Our aim in this study was to determine the outcome of hip arthroplasty with regard to infection at our unit. Infection after total joint arthroplasty is a devastating complication. The MRC study in 1984 recommended using vertical laminar flow and prophylactic antibiotics to reduce infection rates. These measures are now routinely used. Between 1993 and 1996, 1727 primary total hip arthroplasties and 305 revision hip arthroplasties were performed and 1567 of the primary and 284 of the revision arthroplasties were reviewed between five and eight years after surgery by means of a postal questionnaire, telephone interview or examination of the medical records of those who had died.

Seventeen (1.08%) of the patients who underwent primary and six (2.1%) of those who underwent revision arthroplasty had a post-operative infection. Only 0.45% of patients who underwent primary arthroplasty required revision for infection.

To our knowledge this is the largest multi-surgeon audit of infection after total hip replacement in the UK. The follow-up of between five and eight years is longer than that of most comparable studies. Our study has shown that a large cohort of surgeons of varying seniority can achieve infection rates of 1% and revision rates for infection of less than 0.5%.

Infection after total hip arthroplasty
THE AVON EXPERIENCE
From the Avon Orthopaedic Centre, Bristol, England

Infection is an uncommon, but potentially devastating complication of total joint arthroplasty. The MRC study published in 1984 by Lidwell et al demonstrated that the rates of deep infection may be reduced by using laminar flow and prophylactic antibiotics. In addition to these measures at our unit we routinely wash all arthroplasty wounds with chlorhexidine. Between 1993 and 1996, it was our standard practice for antibiotic prophylaxis to give three intravenous doses of cefamandole to all patients. Two drains were used and were removed between 24 and 48 hours after operation. In our unit 27 consultant surgeons, their registrars and senior house officers, as well as clinical fellows, research fellows and visiting surgeons performed the operations, representing a wide spectrum of experience, ability and seniority.

We have performed an audit of all the primary and revision hip arthroplasties which were undertaken between 1993 and 1996 and report the outcome with regard to deep infection.

Patients and Methods
A postal questionnaire was sent to all patients who underwent primary or revision hip arthroplasty between January 1993 and December 1996. Those who did not respond were sent a second questionnaire and an attempt was made to contact by telephone all those who responded to neither questionnaire. The notes of all deceased patients were available.

The patients were asked: have you had any problem with infection in the joint or wound after your hip replacement? If the answer was in the affirmative they were then asked whether the infection was:
  a) a reddened or inflamed wound in hospital requiring extra antibiotics from the hospital staff or a delay in discharge from hospital because of infection
  b) a reddened or inflamed wound after leaving hospital requiring extra antibiotics from a general practitioner
  c) an infection which required readmission to hospital for further treatment or investigation
  d) a deep infection (inside the joint) requiring further surgery, or
  e) other (please specify)?
The notes of all those who responded and all deceased patients were examined, and all patients who received additional antibiotics or who underwent further surgery for suspected infection were identified.

**Results**

Table I gives the results for primary arthroplasty and Table II for revision arthroplasty.
Primary total hip arthroplasty (THA). Between 1993 and 1996, a total of 1727 primary THAs were performed; 1377 were contacted either by post or telephone, 190 had died and 160 had been lost to follow-up. The notes of the deceased were examined. Therefore 1567 patients were reviewed between five and eight years after surgery. Seventeen (1.08%) had been prescribed extra antibiotics. In 11 of these (64.7%) an organism was identified from a wound swab. This was *Staph. aureus*, sensitive to flucloxacillin, in seven cases, coliforms in two (in one combined with *Serratia marcescens*), *Staph. epidermidis* in one and beta-haemolytic streptococcus in one.

Of the 17 patients, seven (41.2%) underwent exploration, debridement and washout and five (29.4%) subsequently required a revision procedure. Thus, ten of the 17 patients (58.8%) did not undergo exploration, debridement or washout. However, two of these subsequently required a revision procedure. Of the patients with a primary THA who were contacted, seven (0.45%) required a revision for deep infection. No organisms were identified at the time of revision which had not previously been identified.

Revision total hip arthroplasty. A total of 305 revision THAs was performed during the period of the study; 284 patients were contacted and 21 were lost to follow-up. Six (2.1%) had been prescribed extra antibiotics and 56 had died.

In all patients an organism was identified from a wound swab. This was *Staph. aureus* in one, coliforms in one, *Staph. epidermidis* in three and *Streptococcus* in one. These organisms were treated with the appropriate intravenous antibiotics to which they were sensitive.

Of the six patients with infected wounds, four underwent exploration, debridement and washout. One made an uneventful recovery and was asymptomatic eight years later. In the other three the infection did not settle. One developed a chronic sinus, one required an excision arthroplasty and one a further revision procedure. The last was asymptomatic two years after surgery. Of the patients with infection, two of six (33%) were treated with intravenous antibiotics, but did not require exploration and washout. In both of these, the infection settled and the patients were asymptomatic at five and eight years, respectively. Thus, in three of the six patients, the prostheses survived without evidence of chronic infection.

Discussion

The introduction of vertical laminar airflow, prophylactic antibiotics and occlusive clothing during routine THA has led to a dramatic decrease in deep infection. The MRC study\(^2\) showed that the rate of infection could be reduced from 3.4% to 1.7% by the use of ultra-clean air, to 0.4% by using ultra-clean air and antibiotics and to 0.2% by using ultra-clean air, antibiotics and occlusive clothing. Before the introduction of these measures Charnley and Eftekhar\(^3\) had reported rates of infection of 9% in primary THA. Subsequently, these have declined.

Good results have been reported in single-surgery series. Schutzer and Harris\(^4\) reported a rate of infection of 0.38% in 659 THAs at a mean of 4.2 years, and Eftekhar and Tzitzikalakis\(^5\) reported one revision for infection in 499 THAs. Less good results have been reported in multi-surgeon series. Fender, Harper and Gregg\(^6\) reported a rate of deep infection of 1.4% and of superficial infection of 3.1% at five years in a cohort of 1080 patients who had undergone primary THA in a single health region in England, and they reported a rate of revision for infection of 1.2%. Revision rates for deep infection of 0.23% at only three months have been reported in the Medicare population in the USA.\(^7\) Gaine et al\(^8\) reported an early deep infection rate of 1.1% within three weeks of surgery, and a superficial infection rate of 17.3%. Williams et al\(^9\) examined the notes of 110 randomly selected patients who had undergone primary THA. Antibiotics were prescribed for wound infection in 4.5% of patients within one year of surgery. In comparison, at between five and eight years only 1.08% of our patients had received extra antibiotics and only 0.45% required revision for deep infection. A disadvantage of investigating rates of infection by our questionnaire is that it may fail to detect patients with a latent infection and well-healed wounds who have non-specific symptoms, leading to a poor outcome. A prospective study in which wound swabs were obtained from all revision cases would avoid this.

The reported rates of infection after revision THA vary between 2.5% and 29%.\(^5,10\) Our rate of 2.1% compares favourably with these series. Half of the patients in our series were successfully treated without revision.

It is thought that decreasing intra-operative wound contamination will decrease the rate of infection. Lister\(^11\) in 1866 reduced his mortality from 46% to 15% by adopting antiseptic techniques. A number of measures have been shown to decrease intra-operative wound contamination. These include the use of chlorhexidine lavage, clothing with occlusive cuffs, the use of disposable non-woven drapes, hats and masks and limiting the number of people in the operating theatre.

Taylor, Leeming and Bannister\(^12\) showed that chlorhexidine lavage significantly decreased wound contamination. Dust on footwear can transfer bacteria into the operating theatre.\(^13\) Hubble et al\(^14\) have shown that sleeves and trousers with elasticated edges reduce the shedding of bacteria and that wearing masks decreases the contamination of settle plates placed at waist height in a laminar flow theatre by a factor of 15.

Taylor and Bannister\(^15\) showed that interposition of personnel between the ultra-clean air source and the wound led to a 27-fold increase in bacterial count in the wound. Disposable non-woven drapes prevent the passage of bacteria, while bacteria easily penetrate re-usable cotton and polyester drapes within 30 minutes.\(^16\)

However, Madhavan et al\(^17\) have shown that theatre protocols designed to decrease wound contamination are seldom adhered to in hospitals in the UK. We have, how-
ever, managed to achieve low rates of deep infection in a large multi-surgeon study in which theatre protocols have been adhered to.

Exploration, washout and debridement of the wound were effective treatment in only two of seven infected primary THAs and one of four infected revisions. These results are disappointing. In most cases the notes were inexact as to what constituted wound debridement and it may be that the debridement was inadequate and therefore ineffective. It is not possible in a retrospective study to ascertain the extent of debridement and the individual surgeon’s threshold for exploring a potentially infected wound.

To our knowledge this is the largest multi-surgeon audit of infection after THA in the UK. The follow-up of between five and eight years is longer than that of most comparable studies. We have shown that a large cohort of surgeons of varying seniority can achieve infection rates of 1% and revision rates for infection of less than 0.5% in THA.

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References