Audit

Timing of antibiotic prophylaxis in surgery for adult hip fracture

Raghuram Thonse, Muthyala Sreenivas, Kevin P Sherman

Department of Orthopaedic Surgery, Hull Royal Infirmary, Hull, UK

Background: Antibiotic prophylaxis is widely used in surgery for hip fractures.

Methods and Results: In a retrospective study of case notes of 100 patients, frequent inaccuracies in dose administration were observed. This was applicable to both the pre-operative and the postoperative doses. Longer time intervals between the doses, failure to administer the prescribed doses, and failure of proper documentation were observed.

Conclusions: Improvement in the awareness of staff and timely administration of prophylactic antibiotic has resulted from this study.

Key words: Antibiotics – Prophylaxis – Hip fracture

Administration of antibiotic prophylaxis is standard practice in surgery for hip fractures. Although the regimen adopted varies in each hospital, it is agreed that the timing of antibiotic administration in relation to surgery is crucial.^{1,2} Administration of antibiotics in the 2-h period (ideally 30–60 min) before surgical incision is associated with the lowest risk of surgical wound infection. Similarly, timing of the postoperative doses of antibiotics is crucial if the prophylaxis is to be effective and surveillance of this is essential if standards are to be maintained.^{3–5} The prophylactic antibiotic regimen in surgery for hip fracture in our hospital is cefuroxime 1.5 g i.v. at induction of anaesthesia and two subsequent doses of cefuroxime 750 mg i.v. at 8 h and 16 h postoperatively. We sought to ascertain the timing of antibiotic prophylaxis in relation to the time of surgery.

100 patients (81 female and 19 male patients) were randomly selected for this study after excluding patients who received regular antibiotics for other reasons such as chest infection. The hospital records including the operation and anaesthetic notes and the drug charts were analysed. Data on the type of fracture, type of surgery and the pre-operative and postoperative doses of antibiotics were collected. The intervals between these doses were calculated. These were analysed separately for patients with factors that increased the likelihood of infection. The complications documented in the hospital records were noted and, where possible, defined according to the Scottish Intercollegiate Guidelines Network (SIGN) guidelines.⁶

The differences in the intervals between antibiotic administration were analysed statistically.

Patients and Methods

A total of 346 patients with hip fractures were treated at our hospital between January and August 2001. Of these,

Results

Table 1 lists the interval between pre-operative dose and the first postoperative dose grouped according to the type

Correspondence to: Kevin P Sherman, Consultant, Department of Orthopaedic Surgery, Hull Royal Infirmary, Hull, UK
Email: thonser@hotmail.com

Table 1 Timing of administration of antibiotic prophylaxis in relation to type of hip fracture surgery

Timing	DHS		Austin Moore		Cannulated screws		Furlong		Others	
	n	Comp.	n	Comp.	n	Comp.	n	Comp.	n	Comp.
None	3		1		1		2	Superficial		
0–4 h	1		2							
4–6 h	4	Superficial	6	Other	1					
6–8 h	10	Other (2), superficial	6	Other			6	Superficial		
8–10 h	3		4		2	Other	1		1 (Hastings)	–
10–12 h	4		8	Other, superficial	1	Other	2	Superficial	1 + 1*	–
12–14 h	5	Superficial	4	Other (2)			1	Superficial		
14–16 h	2	Superficial, deep	0							
16–18 h	0		0				1			
18–24 h	2		5	Other, superficial			2			
> 24 h	4		1		1					

Comp. – Complications

n – No. of patients

Superficial – clinical evidence of active infection $\pm$ bacteriological confirmation.

Deep – infection deep to the deep fascia.

Other – discharge (serous or otherwise), other wound problems not meeting the criteria of superficial infection (SIGN guidelines).

*One Charnley and one reconstruction nail.

of hip fracture surgery. This interval ranged from 90 min to 45.5 h. The interval between first and second postoperative doses ranged between 230 min and 24 h and that between the second and the third postoperative doses between 4–16 h. The intervals between pre-operative and first postoperative doses in relation to different high risk situations are shown in Table 2.

Seven patients (7%) did not receive any prophylactic antibiotics. Of the rest, 22 patients (24%) had their antibiotics doses given within 1 h of the intended time for the regimen followed in our hospital (8 ± 1 h) whereas 71 patients (76%) had their doses administered outside this period (difference of 52%; 95% CI of 41–65%; $P < 0.05$).

Taking a wider range of 2 h on either side of the intended time on the regimen (8 ± 2 h), 36 patients (39%) were given their doses within this time period and 57 patients (61%) outside this period (difference 22%; 95% CI 4–33%; $P < 0.05$).

The dose at induction (peroperative dose) was always administered by the anaesthetist and recorded in the anaesthetic or drug chart or both and sometimes recorded by the surgeon in the operation notes. The postoperative doses were prescribed by the senior house officer on the

ward or on-call either postoperatively (in 54% of cases) or pre-operatively (in 19% of cases), by the operating surgeon in 20% of cases and not prescribed in 7 cases. Table 3 shows doses prescribed against those actually administered.

The reasons for improper timing of antibiotic doses were recorded in only a proportion of case notes. These included: antibiotics not prescribed in time; intravenous access not available and delay in the senior house officer re-establishing this access (being busy in the accident and emergency department); timing of the doses not indicated on the drug charts; inadequate trained staff to administer antibiotics (due to other seriously ill patients); and the antibiotic doses being prescribed in the once only section of the drug card rather than the usual regular medication section.

Discussion

In most instances, the bacteria responsible for clinical infection in hip fracture surgery enter the wound at the time of surgery.¹ Prophylactic antimicrobial agents should ideally be administered intravenously 30–60 min before

Table 2 Timing of prophylactic antibiotic administration in high risk scenarios

High risk scenarios	Time < 8 h	Time > 8 h	Not given	Complications
Rheumatoid arthritis	–	4	–	Other x2
Malignancy (cancer, leukaemia)	2	9	1	Superficial infection x2
Diabetes mellitus	1	2	1	Other, superficial infection x2
Chronic renal failure/dialysis	–	1	–	–
Chronic obstructive airway disease/recurrent chest infection	–	2	–	Deep infection
Anaemia	–	2	–	–
Hemicolectomy	–	1	–	–
Alcoholic liver disease	1	–	–	–
Coeliac disease	–	1	–	–
Steroid therapy	–	3	–	Other (deep infection)
Methotrexate	–	1	–	Other

Table 3 Antibiotic prophylaxis – doses prescribed versus doses administered (n = 100)

Doses prescribed	Doses administered	No of patients
0 (n = 10)	0	7
	2	3
2 (n = 62)	1	5
	2	53
3 (n = 25)	2	3
	3	20
	4	2
Other number of doses		
6 (n = 3)	8	1
Number of doses not specified	7,8	2

skin incision. Antibiotic concentrations in blood and bone typically peak within 20 min and 60 min, respectively, of systemic administration and need to be maintained above the minimum inhibitory concentration (MIC) of the infecting organisms until skin closure.^{1,3}

Infection following surgery for closed fractures is more common than after elective surgery, probably because the health of the patient and of the soft tissues is better in elective cases. The rate of surgical site of infection after repair of a closed fracture of a long bone is around 3–4%. The spectrum of infecting organisms is similar to that following prosthetic joint implantation.¹

Pooled results suggest that antibiotic prophylaxis is effective.^{7,8} Single pre-operative plus two or more postoperative doses administered parenterally reduced the absolute risk of wound infection by 2.9% (95% CI 1.3–4.4%) from 4.3% in controls to 1.4%. A single pre-operative dose reduced the risk by 1.8%, from 3.0% to 1.2%.¹ There is still considerable discussion in the current literature as to the duration of prophylactic treatment required for optimal effectiveness. Their role in surgery for closed fractures is more controversial.⁹ This is true even in the area of hip fracture surgery, where large numbers of patients are treated in every hospital and large studies have been conducted.¹⁰ The value of the pre-operative dose of antibiotics is better established in many studies than the postoperative doses. The studies which question the use of postoperative doses of antibiotics have many drawbacks.^{11,12} Moreover, when operating to treat hip fractures, sometimes the standards of hygiene may slip from those rigorously strived for in joint replacements (like an open fracture or an infected case preceding the surgery for hip fractures). Sometimes, such surgery may be performed without the benefit of laminar flow theatres. As occurrence of infection can be disastrous, the regimen for antibiotic prophylaxis should be followed rigorously. Many surgeons use prophylactic antibiotics when using metal implants and prostheses.¹³

Orthopaedic surgery represents a special situation in which large volume foreign bodies are implanted into the body. The presence of any such foreign material greatly reduces the number of bacteria needed to infect the operation site.¹ Moreover, the results of infection in hip fractures can be disastrous, impairing the quality of life permanently in most instances.

Until there is indisputable evidence to the contrary, prophylactic antibiotics will continue to be used in hip fracture surgery. Some factors increase the likelihood of infection: co-morbid systemic disease (e.g. diabetes mellitus, rheumatoid arthritis and malignancy); longer duration of surgery (especially over 3 h) and previous surgery involving the same joint. In these scenarios, use of prophylactic antibiotics and their timely administration may be more crucial. Extra care is needed to ensure that antibiotic prophylaxis is administered correctly in these high risk scenarios.

A trend towards an increased incidence of infections or wound discharges was noted in patients with inadequate antibiotic prophylaxis. This study is too small to show any statistically significant increase in the infection rates secondary to inadequate antibiotic prophylaxis. This is true even for cases with factors which increase the risk of infection. Small sample size and heterogeneity in patient and surgical factors lead to difficulties in interpretation of the results. As in any retrospective study, the extent and clarity of documentation varies widely, particularly with regard to information about wound complications. We have an established regimen for antibiotic prophylaxis for hip fracture surgery and it was the purpose of this study to audit if this was being implemented correctly, otherwise the benefits may be outweighed by the side effects and the cost of antibiotic prophylaxis.

This study has helped raise awareness of our daily practise and the problems associated with the prophylactic use of antibiotics. Surgeons are more aware of the need to ensure that antibiotics are prescribed and administered according to the regimen. Nurses have been informed of the importance of the timing of antibiotic administration and the methods to ensure timely administration. Better documentation of pre-operative dose administration has been achieved.

To complete the audit cycle, regular checks are required to ensure that the prophylaxis is administered as intended, especially if there is a change in the regimen in the future.

Acknowledgements

The authors are grateful for the feedback and support given by the orthopaedic consultants and trainees and other staff at the Hull and East Yorkshire Hospitals NHS Trust

during this study. We also gratefully thank Mrs Elaine Howarth, Hull University, for help with the statistical analysis.

References

1. Antimicrobial prophylaxis for orthopaedic surgery. *Drug Therap Bull* 2001; **39**: 43–6.
2. Classen DC, Evans RS, Pestotnik SC, Horn SD, Menlove RI, Burke JP. The timing of prophylactic administration of antibiotics and the risk of surgical wound infection. *N Engl J Med* 1992; **326**: 281–6.
3. William DN, Gustilo RB, Beverly R, Kind AC. Bone and serum concentrations of five cephalosporin drugs: relevance of prophylaxis and treatment in orthopaedic surgery. *Clin Orthop* 1983; **179**: 253–65.
4. Zoutman D, Chau L, Watterson J, Mackenzie T, Djurfeldt M. A Canadian survey of prophylactic antibiotic use among hip fracture surgery. *Infect Control Hosp Epidemiol* 1999; **20**: 752–5.
5. Martin C, Viviani X, Gayte-Sorbier A, Saux MC. Survey of 39 South East Group hospital centres on the practice of antibiotic prophylaxis in surgery. *Ann Fr Anesth Reanim* 1998; **17**: 764–8.
6. Scottish Intercollegiate Guidelines Network. *Antibiotic Prophylaxis in Surgery*. SIGN Publication no 45, 2000 (see <<http://www.sign.ac.uk>>).
7. Gillespie WJ, Walenkamp G. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures In: *The Cochrane Library*, Issue 2, 2001; Oxford: Update Software.
8. Norden CW. Antibiotic prophylaxis in orthopedic surgery. *Rev Infect Dis* 1991; **13** (Suppl 10): S842–6.
9. Court-Brown CM. Antibiotic prophylaxis in orthopaedic surgery. *Scand J Infect Dis Suppl* 1990; **70**: 74–9.
10. Dougall TW, Duthie R, Maffulli N, Hutchison JD. Antibiotic prophylaxis: theory and reality in orthopaedics. *J R Coll Surg Edinb* 1996; **41**: 321–2.
11. Hjortrup A, Sorensen C, Mejdahl S, Horsnaes M, Kjersgaard P. Antibiotic prophylaxis in surgery for hip fractures. *Acta Orthop Scand* 1990; **61**: 152–3.
12. McQueen MM, Little John MA, Miles RS, Hughes SP. Antibiotic prophylaxis in proximal femur fracture. *Injury* 1990; **21**: 104–6.
13. Leach WJ, Wilson NIL. Trends in infection prophylaxis in orthopaedics. *J R Coll Surg Edinb* 1992; **37**: 265–6.