2 Profile of Admissions

**Table 2** shows the demographics of cases examined. There was an equal gender distribution among admissions, the majority of which were medical (56%) in nature. Almost a third of admissions were Aboriginal or Torres Straight Islander (ATSI) patients.

**Table 2.: Demographics of patients studied at Kalgoorlie Regional Hospital, 2001**

Number of cases	126
Female (%)	50%
ATSI	29%
Medical admissions	56%
Surgical admissions	44%

**Table 3** shows the average age of cases, separated by gender and clinical division for indigenous and non-indigenous patients within the study group. Generally ATSI admissions were of similar or younger age compared to the remained of the study population. This trend was most marked in relation to female patients and medical admissions. Surgical patients were younger, and this applied to both indigenous and non-indigenous groups.

**Table 3.: Average Age at Kalgoorlie Regional Hospital**

Admission group	Non-ATSI		ATSI	
	Number	Average Age (+ 95% CI)	Number	Average Age (+ 95% CI)
Total	90	46.8 ± 4.5	36	39.9 ± 4.7
Female	41	50.5 ± 6.9	22	36.2 ± 5.5
Male	49	43.6 ± 5.7	14	45.8 ± 7.3
Medical	43	55.8 ± 6.3	28	42.4 ± 5.2
Surgical	47	38.4 ± 5.3	8	31.1 ± 7.7

**Table 4** shows the average length of stay (LOS) of indigenous (ATSI) and non-indigenous admissions, separated according to gender and admission status. Length of stay was generally higher in indigenous patients, most notably in female patients and surgical admissions. The length of stay for non-indigenous patients was shorter in surgical than medical admissions.

**Table 4.: Average Length of Stay at Kalgoorlie Regional Hospital**

Admission group	Non-ATSI		ATSI	
	Number	Average LOS ( $\pm$ 95% CI)	Number	Average LOS ( $\pm$ 95% CI)
Total	90	5.0 $\pm$ 5.0	36	6.8 $\pm$ 3.1
Female	41	5.4 $\pm$ 1.5	22	8.5 $\pm$ 4.9
Male	49	4.6 $\pm$ 1.4	14	4.1 $\pm$ 1.6
Medical	43	6.1 $\pm$ 1.7	28	6.1 $\pm$ 2.8
Surgical	47	3.9 $\pm$ 1.2	8	8.9 $\pm$ 9.8

Surgical cases were mostly acute admissions (73%) and were mainly associated with general (22) and orthopaedic (15) surgery. Most elective surgery admissions also occurred in general (6), and orthopaedic (5) surgery (**Table 5**). Antibiotics used in surgical cases were mostly administered for surgical prophylaxis (27) cases, and for treatment of skin and wound infections (20).

**Table 5.: Surgical admissions by elective status and surgical specialty.**

Surgical Specialty	Acute	Elective	Total Cases
General	22	6	28
Orthopaedic	15	5	20
Gynaecology	3	3	6
Urology	0	1	1
Total	36 (71%)	15 (29%)	51

**Table 6** shows antibiotic used in medical cases and the diagnostic category corresponding to administration. Treatments for acute respiratory tract infections, and for skin and wound infections were the most common. All medical cases were acute admissions, except one elective admission for gallstones that received coincidental therapy for persistent pneumonia during investigations. Information in Table 6 is for medical cases only and differs from Figure 1, which shows diagnosis associated with each course of antibiotics in medical and surgical admissions combined.

**Table 6.: Medical cases receiving antibiotics and associated diagnostic category.**

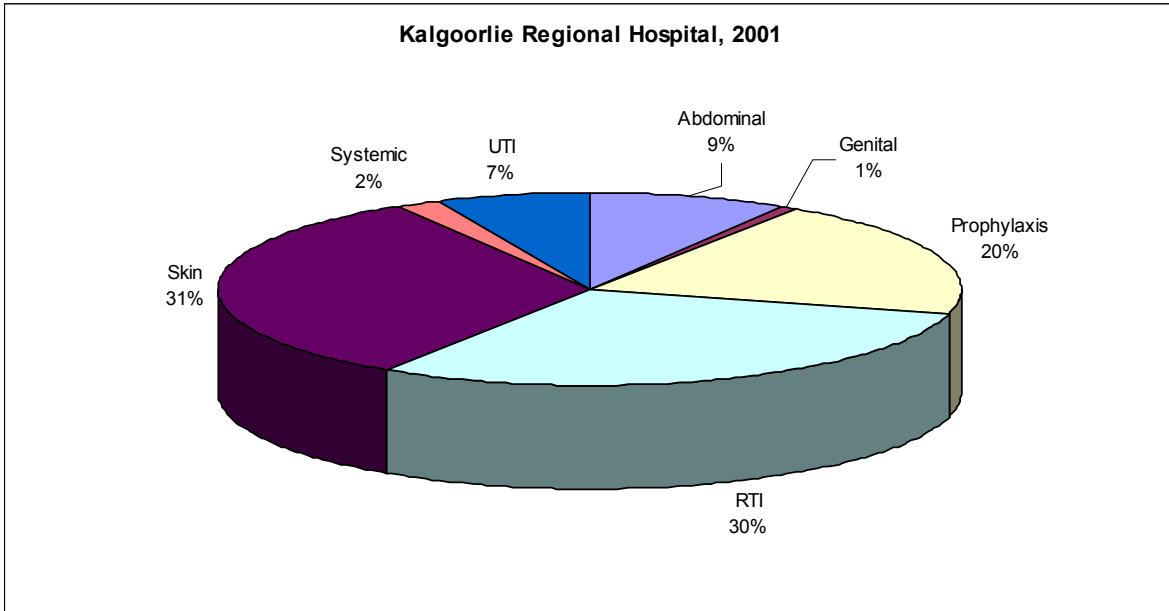
Diagnostic Category	Number (percent of total) of Medical Cases
Respiratory tract infections	33 (46%)
Skin and soft tissue infections	21 (30%)
Urinary tract infections	9 (13%)
Abdominal infections	5 (7%)
Systemic infections	2 (3%)
Prophylaxis	1 (1%)
Total	71

### 3.4 Diagnostic Categories

Each episode or course of antibiotics was categorised according to the diagnosis that resulted in antibiotic administration. **Figure 1** includes both surgical and medical admissions. Most prescribing events were associated with skin and wound infections (35%), followed by respiratory tract infections (29%), prophylaxis (15%) and urinary tract infections (11%).

**Figure 2: Diagnostic categories associated with administration of antibiotics.**

Abbreviations: RTI = Respiratory tract infections; SKIN = Skin, muscle and bone infections; SYSTEMIC = Septicaemia or generalised infections; UTI = Urinary tract infections; ABDOMINAL = Gastrointestinal and intra-abdominal infections; GENITAL = Genital tract infections.



### 3.5 Variance from the Guidelines

Variance from the Guidelines was determined for each episode by comparing the observed and recommended prescribing. There were 243 episodes of antibiotic use in this audit, and 153 (63%) of these indicated appropriate use relative to the prescribing standard. Significant variance from the Guidelines occurred in 37% of episodes and is shown in **Table 7**. Also shown is the number of episodes and percent of total variance within surgical and medical divisions. Significant Variance was higher for surgical (42%) than medical (33%) episodes. Minor variance was not common, indicating appropriate dose, timing and frequency of antibiotic administration.

**Table 7. Total and divisional antibiotic usage variance at Kalgoorlie Regional Hospital.**

	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
General Medicine	47 (33%)	1	96 (67%)	144
Surgery	42 (42%)	0	57 (58%)	99
Total Episodes	89 (37%)	1 (<1%)	153 (63%)	243

See Methods section (page 1) for definitions of Significant and Minor Variance, and Appropriate Use.

### 3.5.1 Variance by Antibiotic

**Table 8** ranks antibiotics by the frequency that they were prescribed, and their variance from the Guidelines. Flu(di)cloxacillin was the most frequently prescribed antibiotic, but amoxicillin plus clavulanate (Augmentin), ceftriaxone, metronidazole, gentamicin and roxithromycin were also commonly used. Flu(di)cloxacillin use occurred mostly in relation to the treatment of skin and wound infection (34 episodes), but also for prophylaxis (7). Augmentin was used mainly for respiratory tract (14) and skin and wound (6) infections, while ceftriaxone was used mainly in the treatment of respiratory (13) and abdominal (8) infections. Metronidazole was used for a range of infections, but mostly skin (9) and abdominal (7) infections.

Agents used for surgical prophylaxis in order of preference, were cefotetan (13), cephalothin (10), gentamicin (10) and flucloxacillin (7). Antibiotic prophylaxis during surgery was omitted on 5 occasions when indicated. These later episodes are shown by NIL Antibiotic Used in Table 8. Episodes of significant variance related to the antibiotic agent used was most commonly associated with ceftriaxone (18), Augmentin (14) and cephalothin (12).

**Table 8.: Frequency of variance for antibiotics used at Kalgoorlie Regional Hospital.**

Antibiotic Used	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
Flu(di)cloxacillin	0	0	42	42
Augmentin	14	0	9	23
Ceftriaxone	18	0	4	22
Metronidazole	10	0	12	22
Gentamicin	0	0	20	20
Roxithromycin	3	0	17	20
Cephalothin	12	0	4	16
Amoxicillin	3	0	12	15
Cefotetan	5	0	8	13
NIL	6	0	0	6

### 3.5.2 Variance among General Medical Admissions

Most antibiotic use among the 144 episodes occurring in general medical admissions were associated with the therapy of respiratory tract infections (49%), followed by skin and wound (31%) and urinary tract infections (8%). **Table 9** shows the number of episodes and frequency of variance in each diagnostic category. Significant Variance occurred in 33% of all medical admissions, and was most common in relation to respiratory tract infections.

**Table 9.: Variance in medical admissions associated diagnostic categories.**

Abbreviations: RTI = Respiratory tract infections; SKIN = Skin, muscle and bone infections; UTI = Urinary tract infections; ABDOMINAL = Intra-abdominal infections; SYSTEMIC = Systemic or generalised infections.

Diagnostic Category	Significant Variance	Minor Variance	Appropriate Use	Number of Episodes
RTI	30 (42%)	1	40 (56%)	71
Skin	9 (20%)	0	35 (80%)	44
UTI	4 (33%)	0	8 (67%)	12
Abdominal	3 (33%)	0	6 (67%)	9
Systemic	1	0	4	5
Total	27 (33%)	1	96 (67%)	144

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## Respiratory tract infections

Higher than average variance (42%) was seen in association with the treatment of respiratory tract infections. Antibiotics associated with significant variance are shown in **Table 10**. Ceftriaxone (85%) and Augmentin (85%) variance resulted because they were not the preferred choice for therapy. Use of ceftriaxone for upper respiratory tract infections (3 episodes), mild to moderate (7) and severe lower respiratory tract infections (1) was not appropriate. In the case of severe pneumonia, the preferred therapeutic agents were not contraindicated, and ceftriaxone use was therefore not warranted. There was one case each in which ceftriaxone was also inappropriately prescribed using either 2g a day or 1g twice daily, instead of the recommended 1g daily.

Augmentin was inappropriately used (11 episodes) to treat upper tract and mild to moderate chest infections. Augmentin is usually no more effective than amoxicillin and is recommended only when there is evidence or suspicion of resistance. The later criteria were not apparent in any of the 11 episodes showing variance.

**Table 10.: Antibiotic variance in medical admissions: Respiratory tract infections**

	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
Roxithromycin	3	0	17	20
Ceftriaxone	11	0	2	13
Augmentin	11	0	2	13
Amoxicillin	0	0	9	9
Penicillin	0	1	3	4
Total	30 (42%)	1	40	71

## Skin infections

Significant variance occurred in 20% of episodes in the category of skin infection. (**Table 11**) Di(flu)cloxacillin was the most frequently used antibiotic, and all episodes were consistent with the Guidelines. Co-administration of flucloxacillin and penicillin in 4 episodes resulted in penicillin variance because therapy was being unnecessarily duplicated. Flucloxacillin alone is effective against both *Staphylococcus* and *Streptococcus* infections, and co-administration of penicillin is unnecessary. Augmentin was also unnecessary in 1 case when co-administered with flucloxacillin for cellulitis. Flucloxacillin and Augmentin have similar activity against *Staphylococcus* and *Streptococcus*, but Augmentin has additional activity against other organisms. Cefotaxime was inappropriately used in one case for therapy of an abscess, but ceftriaxone was not used in any of the skin and wound infections treated.

**Table 11.: Antibiotic variance in medical admissions: Skin, muscle and bone infections**

	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
Flu(di)cloxacillin	0	0	21	21
Metronidazole	1	0	4	5
Penicillin	4	0	1	5
Gentamicin	0	0	3	3
Augmentin	1	0	1	2
Cephalexin	0	0	2	2
Cephalothin	0	0	2	2
Total	9 (20%)	0	35 (80%)	44

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### Urinary tract infections

There were 4 episodes of variance recorded among 14 episodes of antibiotic therapy of urinary tract infections (**Table 12**). In 2 episodes, variance was produced by use of trimethoprim during placement of an indwelling catheter. In 1 other episode, Augmentin was commenced despite laboratory findings showing that the isolate was susceptible to amoxicillin. Variance due to omission of therapy occurred in one case, despite the patient being symptomatic and available culture results being positive.

**Table 12.: Antibiotic variance in medical admissions: UTI**

	Significant Variance	Minor Variance	Appropriate Use	Total
Trimethoprim	2	0	4	6
Gentamicin	0	0	2	2
NIL	1	0	0	1
Total	4 (33%)	0	8 (67%)	14

### 3.5.2 Variance among Surgical Admissions

Antibiotic prescribing among surgical admissions at Kalgoorlie was most often to provide prophylaxis (45%) during surgical procedures. However, treatment of skin and wound (34%) and abdominal (12%) infections also accounted for many episodes of surgical antibiotic use. **Table 13** shows the frequency and associated variance for the main diagnostic groups encountered for surgical admissions.

**Table 13.: Frequency and variance of surgical episodes and associated diagnostic categories.**

Abbreviations: Abdominal = Intra-abdominal infections; Genital = Genital tract infections; UTI = Urinary tract infections; SKIN/BONE = Skin, muscle and bone infections.

	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
Prophylaxis	23 (51%)	0	22 (49%)	45
Skin	7 (21%)	0	27 (79%)	34
Abdominal	9	0	3	12
Total Episodes	42 (42%)	0	57 (58%)	99

#### *Variance by diagnostic category*

Most episodes of surgical variance (23) were associated with prophylaxis and were the result of antibiotic use when not indicated (13), use of an inappropriate agent (5), and omission (5). In 12 of 13 episodes in which antibiotic use was not indicated, variance was attributed to unnecessary post-operative antibiotic administration, usually following orthopaedic surgery (10 episodes). Four of 5 episodes of variance associated with an inappropriate agent were due to use of cefotetan for procedures with low risk of anaerobic infection and a higher risk of Staphylococcal infection, where either cephalothin or cephazolin\* are preferred. There was a single episode of inappropriate vancomycin use during an orthopaedic procedure. This agent is reserved for when resistance is proven or strongly suspected, and is inappropriate without these indications. Omission of prophylaxis occurred during 3 abdominal procedures and 2 internal fixation procedures, each being a recommended indication for the use of surgical antibiotic prophylaxis.

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\* Where the Guidelines recommend either cephalothin or cephazolin, the agent chosen should be according to the hospital formulary as it is generally not necessary to stock both antibiotics.

Variance occurring in 5 of 7 surgical episodes being treated for skin infections was the result of unnecessary duplication of antibiotic cover. Combinations seen included flucloxacillin and penicillin (2), Augmentin and metronidazole (2), and Augmentin and cephalothin. In each case the latter agent is unlikely to provide any benefit in addition to that already provided by the former agent. Variance in the 2 other episodes was due to inadequate cover provided by amoxicillin when infection due to *Staphylococcus* was likely, and unnecessary use of cefotaxime when cephalothin or cephalozin are preferred due to better activity against *Staphylococcus*.

The number of episodes of variance associated with abdominal infections was proportionately high (9), although total episodes (12) was less than usually desired to make meaningful conclusions. However, there was a common pattern to this variance as all episodes involved treatment of acute biliary tract infections. The agents used in 4 of the 5 cases were ceftriaxone plus metronidazole, and in the fifth case cefotaxime was used alone. Evidence of sepsis was present in only one case and under these circumstances, the preferred agents were gentamicin plus amoxicillin. Ceftriaxone is recommended only if gentamicin is contraindicated, and metronidazole is not recommended because infections are usually due to aerobic intestinal flora and not anaerobes.

#### ***Variance by surgical specialty***

Antibiotic episodes in surgery were mainly within orthopaedic (49%) and general (42%) surgical specialties (**Table 14**). There were 19 episodes of variance in orthopaedic surgery and 22 in general surgery. Variance in orthopaedic surgery was due to antibiotic use when not indicated (13 episodes), use of an inappropriate agent (4) and omission (2). Antibiotic use that was not indicated occurred when prophylaxis was administered post-operatively (10 episodes) and when therapy of skin infections involved use of agents without consideration for the antimicrobial cover simultaneously being provided by other agents (3 episodes). Variance due to inappropriate agents included use of cefotetan and vancomycin, which were administered when other agents were preferred or recommended. Variance due to omission of prophylaxis occurred during 2 procedures involving internal fixations.

General surgery variance resulted from antibiotic use when not indicated (12 episodes), including post-operative prophylaxis (2), use of metronidazole and ceftriaxone for cholecystitis without evidence of sepsis (7) and unnecessary use of penicillin for skin infections (2). Use of an inappropriate agent (7) occurred in a range of circumstances but characterised by overuse of cephalosporins (5) and over-treatment of infections with known susceptibility (2). Prophylaxis was omitted in 3 general surgical admissions undergoing cholecystectomy (2) or appendicectomy (1) procedures.

**Table 14.: Variance in surgery associated with specialty of admission.**

	<b>Significant Variance</b>	<b>Minor Variance</b>	<b>Appropriate Use</b>	<b>Total Episodes</b>
Orthopaedic	19 (39%)	0	30 (61%)	49
General	22 (42%)	0	20 (48%)	42
Gynaecology	1	0	6	7
Urology	0	0	1	1
Total Episodes	42 (42%)	0	57 (58%)	99

### ***Variance by antibiotic agents used***

The principal agents used in surgical patients are listed in **Table 15**. Flu(di)cloxacillin was the most frequently prescribed antibiotic, and was not associated with any episodes of variance. Flu(di)cloxacillin was administered for prophylaxis (6 episodes) and for treatment of skin infections in surgical patients (13 episodes). Cephalothin on the other hand was frequently used (13 episodes) and was also often associated with variance (11 episodes). Ten episodes of cephalothin variance were due to prophylaxis administered after surgery. Furthermore, in each episode only 1g was administered. One episode of variance occurred in relation to skin infection therapy when cephalothin activity was largely duplicated by Augmentin. Cefotetan variance in 5 out of 13 episodes occurred because it was not the preferred agent for prophylaxis when cover against *Staphylococcus* is more important than against anaerobic infections. The dose of cefotetan used was 1g in 10 episodes and 2g in 3 episodes. Either dose of cefotetan is acceptable, unlike cephalothin where 2g is recommended because of its shorter half-life. Eight of 11 episodes of metronidazole use produced variance. This variance was associated with therapy of gall bladder infections (4 episodes), duplication of therapy when combined with Augmentin for mild wound infections (2), use for post-operative prophylaxis (1) and when used to treat pelvic inflammatory disease (PID) instead of Augmentin plus doxycycline (1).

**Table 15.: Frequency and variance of antibiotics used for surgical admissions.**

	<b>Significant Variance</b>	<b>Minor Variance</b>	<b>Appropriate Use</b>	<b>Total Episodes</b>
Flu(di)cloxacillin	0	0	19	19
Cephalothin	11	0	2	13
Cefotetan	5	0	8	13
Gentamicin	0	0	11	11
Metronidazole	8	0	3	11
NIL	5	0	0	5
Total	42 (42%)	0	57 (58%)	99

### **Surgical Prophylaxis**

Surgical antibiotic prophylaxis accounted for 45% of episodes and 51% of variance in surgical admissions during this study (see Table 13). Variance was due to administration of antibiotic that was not indicated (13 episodes), use of agents that were not recommended or preferred (5), and 5 episodes of omission. Classification of episodes of surgical prophylaxis is summarised in **Table 16**.

**Table 16.: Variance among surgical specialties associated with administration of prophylaxis.**

	<b>Significant Variance</b>	<b>Minor Variance</b>	<b>Appropriate Use</b>	<b>Total Episodes</b>
Orthopaedic	15 (54%)	0	13 (46%)	28
General	8 (73%)	0	3 (27%)	11
Gynaecology	0	0	5	5
Total Episodes	23 (51%)	0	22 (49%)	45

Agents associated with variance during administration of prophylaxis are shown in **Table 17**. Cefotetan variance was due to inappropriate activity provided in relation to 4 procedures, when use of either flucloxacillin or cephalothin was preferred. In the remaining episode, we recorded cefotetan as not being indicated for prophylaxis during hernia repair. However, this interpretation is currently under review since there may be a marginal benefit from

prophylaxis when mesh is inserted during hernia repairs. Administration of prophylaxis for hernia mesh repairs is currently at the surgeon's discretion, but the preferred agents are either flucloxacillin or cephalothin.

**Table 17.: Antibiotic variance in surgical admissions: Prophylaxis**

	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
Cefotetan	5	0	8	13
Cephalothin	10	0	0	10
Gentamicin	0	0	8	8
Flucloxacillin	0	0	6	6
NIL	5	0	0	5
Total	23 (51%)	0	22 (49%)	45

***Post-operative prophylaxis***

All 10 episodes of variance associated with cephalothin prophylaxis resulted from use of this agent as a course after theatre when there was no indication of infection. Nine of these episodes occurred in orthopaedic surgery, and were usually short courses given in addition to prophylaxis in theatre. In 2 episodes, the short course followed use of 2g of cefotetan in theatre, which is not the preferred agent during orthopaedic surgery. The remaining short courses followed use of 2g flucloxacillin plus gentamicin in theatre. This latter combination provides more than adequate cover, and should not require additional antibiotic use after theatre unless there is evidence of infection. Use of gentamicin during these procedures is indicated only when there is an increased risk of Gram negative infection. While this risk was not evident from the medical records, the surgeon is required to make this determination on the basis of the risk in each case.

In one admission, the post-operative course of cephalothin was followed by a course of cephalexin, further compounding the pattern of inappropriate prophylaxis. As most patients are discharged within a few days, it was not possible to determine if ongoing prophylaxis with cephalexin was a common feature of post-operative management.

Prophylaxis administered post-operatively is generally not indicated and is at variance with the Guidelines. **Table 18** shows the number of episodes of post-operative prophylaxis and how this relates to prophylaxis already administered in theatre. In 8 episodes, appropriate prophylaxis was given in theatre, but was nullified by inappropriate prophylaxis after theatre. In 4 other episodes, inappropriate prophylaxis in theatre was compounded by additional inappropriate prophylaxis after theatre.

**Table 18.: Episodes of post-operative antibiotic prophylaxis, and corresponding prophylaxis administered in theatre.**

Total episodes post-op prophylaxis	Inappropriate	12
CORRESPONDING PROPHYLAXIS ADMINISTERED IN THEATRE		
Single dose correctly administered when indicated	Appropriate	8
Single dose incorrectly administered when indicated	Inappropriate	2
Single dose indicated but omitted	Inappropriate	2
Prophylaxis not indicated but given	Inappropriate	0
Prophylaxis not indicated and not given	Appropriate	0

**Table 19** considers all surgical admissions examined in this study, and separates those episodes in which antibiotic prophylaxis was given (40) from admissions in which no prophylaxis was given (45). Information is further separated into appropriate and inappropriate prophylaxis on the basis of the corresponding indication for use. In 40 admissions, prophylaxis was appropriately not given usually due to the minor nature of procedure being performed. When surgical prophylaxis was administered, appropriate use was seen in 55% of episodes. Inappropriate prophylaxis occurred because antibiotic use was not indicated (33%), or antibiotic was indicated but a non-preferred agent was administered (12%).

**Table 19.: Summary of antibiotic prophylaxis administered in relation to surgery**

Prophylaxis Given (40 episodes)			Prophylaxis NOT Given (45 episodes)	
NOT INDICATED	INDICATED	INDICATED	NOT INDICATED	INDICATED
Inappropriate	Appropriate	Inappropriate	Appropriate	Inappropriate
13 (33%)	22 (55%)	5 (12%)	40	5 (11%)

### Antibiotic therapy in surgical admissions

In addition to surgical antibiotic prophylaxis, this study was also characterised by antibiotic therapy of infections in surgical patients. Therapy was the most common for skin (37 episodes) and abdominal (12) infections.

### *Skin and wound infections*

**Table 20** shows antibiotic episodes used in the therapy of skin and wound infections, and that variance occurred in 22% of episodes. The most frequently used agent was flucloxacillin (11 episodes) which was used appropriately. Augmentin (4) and gentamicin (3) were also used appropriately when required. Variance was associated with metronidazole (2 episodes) when used in conjunction with Augmentin because it was unlikely to contribute to therapy of infection with only a mild risk of anaerobic organism involvement. Penicillin (2) and cephalothin (1) were also unnecessary when given in conjunction with flucloxacillin or Augmentin, respectively. There was no evidence of ceftriaxone being used for skin infections in surgical admissions, although there was 1 episode of cefotaxime use when cephalothin or cephalexin would have been preferable.

**Table 20.: Frequency and variance of antibiotic episodes in surgical admissions: Skin, muscle and bone infections**

	Significant Variance	Minor Variance	Appropriate Use	Total Episodes
Flucloxacillin	0	0	11	11
Metronidazole	2	0	2	4
Augmentin	0	0	4	4
Gentamicin	0	0	3	3
Penicillin	2	0	1	3
Cephalothin	1	0	2	3
Total	7 (21%)	0	27 (79%)	34

### ***Abdominal infections***

Treatment of abdominal infections in surgical admissions (**Table 21**) produced a high proportion of episodes with variance. The use of ceftriaxone (4 episodes) and cefotaxime (1) when gentamicin was preferred but not contraindicated was a principal cause of variance. In each case, ceftriaxone was given with metronidazole. Metronidazole (4 episodes) is not indicated for the treatment of cholecystitis or biliary colic since anaerobic organisms are unlikely to cause infection.

**Table 21.: Antibiotic variance in surgical admissions: Abdominal infections**

	<b>Significant Variance</b>	<b>Minor Variance</b>	<b>Appropriate Use</b>	<b>Total Episodes</b>
Ceftriaxone	4	0	1	5
Metronidazole	4	0	1	5
Cefotaxime	1	0	0	1
Total	9 (75%)	0	3 (25%)	12

## **4. DISCUSSION**

The percent of episodes showing appropriate antibiotic use at Kalgoorlie Regional Hospital was 63%, and is compared with other Western Australian hospitals surveyed (**Table 22**).

**Table 22.: Information from the antibiotic use evaluation at Kalgoorlie Regional Hospital compared to other health services recently evaluated by WADTC.**

HOSPITAL	KALGOORLIE	PT. HEDLAND	BUNBURY	ROCKINGHAM	SWAN	ARMADALE
Audit Period	APR 2001	FEB 2001	SEPT 2000	MAY 2000	MAY 2000	FEB 2000
RECORDS	242	208	242	222	212	226
CASES	126	113	108	90	100	120
TOTAL EPISODES	243	219	210	134	159	173
Medical Episodes	144	62	54	81	51	59
Surgical Episodes	99	51	54	53	108	114
ANTIBIOTIC PRESCRIBING FREQUENCY	52%	54%	45%	41%	47%	53%
AVERAGE PRESCRIPTIONS PER CASE	1.9	1.9	1.9	1.5	1.6	1.4
<b>Percent Appropriate Antibiotic Use</b>						
Medical Episodes	67%	56%	59%	56%	65%	49%
Surgical Episodes	58%	61%	56%	36%	44%	55%
Total Episodes	63%	59%	57%	48%	50%	53%

This was the third evaluation at Kalgoorlie, conducted according to the respective recommendations of the 9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> Edition of Therapeutic Guidelines: Antibiotic (**Table 23**). After marked initial improvement, a high standard of prescribing has been maintained over a period of several years that is consistent with generally good antibiotic prescribing and management practices. Where variance continues to occur, antibiotic use tends to exceed recommendations. This may not appear to have a direct negative impact on patient outcomes, but is contrary to the notion of rational antibiotic use in so far as it increases demand on hospital resources and contributes to the selective pressures promoting microbial resistance. The negative impact on patients is that unnecessary antibiotic use also exposes patients to the risk of adverse drug events and medication errors, and reduces the potential for

effective therapeutic agents in the future. These factors should not be overlooked or isolated from immediate clinical outcome.

**Table 23.: Appropriate antibiotic use compared between three evaluations conducted at Kalgoorlie Regional Hospital.**

Audit Period	September 1997	August 1998	April 2001
Medical Episodes	41%	67%	67%
Surgical Episodes	38%	62%	58%
Total Episodes	40%	64%	63%

Areas of antibiotic use that were found to be unnecessary or unlikely to provide benefit included,

- ◆ post-operative administration of prophylaxis, notably cephalothin as a short course,
- ◆ use of third generation cephalosporins when more effective and specific agents are recommended, notably for respiratory tract infections, abdominal and biliary tract infections,
- ◆ use of Augmentin for respiratory tract infections when it is generally no more effective than amoxicillin against respiratory pathogens,
- ◆ use of metronidazole for biliary tract infections when anaerobes are not usually involved,
- ◆ co-prescription of penicillin with flucloxacillin when treating Staph and Strep infections,
- ◆ co-prescription of metronidazole or cephalothin with Augmentin when the latter agent has broad activity against Staph, Strep, Enterococci, Gram negatives and anaerobes,
- ◆ use of vancomycin without evidence to justify

Treatment of skin infections was the principal diagnosis resulting in antibiotic use at Kalgoorlie, and was common in medical and surgical admissions. Antibiotic use for this indication was generally very good. Flucloxacillin was prescribed most often and presented few problems with the manner in which it was prescribed. The main concern with treatment of skin infection in both medical and surgical admissions was that the crossover in activity between some of the agents being used was not fully appreciated. Antibiotics usually used include flucloxacillin, dicloxacillin, penicillin, cephalothin, cephazolin and Augmentin, while usual pathogens include *Staphylococcus* and *Streptococcus*, and sometimes possibly Gram negatives or anaerobes. Flucloxacillin is the agent of choice in most situations, but it is important that prescribers discriminate between alternative agents when required. Prescribing 2 or more agents is unnecessary when adequate cover can be provided by one of these agents. It was encouraging to find that ceftriaxone was not used in any of the cases presenting with skin infection, although cefotaxime was used twice.

Treatment of respiratory tract infection occurred mainly in medical admissions and was the source of most variance in this study. Variance was mainly associated with use of Augmentin and ceftriaxone, which were the second and third most frequently prescribed antibiotic for respiratory infections after roxithromycin. Neither of these antibiotics is recommended for first line treatment of respiratory tract infections, and ceftriaxone is an option only when severe pneumonia is diagnosed according to defined criteria and preferred agents are contraindicated. Augmentin is an option when resistance to amoxicillin is proven or suspected. In general, use of antibiotics from upper tract infections is of little benefit and not usually recommended. Preferred agents for pneumonia are amoxicillin, doxycycline or roxithromycin but in this study accounted for 19%, 3% and 27% of prescriptions respectively, for treatment of respiratory infections. Severe pneumonia was seen in only 2 admissions.

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Antibiotics used for surgical prophylaxis comprised 20% of all episodes, with variance occurring in 51% of these episodes. Principal causes of variance were the administration of antibiotic prophylaxis (usually cephalothin) after theatre, inappropriate use of cefotetan and omission when indicated. Prophylaxis is most effective at preventing infection when administered so that peak antibiotic levels are achieved during a procedure and in this respect, a single dose in theatre is usually recommended. Post-operative exposure to antibiotic may be of limited benefit, but also increases the risk of selecting resistant organisms that are more difficult to treat when colonising a prosthetic device or causing overt infection. Appropriate prophylaxis in theatre is recommended, and if post-operative infection emerges, then appropriate therapy should be implemented.

In relation to use of cefotetan for prophylaxis, it does not provide appropriate cover for some procedures although often recommended during abdominal and gynaecological procedures. Cefotetan has broad activity against Gram negative and many anaerobic organisms. It also has some activity against *Staphylococcus*, but cephalothin or cephazolin are more active and are recommended when there is a higher risk of *Staph* infection. These later agents are also active against Gram negative organisms, but are not effective against anaerobes. Flucloxacillin is recommended when *Staph* or *Strep* infections are the primary concern, and cover against Gram negative and anaerobic organisms is not required. Prophylaxis was not administered during 3 abdominal procedures and 2 orthopaedic procedures involving internal fixation. These omissions were at variance with the recommendations of the Guidelines.

The high level of ceftriaxone use and associated variance is a matter of concern, particularly since this has been previously identified as an area requiring attention. The increasing incidence of antibiotic resistant organism in Western Australian hospitals mandates cautious use of potent agents with a strong propensity for selection of resistance. This clearly applies to ceftriaxone, because of the high level of inappropriate use seen. As a result, ceftriaxone should only be used when absolutely necessary as indicated in the Guidelines. In a similar vein, we were concerned by reports of inappropriate use of vancomycin, although only one episode was seen during this study. Prescribers should restrict their use of this agent to cases where the need is clearly evident. Hospital based restriction remains an option if this approach is unsuccessful. In general however, we were pleased with the generally high standard of antibiotic prescribing that has been maintained at Kalgoorlie Regional Hospital.

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## **5. RECOMMENDATIONS**

- That Kalgoorlie Regional Hospital continues to support, encourage and educate best practice antibiotic prescribing amongst all medical and surgical staff.
- That this Report be subject to initial review by the Kalgoorlie Drugs and Therapeutics Committee, and upon acceptance be widely distributed within the Health Service. At each stage, WADTC would welcome feedback in response to this Report.
- That any regular variation from the provisions of Therapeutic Guidelines: Antibiotic, Version 11 be ratified by the hospital Drugs and Therapeutics Committee within the context of best practice and any special local needs.
- Furthermore, that in individual cases, the reasons for variation from the Guidelines should be clearly documented and, if necessary, a clinical microbiologist consulted.
- That the hospital Drugs and Therapeutics Committee and hospital management develop effective policies to prevent empirical post-operative antibiotic prophylaxis.
- That measures be taken to minimise third generation cephalosporin use.
- That measures be taken to stop unnecessary duplication of antibiotic therapy when drugs with overlapping activity are co-administered.

## **6. ACKNOWLEDGMENTS**

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