■ SHOULDER AND ELBOW

# Evaluation of fever in the immediate post-operative period following shoulder arthroplasty

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doi:10.1302/0301-620X.99B11.BJJ-2017-0469.R1 $2.00

*Bone Joint J* 2017;99-B:1515–19.
*Received 25 April 2017; Accepted after revision 03 July 2017*

## Aims
**To determine the incidence and timing of post-operative fevers following shoulder arthroplasty and the resulting investigations performed.**

## Patients and Methods
**A retrospective review was conducted of all patients undergoing shoulder arthroplasty over a nine-year period. The charts of all patients with a post-operative fever (≥ 38.6°C) were reviewed and the results of all investigations were analysed.**

## Results
**A total of 2167 cases (in 1911 patients) were included of whom 92 (4.2%) had a documented fever. Obese cases had a significantly greater risk for fever (relative risk 1.53; 95% confidence interval 1.02 to 2.32; p = 0.041). Investigations were performed in 43/92 cases (46.7%), with a diagnosis being made in six cases (6.6% of the total, two of whom had their diagnosis made post-discharge).**

## Conclusion
**Around one in 25 cases develop a fever following shoulder arthroplasty; most have no infective aetiology. These patients may be being over-investigated; investigations should be performed in patients with persistent fever or on those with an identifiable source of infection on clinical examination.**

**Cite this article: *Bone Joint J* 2017;99-B:1515–19.**

Elevated temperature is a common finding in the first 24 hours post-operatively and is considered, in the vast majority of cases, to be benign. Post-operatively this may be due to transient alterations in temperature regulation due to anaesthesia, the presence of endogenous and exogenous pyogens and the direct effect of surgery on the patient's central nervous system.[1,2] In contrast, elevated temperature occurring between three and five days following surgery is more likely to be pathological. The causes at this point include infection, either related to the wound or from other sources such as the respirator system or urinary tract,[3] and non-septic causes such as deep venous thrombosis (DVT), pulmonary embolism (PE) and intravenous phlebitis.[2,4]

Post-operative fever and the ensuing investigations result in delays in discharge from hospital and substantial costs to healthcare providers.[5,6] Ward et al[6] reported that the total direct cost associated with the investigation of fever following total hip and knee arthroplasty (THA and TKA) was $73 878 for their cohort of 1100 consecutive patients at a single institution (in which fever occurred in 15% of patients), with an average cost of a fever evaluation per patient of $959.45 and with a cost per change in clinical management (total costs of the evaluation divided by the number of fever evaluations that resulted in changes in patient care) of $8209. The investigations undertaken rarely result in any change in management; it has been reported that they are negative for between 76% and 98% of patients following lower limb arthroplasty.[6,7] While there are several studies which examine post-operative fever following hip and knee arthroplasty,[4,6-9] fevers following upper limb arthroplasty have not previously been studied.

The purpose of this study was to define the incidence and timing of fever following upper limb arthroplasty and the outcome of the investigations which result. We hypothesised that post-operative fever is both relatively common and frequently benign with the majority of investigations being normal.

## Patients and Methods
**Study design.** Following institutional review board (IRB) approval by the IRB at Rush

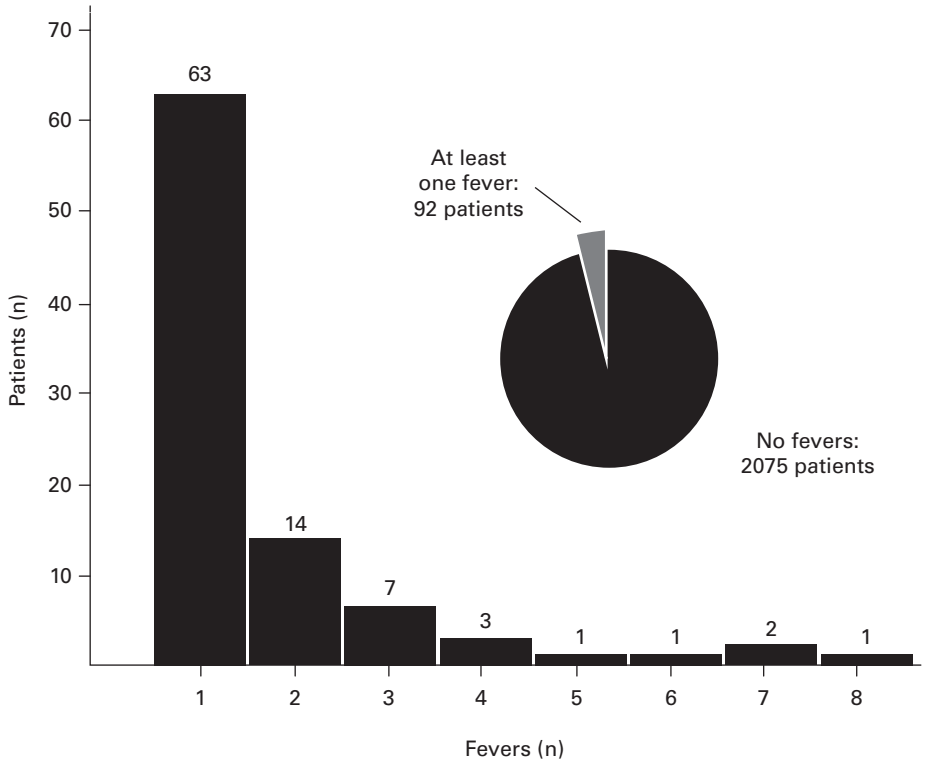


Fig. 1

Graph showing the number of fevers following shoulder arthroplasty.

University Medical Center (ORA number 16032601-IRB01), a retrospective cohort study was conducted including all patients who underwent primary or revision shoulder arthroplasty between July 2007 and February 2016 at a single institution under the care of one of four fellowship-trained surgeons. Patients underwent their surgery (total shoulder arthroplasty (TSA), either conventional or reverse geometry or hemiarthroplasty) for a number of degenerative conditions, including osteoarthritis, rheumatoid arthritis, trauma, avascular necrosis and cuff arthropathy; those undergoing revision surgery for infection were ineligible for inclusion. Patients with a pre-operative fever or a pre-operative diagnosis of urinary tract infection (UTI), pneumonia, or DVT were excluded as were those with incomplete documentation.

The following patient demographic and intra-operative data were recorded: gender, body mass index (BMI), duration of surgery (minutes), surgical procedure (TSA or hemiarthroplasty), and pre-operative diagnosis.

All cases received a standard 2 g intravenous dose of cefazolin (raised to 3 g in patients weighing > 100 kg) prior to surgical incision and received additional doses every eight hours until the first 24 hours post-operatively or discharge, whichever was earlier. Patients were considered to have had a post-operative fever if a temperature ≥ 38.6°C had been documented post-operatively. Our institution uses this clinical threshold in part to discourage unnecessary investigation of low-grade fevers. In these patients, the timing of the fever and its duration (i.e. the number of four hourly temperature recordings above the threshold) were noted. There were no strict guidelines for the investigation of fever: the need for investigation and the choice of investigations instituted were at the discretion of the on-call physician at the time. Any investigations ordered and the incidence of any complications (DVT, PE, UTI or respiratory tract infection (RTI)) in the first 90 post-operative days were recorded, as was any treatment received for these complications. Finally, the length of post-operative stay (in hours), and the number of re-admissions were recorded. Our institution has a sophisticated and reliable system of data collection and we consider the data collected to be highly accurate.

The diagnosis of UTI was made on the basis of both urinalysis (positive if either leukocyte esterase or nitrites were present) and a positive urine culture. RTIs were diagnosed on the basis of findings on chest radiograph or positive sputum culture.

**Statistical analysis**. Potential risk factors for the development of post-operative fever were tested using chi-squared tests (threshold, $p = 0.1$); these included age (dichotomised into patients < 70 years and those ≥ 70), gender, BMI (either non-obese, < 30 kg/m$^2$ or obese, ≥ 30 kg/ m$^2$), procedure performed (primary TSA, revision TSA, hemiarthroplasty) and length of surgery (< 120 minutes or ≥ 120 minutes). A multivariable Poisson regression model with robust standard errors was used to identify independent risk factors.

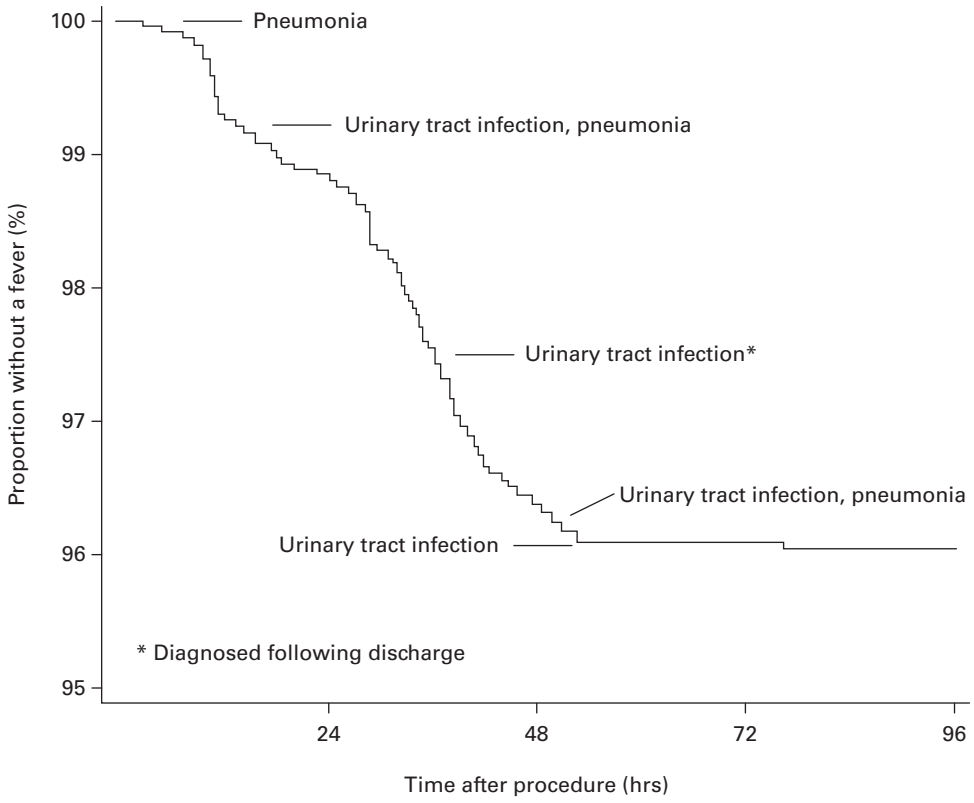


Fig. 2

Graph showing the timing of fevers following shoulder arthroplasty.

Statistical analysis was performed using Stata MP version 13.1 for Mac (Stata Corp, College Station, Texas) and statistical significance was set at a p-value < 0.05.

## Results

Of 2306 shoulder arthroplasty procedures performed in the study period, 139 were excluded due to incomplete data or periprosthetic infection, leaving a total of 2167 cases (in 1911 patients, as 256 patients underwent two separate procedures). Of these, 189 cases (8.7%) underwent hemiarthroplasty, 1813 cases (83.7%) primary TSA and 73 cases (3.4%) revision TSA. The study population had an average age of 69.1 years (standard deviation (SD) 11.5) and 1105 were female (51.0%). The mean post-operative length of stay was 46.9 hours (SD 26.6). A total of 92 patients (4.2%) had a documented fever post-operatively during the inpatient admission. Of these, 63 had a single measured fever; 57 of these (90.5%) received an immediate 650 mg dose of paracetamol. The remaining patients had either two (14 patients) or three measured febrile epsidoes (Fig. 1). In all, 26 (28.2%) fevers occurred during the first 24 hours, 55 (59.8%) in the next 24 hours and 11 (12.0%) occurred > 48 hours post-operatively (Fig. 2).

On univariable analysis (using chi-squared tests), fevers were more common in obese patients (n = 913 of 963 (5.2%) *versus* n = 1162 of 1204 (3.5%), p = 0.051). No other variable was found to have a statistically significant effect on rate of fever. The multivariable Poisson regression analysis confirmed that obese patients had a significantly greater risk for developing fever (relative risk, 1.53; 95% confidence interval 1.02 to 2.32; p = 0.041), whereas neither age, gender, nor operative time had any statistically significant effect on the risk of developing fever (Table I).

At least one investigation was conducted in 43 of the 92 cases who had fever (46.7%). Common investigations included chest radiograph (31 patients, 33.7%), urinalysis (29 patients, 31.5%), urine culture (17 patients, 18.5%), blood culture (seven patients, 7.6%), duplex ultrasound (three patients, 3.3%), sputum culture (two patients, 2.2%) and chest CT (two patients, 2.2%). Of the 43 investigated cases, six investigations resulted in a diagnosis (6.6%). Of these, four (4.4%) were made prior to discharge and two (2.2%) were made after discharge but within 90 days. Allowing for the fact that two cases had multiple diagnoses, there were four UTIs (one of which was diagnosed post-discharge), three RTIs and one DVT (Fig. 2). The DVT was diagnosed on follow-up duplex imaging; a duplex ultrasound performed as an inpatient was negative. No case had a diagnosis of PE or wound infection.

**Table I.** Risk factors for fever on univariate and multivariate analysis

| Characteristic | Sample size (n = 2075) | Fevers (n = 92) | Rate (%) | Univariatep-value* | Multivariate p-value |
|---|---|---|---|---|---|
| Age (yrs) | | | | 0.149 | 0.396 |
| < 70 | 971 | 36 | *3.6* | | |
| ≥ 70 | 1104 | 56 | *4.8* | | |
| Gender | | | | 0.131 | 0.376 |
| Female | 1051 | 54 | *4.9* | | |
| Male | 1024 | 38 | *3.6* | | |
| Body mass index (kg/m$^2$) | | | | 0.051 | 0.041 |
| < 30 (non-obese) | 1162 | 42 | *3.5* | | |
| **≥ 30 (obese)** | **913** | **50** | **5.2** | | |
| Procedure | | | | 0.444 | 0.497 |
| Hemiarthropalsty (23 470) | 189 | 12 | *6.0* | | |
| Total shoulder arthroplasty (23 472) | 1813 | 77 | *4.1* | | |
| Revision shoulder arthroplasty (23 473/23 474) | 73 | 3 | *4.0* | | |
| Operative time (mins) | | | | 0.309 | 0.578 |
| < 120 | 1220 | 59 | *4.6* | | |
| ≥ 120 | 855 | 33 | *3.7* | | |

Bold indicates statistical significance
*p-values calculated using chi-squared analysis

## Discussion

Around one in 25 cases in this study developed a fever following shoulder arthroplasty, with the majority occurring between 24 and 48 hours post-operatively. Obese patients were more likely to develop fever but no other patient- or surgical-related factor was found to predict the development of fever. Almost half of these cases underwent no diagnostic workup; the vast majority of investigations that were performed were negative. In patients with positive investigations, the most common diagnoses made were of UTI and RTI and the highest diagnostic yield was obtained by the use of urinalysis and chest radiographs.

Multiple studies[4,6,9] of patients undergoing THA and TKA have concluded that most fevers in the first three days following surgery are benign and do not require investigation. Athanassious et al[4] reported that 36% of patients (n = 52 of 146) undergoing THA and 31% (n = 60 of 195) of patients undergoing TKA developed a post-operative fever. Most of these occurred within 24 hours and peaked within 48 hours and a significant proportion had negative investigations even as late as four days post-operatively. Lu et al[9] found that 48.2% of their 980 patients undergoing THA or TKA experienced post-operative fevers, most commonly within 24 hours of surgery. Fevers were more likely to be a result of infection if they lasted three or more days or were above 39°C. Likewise, Ward et al[6] in their study of 1100 patients (15% of whom had a post-operative fever) found an association between infection and higher fevers (≥ 39°C) and those which occurred three or more days post-operatively. The incidence of fever in our study is substantially lower than reported in these studies of lower limb arthroplasty[4,6,9] but this may be due to the higher threshold used to define a post-operative fever at our institution (38.6°C, rather than 38.0°C as used elsewhere).

Clinicians should be judicious in their investigation of post-operative fevers. Vijaysegaran et al[10] reported that only two of 141 blood cultures performed for fever following lower limb arthroplasty returned a positive result, both of which were thought to be contaminants. Likewise, in the study of Bindelglass and Pellegrino[11] two of 100 patients with fever following lower limb arthroplasty had positive blood cultures, again both thought to be contaminants. No patient in either study had any infectious sequellae.

Of those patients in our study with recorded fevers, nearly 70% had only one and 57 of the 92 patients received paracetamol immediately after the fever was recorded. The proportion of patients with a post-operative fever was lower than in previous studies of lower limb arthroplasty. This is multifactorial but may in part be due to the multimodal pain management regimen used in our institution; such regimens have previously been shown to reduce the temperature response to the surgical insult.[12]

This is a retrospective study with several limitations. It relies on accurate records and so the incidence reported may be an under- or over-estimate. In addition, as 70% of fevers occurred after the first 24 hours, and a substantial proportion of patients were discharged within the first post-operative day, some patients will have had fevers which were not identified. There was no set routine for the investigation of post-operative fevers; tympanic or oral temperature readings may not accurately reflect core temperatures and urinalysis results may have been subject to contamination (although contaminated samples were identified by the presence of squamous epithelial cells and repeated). Patients may have had their febrile response affected by paracetamol-containing analgesics peri- or post-operatively. The number of patients with a fever was small, and the number who had investigations even smaller. However, our evaluation of patients for 90 days following discharge makes it likely that a clinically significant complication related to the febrile episode in the 49 uninvestigated patients would have been identified in that post-operative

time period. Future prospective studies may address these deficiencies.

This is the first study of fever following shoulder arthroplasty. Overall, the data suggest that post-operative fevers following shoulder arthroplasty are over investigated and investigations may be of most use in persistent fevers or where a potential source is identified on clinical examination. Obese patients had a greater risk of developing post-operative fevers, but given the small number of patients included in this study it was underpowered to determine whether investigations in this group of patients were more likely to reveal an infective aetiology for the fever.

Based on our study, around one in 25 patients develops a fever following shoulder arthroplasty, and the majority of investigations performed for post-operative fever in this group were negative. Overall, the investigation of fever immediately following shoulder arthroplasty has a low yield of positive results from the investigation. Any investigation is probably most effective if guided by post-operative symptoms which suggest a potential source.

**Take home message:**

- The data suggest that diagnostic workups for fever in the early post-operative setting after shoulder arthroplasty are being over-used and are most effective after persistence of a fever or when pursued with guidance of a post-operative symptom or physical examination suggesting a potential source rather than on vital signs alone.

**Author contributions:**
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D. D. Bohl: Project idea generation, Data analysis and comprehension, Manuscript writing/revisions.
R. M. Frank: Project idea generation, Data analysis and comprehension, Manuscript writing/revisions.
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No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

This article was primary edited by A. D. Liddle and first proof edited by G. Scott.

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