

Inappropriate prescribing of antibiotics following discharge after major surgery: an area for improvement

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ABSTRACT

AIM: This study aims to determine the indications for antibiotic use in patients discharged following major surgery at Auckland City Hospital (ACH); to determine if the indications were appropriate and to identify opportunities where antimicrobial stewardship interventions would be beneficial.

METHODS: This was a retrospective study of adult patients who were dispensed an antibiotic within the first two days of discharge after major surgery at ACH between 1 January 2013 and 31 December 2013. The indication for antibiotic use was determined and subsequently classified as either 'appropriate', 'not assessable' or 'inappropriate'.

RESULTS: Among the 378 patients analysed, an indication for antibiotic use was not documented in 52 patients (13.8%). Antibiotics were prescribed for an established infection in 172 patients (45.5%), as empiric therapy in 100 patients (26.4%), and as prolonged surgical antimicrobial prophylaxis in 41 patients (10.8%). Overall, nearly half of the antibiotic courses dispensed (48.7%) were either 'inappropriate' or the indication was 'not assessable'.

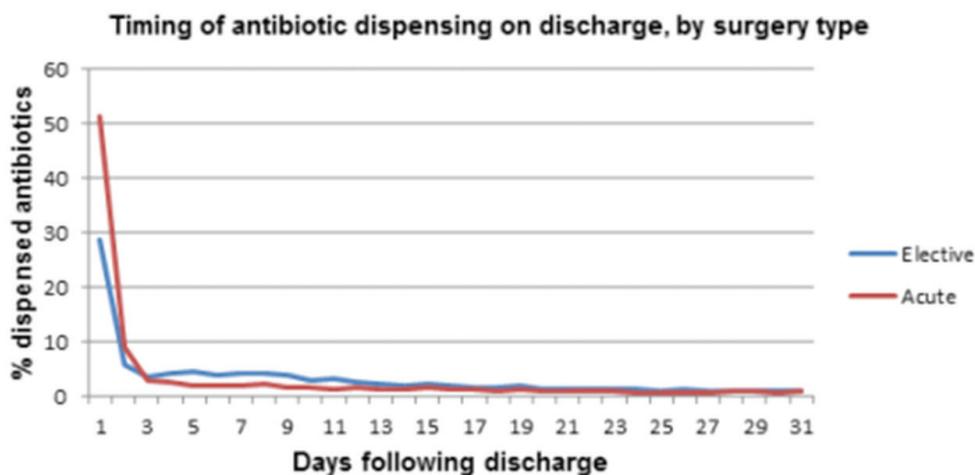
CONCLUSIONS: This study demonstrates that a significant proportion of antibiotics prescribed in patients discharged following surgery are inappropriate and there is need for enhanced antimicrobial stewardship in this area.

Antimicrobial resistance (AMR) is a growing global issue which threatens the effective treatment and prevention of infections worldwide.¹ New Zealand, has seen a dramatic rise in AMR over the recent years.² Inappropriate and excessive use of antimicrobials is an important driver of antimicrobial resistance, and is also associated with avoidable adverse drug reactions and increased healthcare costs.³ Worldwide, antimicrobial stewardship programmes aim to optimise antimicrobial use in order to lessen the impact of inappropriate use on patients and health systems.

In 2012, the Health Quality & Safety Commission (HQSC) of New Zealand introduced the "Atlas of Healthcare Variation"

(the Atlas) which highlights regional variation in healthcare provision, use of specific health services and health outcomes in New Zealand.⁴ The Atlas aims to promote discussion about differences in practice and identify areas for improvement in healthcare. One domain of the Atlas examined the incidence of infection and the rate of antibiotic use following major surgery. A key finding of the Atlas was that on average, 34% of patients discharged following major surgery at New Zealand public hospitals in 2013 were dispensed an antibiotic within 30 days of discharge.⁴ A significant proportion of the dispensing occurred on the day of discharge or the following day (Figure 1). Consistent with this

Figure 1: Percentage of dispensed antibiotics per day following discharge after major surgery (2013).



Source: <http://www.hqsc.govt.nz/atlas/infection>⁴

national rate, 32.4% of patients discharged following major surgery at Auckland District Health Board (ADHB) were dispensed an antibiotic within 30 days of discharge. This contrasts with the average 2.6% of patients being recorded as having an infection after major surgery.⁴

The available data on antibiotic use following major surgery raises several important questions: what are the indications for antibiotic use after surgery—is it for infection or prophylaxis and why is the rate of antibiotic prescribing after surgery high?

The primary objectives of this study were to determine the indications for antibiotic use in patients discharged following major surgery at Auckland City Hospital (ACH); to determine if the indication was appropriate and to identify opportunities where antimicrobial stewardship interventions would be beneficial.

Method

A retrospective audit was conducted of adult patients ≥ 18 years discharged from ACH, after major surgery between 1 January 2013 and 31 December 2013. ACH is an adult tertiary care-teaching hospital, providing a wide range of surgical services, including general surgery, cardiothoracic surgery, neurosurgery, orthopaedics, trauma, urology, vascular and otorhinolaryngology (ORL).

Data source

Data for the Atlas was drawn from the Ministry of Health's national hospital inpatient data (National Minimum Dataset (NMDS)) and the Pharmaceutical Collection.⁴ The Pharmaceutical Collection contains reimbursement claims information from community pharmacists for subsidised dispensing of medicines including antibiotics.

Infections captured by the NMDS using coded data and included in the Atlas were infections following a procedure. These include infections coded as: post-procedural infection or sepsis, intra-abdominal abscess, stitch abscess, subphrenic abscess and wound abscess.⁴ Surgeries were only included if they required a length of stay of at least two days ('major surgery').⁴ This excluded minor or short stay surgeries such as elective hernia or carpal tunnel operations. In addition, people with a primary diagnosis of infection or sepsis were excluded.⁴ People with any code of immunocompromise, any code of cancer and the major diagnostic category 14 (pregnancy, childbirth or puerperium) were also excluded.⁴

Data for ADHB was provided by the Ministry of Health Analytical Service using the Atlas defined cohort of those patients dispensed an antibiotic within 30 days of discharge following major surgery. For inclusion in this study, patients were

required to have had one or more antibiotics dispensed within the first two days of discharge following a major surgery at ACH (in order to capture prescriptions issued by the secondary care team and not primary care). Any patients with antibiotic prescriptions written by primary care providers or non-ADHB prescribers within those first two days were excluded. Furthermore, cases where there was uncertainty as to whether the prescription was written by a hospital clinician or a primary care provider were also excluded.

Additional clinical data were collected for each patient through review of medical records (MR) and discharge summaries. Data collected included: the specialty service on discharge; antibiotic dispensed; indication for antibiotic use; and any relevant microbiology results within one week of discharge to support a diagnosis of infection (including specimen type and organism).

Definitions and classifications

The indication for antibiotic use was categorised into one of six categories based on information available in the medical records: (1) infection present on admission (POA); (2) healthcare-associated infection (HAI); (3) surgical antimicrobial prophylaxis (SAP); (4) empiric therapy or clinical decision to use antibiotics in the absence of a definite diagnosis of infection; (5) no documented indication; and (6) other reason.

Indication category

1. Infection POA. Infection clearly documented in the MR as present on admission to hospital.
2. Healthcare-associated infection. The indication for antibiotic prescription was attributed to a HAI in one of two cases: (i) a clinical diagnosis of an infection was documented in the medical records by the clinical team; or (ii) an infection diagnosis was not documented, but there were documentation of clinical findings (with or without laboratory results) indicative of the presence of an infection and meeting the Centers for Disease Control and Prevention (CDC) criteria for a HAI.⁵ For each HAI, an assessment was made as to whether

findings met the standardised surveillance definitions for specific types of infections as used by the CDC.

3. Prolonged SAP was defined as the use of any antimicrobial agent commenced peri-operatively and continued post-operatively in the absence of an infection. This included cases where prophylactic antibiotics were continued longer than that recommended by the current hospital SAP guidelines or exceeded 24 hours after the completion of surgery.
4. Empiric therapy was defined as the use of an antimicrobial, in the absence of a definite diagnosis or evidence of infection to support this decision. This included cases that were treated for suspected infection but did not meet the definition for a HAI or an infection POA.
5. No documented reason in the MR
6. Other reasons. Prescribed for conditions unrelated to the surgical procedure such as *Helicobacter pylori* eradication therapy, secondary prophylaxis for CSF leak or recurrent urinary tract infections.

Justification for antibiotic use

For each patient, antibiotic use was further classified as 'appropriate', 'not assessable' or 'inappropriate' using the Australian National Antimicrobial Prescribing Survey guideline to assist with assessment of appropriateness.⁶ Antibiotic use for an established infection (ie, infection POA or HAI) was considered appropriate. Any antibiotic use for treatment of a HAI, regardless of whether or not the CDC surveillance definition was met, was considered to be appropriate.

Antibiotic use as prolonged SAP or without a documented indication was considered 'inappropriate'. Empiric therapy or antibiotic use for other reasons was also categorised as 'appropriate', 'not assessable' or 'inappropriate'. 'Appropriate' if it was in accordance with local antibiotic guidelines or if there was a clearly defined clinical indication such as documentation in the medical record of signs and symptoms of local infection or recurrent urinary tract infection prophylaxis. 'Not assessable' if there was limited clinical and laboratory evidence to

support infection. 'Inappropriate' if there was no clinical or laboratory evidence to support infection, or if antibiotic use was not consistent with local antibiotic guidelines.

One person [MDA] reviewed all the medical records. Where there was uncertainty about indication and appropriateness the case was discussed with a senior colleague [SR].

Results

In 2013, the Atlas identified 2,241 adult patients in ADHB who were dispensed an antibiotic within 30 days of discharge after major surgery. Of these, 898 were dispensed an antibiotic within two days of discharge. A random sample of 423 of the 898 patients (47.1%) were reviewed. Of the 423 patients, 45 were excluded from analysis for the following reasons: 29 because antibiotics were prescribed by a primary care provider, a non-ADHB prescriber or the prescriber was unknown; six due to missing clinical information (surgery performed at external

hospital); and an additional 10 patients as they were identified as having undergone a minimally-invasive procedure (eg, percutaneous coronary intervention, CT-guided biopsy, punch biopsy, lower limb angioplasty) rather than surgery. This left a total of 378 patients.

Indication for antibiotic use

The indications for antibiotic use in the 378 patients, as stratified by surgical specialty, are shown in Table 1. Four patients had more than one indication for antibiotic use, giving a total of 382 indications. Antibiotics were prescribed for an infection present on admission (POA) in 91 patients (24%), for a HAI in 81 patients (21.4%), as empiric therapy in 100 patients (26.5%) and as prolonged SAP in 41 patients (10.8%). An indication was not documented in 52 patients (13.8%) and 17 patients (4.5%) had other reasons for being prescribed an antibiotic (Table 2). For nine of the 91 patients with infection present on admission, the infection was unrelated to the site of surgery.

Table 1: Indications for antibiotic use stratified by specialty.

Specialty	No. of patients	Indication for antibiotic use					
		Infection POA (%)	HAI (%)	Empirical therapy (%)	Prolonged SAP (%)	No documented indication (%)	Other reason (%)
Cardiothoracic	47 ^a	3 (6.4)	21 (44.7)	11 (23.4)	2 (4.3)	8 (17)	3 (6.4)
General surgery	56 ^b	16 (28.6)	11 (19.6)	11 (19.6)	8 (14.3)	8 (14.3)	3 (5.4)
Vascular	48	21 (43.8)	8 (16.7)	11 (22.9)	4 (8.3)	3 (6.3)	1 (2.1)
Urology	43	15 (34.9)	6 (14.0)	4 (9.3)	8 (18.6)	9 (20.9)	1 (2.3)
Gynaecology	20	3 (15)	4 (20)	4 (20)	3 (15)	4 (20)	2 (10)
Neurosurgery	14 ^c	0	5 (35.7)	4 (28.6)	1 (7.1)	2 (14.2)	3 (21.4)
Orthopaedics	94 ^d	15 (16)	21 (22.3)	45 (47.9)	1 (1.1)	10 (10.6)	3 (3.2)
ORL	28	6 (21.4)	0	3 (10.7)	12 (42.9)	7 (25)	0
Ophthalmology	16	8 (50)	0	7 (43.8)	0	1 (6.3)	0
Oral health	1	0	0	0	1 (100)	0	0
Renal or liver transplant	4	0	3 (75)	0	0	0	1 (25)
Other medical specialty ^e	7	4 (57.1)	2 (28.6)	0	1 (14.3)	0	0
Total (confidence intervals calculated at 95%)	378	91 (24%, 19.8–28.4)	81 (21.4%, 17.3–25.6)	100 (26.5%, 22.0–30.9)	41 (10.8%, 7.7–14.0)	52 (13.8%, 10.3–17.2)	17 (4.5%, 2.4–6.6)

^{a, b, c, d} includes a patient with two different indications for antibiotic use.

^e includes gastroenterology, general medicine, neurology, renal and older persons health.

Table 2: Other reasons for antibiotic prescription.

Reason for antibiotic use	No. of patients (n=17)
<i>Helicobacter pylori</i> eradication therapy	3
Medical prophylaxis for cerebrospinal fluid leak	2
Continuation of regular medication (eg, medical prophylaxis)	9
Prophylaxis for indwelling urinary catheter	1
Pertussis post-exposure prophylaxis	1
Preoperative bacteriuria (prior to transurethral resection of prostate)	1

Healthcare-associated infections (n=81)

Among the 81 patients prescribed an antibiotic for a HAI, 59 (72.8%) met CDC surveillance definitions for a specific type of HAI. Overall, the most common HAIs were pneumonia (18 patients, 22.2%) and surgical site infections (18 patients, 22.2%). Other HAIs included urinary tract infections; both catheter-associated and non-catheter-associated (16 patients (19.8%) and 10 patients (12.3%), respectively). Forty of the 81 (49.4%) patients with a HAI had supporting microbiology.

Empiric therapy (n=100)

For patients given empiric therapy, only 8% were deemed appropriate.

Of note, 37 of 39 patients (95%) with compound fractures, penetrating injuries or open traumatic wounds received empiric treatment that was inconsistent with local guidelines. Patients with these injuries generally received intravenous antibiotics during their hospitalisation and on discharge were prescribed courses of oral antibiotic therapy ranging from 2–14 days (median 7, interquartile range 5–7). In all but two of these patients, the total duration of empiric therapy was prolonged, and thus was considered inappropriate.

Six patients were treated empirically for penetrating eye injuries (considered appropriate). Other indications for empiric therapy included suspected infection (30 patients), post-operative fever (eight patients) and wound discharge (12 patients). The use of antibiotics in these patients was considered ‘not assessable’ due to inadequate information in the medical records.

An additional five patients received empirical therapy despite no clinical evidence of infection and unhelpful microbiological results (eg, for asymptomatic bacteriuria). These were regarded as ‘inappropriate’.

Prolonged surgical antimicrobial prophylaxis (n=41)

The use of prolonged SAP in 41 patients was considered ‘inappropriate’. Use of prolonged SAP was most notable among the ORL, general surgery and urology services. The 12 ORL patients who received prolonged SAP had undergone a range of head and neck surgeries. Among the eight general surgical patients who received prolonged SAP, five had undergone breast surgery of which three had a documented plan to continue oral antibiotics until surgical drains were removed. One of two patients who underwent hernia surgery also had a documented plan to continue antibiotics until surgical drains were removed. The eight urology patients also underwent a range of procedures including urethroplasty and insertion of artificial urinary sphincter.

Other reasons (n=17)

For most patients the indication was ‘appropriate’ except in one case; a patient given prophylaxis for presence of an indwelling urinary catheter.

Antibiotic prescribed on discharge following major surgery

Amoxicillin clavulanate was by far the most commonly prescribed antibiotic (171 patients) followed by flucloxacillin (40 patients), cefaclor (34 patients), ciprofloxacin (28 patients) and doxycycline (26 patients).

Table 3: Appropriateness of antibiotic therapy by indication.

	Number of indications (%)	Appropriate	Not assessable	Inappropriate
Infection POA	91 (23.8)	91	-	-
HAI	81 (21.2)	81	-	-
Empiric therapy	100 (26.2)	8	50	42
Prolonged SAP	41 (10.7)	-	-	41
No documented indication	52 (13.6)	-	-	52
Other reason	17 (4.5)	16	-	1
Total	382	196 (51.3%)	50 (13.1%)	136 (35.6%)

Overall appropriateness of antibiotic use

Overall, nearly half of the antibiotic courses dispensed (48.7%) were 'inappropriate' or 'not assessable' (Table 3).

Discussion

The Atlas demonstrated that a third of patients were dispensed an antibiotic within 30 days of discharge from hospital following major surgery.⁴ Among the random sample of patients dispensed an antibiotic within two days of discharge, clear evidence to support the use of the antibiotic was only present for half of the patients. For one-third the use was inappropriate, and for the remainder, (13%), the reason for use was not assessable and may have been inappropriate. Reducing the unnecessary prescribing of antibiotics will reduce the adverse effects seen in patients such as an increased risk of antibiotic resistance, *Clostridium difficile* infection and other side effects that may lead to readmission.

This study demonstrates that improvement in the use of antibiotics following surgery is needed. Nearly all prescriptions given empirically were given for inappropriate (42%) or not assessable (50%) reasons. Of equal concern was that about 14% had no clear documented indication for antibiotic use and 11% had surgical antimicrobial prophylaxis given beyond recommended timeframes.

All patients treated for a HAI in this study were considered to have been treated appropriately. However, only ~73% of these patients met the CDC surveillance definition

for a specific type of HAI and it possible that we have overestimated the number of true HAIs regarded to have been treated appropriately.

Empiric therapy for suspected, or where there is a high risk of infection, was the most common indication for antibiotic use in this study, accounting for a quarter of prescriptions. Nearly a half (42%) of empiric therapy was considered inappropriate (Table 3). Use of empiric antibiotics was particularly notable among the orthopaedic service and involved patients with traumatic injuries such as open fractures or wounds, lacerations and penetrating injuries, in whom pre-emptive antibiotics were continued for extended durations. Careful evaluation and classification of wounds could direct appropriate antibiotic therapy and reduce overuse of antibiotics. For open fractures, the importance of early administration of antibiotics is well accepted. The Gustilo-Anderson classification system is the most commonly used classification system for grading open fractures and has been used in guidelines to direct the choice and duration of antibiotic therapy.^{7,8} Although the optimal duration of pre-emptive antibiotics for open fractures is yet to be defined, our hospital guidelines are consistent with international guidelines (eg, EAST Practice Management Guidelines and British Orthopaedic Association/British Association of Plastic Reconstructive and Aesthetic Surgeons Guideline), which recommend a maximum of 72 hours for the most severe fractures.^{9,10} In a recent retrospective, case-control study, even shorter courses of antibiotics (one day) were not inferior to longer courses in preventing infections in open fractures.¹¹

This study also found a considerable number of patients were prescribed antibiotics in response to discharge or drainage from surgical wounds. In some cases, the antibiotic was inappropriately prescribed for a wound with serous discharge suggesting that the knowledge about the characteristics of a surgical site infection by ward staff could be improved. In other cases, the nature of the wound discharge was not adequately described (ie, purulent versus serous) to allow an assessment of the appropriateness of antibiotic therapy. Antibiotic therapy is only required for wounds that are clinically infected.¹²

Approximately 10% of patients in this study were prescribed courses of SAP that were prolonged and not adherent with current guidelines. In some cases, prophylactic antibiotics were continued while surgical drainage tubes were in place, although there is no evidence to support this practice.¹³ International guidelines recommend that the duration of prophylaxis for all procedures (except cardiac surgery) should be less than 24 hours.¹³ While appropriate SAP is undoubtedly effective in reducing the risk of surgical site infection, prolonged use of prophylaxis provides no additional benefit, is associated with increased costs and could potentiate antimicrobial resistance.¹³ At a national level, the HQSC's Surgical Site Infection Improvement programme has successfully introduced 'Surgical Antimicrobial Prophylaxis Intervention Guidelines' in order to optimise SAP in hip and knee arthroplasties, and cardiac surgery.^{14,15}

This study has several limitations. Firstly, it is a retrospective, single-centre study and was limited by the quality of documentation in the patient records. Often, the reason behind the decision to prescribe antibiotics was not documented, or apparent, following a review of the medical records. Hence, it is possible that we may have overestimated the prescriptions that were considered 'inappropriate'. Secondly, the data for the Atlas and for this audit was extracted from the NMDS using coded data following patient discharge (ICD-10 codes). Patients with a primary diagnosis of infection or sepsis were excluded. However, 24% of patients in our study had an infection present on

admission and required antimicrobial treatment for this infection, which was continued after discharge. Our findings highlight the limitations of relying on coded data as has been found in previous studies.¹⁶ Thirdly, the findings from ADHB may not be generalisable to other hospitals in New Zealand because the complexity and types of surgeries performed and antibiotic practices of surgeons at different centres may differ. We think that this is less likely because high rates of prescribing were seen across all district health boards in New Zealand.

Antimicrobial stewardship programmes aim to optimise antimicrobial use in order to improve patient outcomes while limiting unintended consequences such as the emergence of resistance, drug toxicity and adverse events, and healthcare costs.³ Surgical patients are a complex group of patients where antimicrobials may be prescribed for a number of reasons. This study has demonstrated a need for enhanced antimicrobial stewardship in this area and the results of this study will assist the ADHB Antimicrobial Stewardship team to target specific areas such as documentation of antibiotic therapy, adherence to SAP guidelines and use of antibiotic following complex trauma. A Quality Improvement strategy would be useful in improving antibiotic use among surgical units. Such QI strategy could include various interventions (eg, education focusing on diagnosis, investigation and treatment of post-operative infections; promotion of institutional guidelines (eg, SAP guidelines); prospective audit and feedback, including the measurement and feedback of process measures (eg, adherence to guidelines) and outcomes measures (eg, local antibiotic consumption)).

Conclusion

In conclusion, this study demonstrates that one-third of antibiotics prescribed following major surgery were inappropriate, and the supporting evidence for use in another 13% was poorly documented. Given the growing problem of antibiotic resistance globally, it is important now more than ever, to take actions to reduce the use of inappropriate and unnecessary antibiotics.

Competing interests:

Nil.

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