Does Treatment of Preoperative Asymptomatic Bacteriuria Reduce the Rate of Postoperative Prosthetic Joint or Surgical Site Infection in Elective Joint Arthroplasty? A Systematic Review

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Abstract: *Introduction:* Inconsistent guidelines for management of preoperative asymptomatic bacteriuria (ASB) prior to elective joint arthroplasty leads to practice variance, surgical delays and antimicrobial overuse. This systematic review examined whether: 1) preoperative ASB in patients awaiting elective arthroplasty was associated with increased rates of postoperative prosthetic joint (PJI) and surgical site infection (SSI) 2) treatment of ASB modifies these rates.

Methods: A textual narrative synthesis was performed of randomised control, quasiexperimental and observational studies (identified through MEDLINE, EMBASE, HMIC and grey literature resources), which included patients with ASB and an outcome measure of rate of PJI/SSI. Significant study heterogeneity precluded meta-analysis.

Results: Eleven studies (comprising a total of 31857 patients) were included: one randomised control, three quasiexperimental, and seven observational studies. Ten studies involved a control group to address whether ASB was associated with PJI/SSI. Eight out of these ten studies found no association between ASB and PJI/SSI; two studies found an association. Only four out of 239 cases across all studies grew identical pathogens in wound and urine cultures. One study only included patients with ASB and focused on whether treatment of ASB reduced PJI incidence. Two of the former ten studies also explored this. No studies reported that treatment of ASB reduced rates of PJI/SSI.

Conclusions: Treatment of ASB prior to joint arthroplasty does not reduce rates of PJI/SSI. Within the current climate of antibiotic stewardship and financial healthcare pressures, this review suggests that preoperative urine cultures should not be routinely sent in asymptomatic patients prior to elective joint arthroplasty.

Keywords: Asymptomatic bacteriuria, Elective joint arthroplasty, Prosthetic joint infection.

INTRODUCTION

International rates of joint arthroplasty are increasing [1] with approximately 160,000 total hip and knee replacement procedures performed annually within the UK [2]. Prosthetic joint infection (PJI) following joint arthroplasty is a significant complication with a fivefold increase in mortality at one year, and is the primary cause of 90 day re-admission following total knee arthroplasty [3]. Established risk factors for PJI include active septicaemia, morbid obesity and poorly controlled diabetes mellitus. Whilst implantation of prostheses in the context of urinary tract sepsis is contraindicated, the association between PJI and asymptomatic bacteriuria (ASB) is less clear [4].

ASB is defined as the presence of bacteria in the urine of an individual without symptoms or signs of urinary tract infection (UTI) [5]. It is frequent in the older population with a reported prevalence in patients awaiting joint arthroplasty of up to 28% [6]. In older community dwelling and care home residents treatment of ASB confer no long term benefit in improving chronic urinary symptoms, delirium, morbidity or mortality [6-13]. In fact treatment can lead to adverse antimicrobial side effects and re-infection with resistant organisms [7].

Various methods are used to diagnose ASB or UTI. "Urine dipstick" continues to be frequently used, despite its low positive predictive value for diagnosis of

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bacteriuria or UTI [7]. Additionally urine culture in asymptomatic patients awaiting elective arthroplasty is frequently undertaken in preoperative clinics in the UK [14].

An online and postal survey of members of the British Association for Knee Surgery reported that two thirds of specialist knee surgeons would treat ASB prior to total knee arthroplasty, but 70% of respondents could not cite evidence for this decision [15]. Furthermore professional guidance on the management of ASB prior to joint arthroplasty is inconsistent [4, 16-18], leading to inconsistent clinical practice, delays in surgery, antimicrobial overuse and resistance, and subsequent healthcare costs [19].

This systematic review aims to examine whether treatment of preoperative ASB in patients awaiting elective joint arthroplasty reduces the risk of PJI and surgical site infection (SSI). The following questions will be considered:

1) Is preoperative ASB in patients awaiting elective hip and knee arthroplasty associated with increased rates of PJI/SSI?

2) If an association is found, does treatment of ASB modify rates of PJI/SSI.

METHODS

This systematic review was conducted according to the protocol registered with PROSPERO (42017059681). Methodological standards outlined in Centre for Reviews and Dissemination's Guidance for Undertaking Reviews in Health Care were followed [20].

Identification of Studies/Data Sources

MEDLINE, EMBASE and Health Management Information Consortium (HMIC) electronic databases via the Ovid Interface were searched using a prespecified search strategy [see Appendix 1]. Unpublished studies were sought by inputting MeSH terms of "joint surgery" or "arthroplasty" in combination with "bacteriuria" into grey literature and clinical trial databases (Web of Science, Open Grey, Grey Literature Report and ClinicalTrials.gov). Additional eligible studies were retrieved by hand searching bibliographies of relevant articles. The search was limited to English language articles but no date restriction was applied. The last electronic search was performed on January 25, 2017.

Study Selection

Article abstracts, and subsequently their full text, were independently assessed for eligibility by two researchers (KS and JP). Discrepancies were resolved through a third reviewer (JD). Duplicate publications were identified through comparison of authors, study setting and methodology; the article reporting the most study data was included.

The criteria for inclusion were: 1) randomised controlled, quasi-experimental and prospective or retrospective observational studies; 2) adults (over 18years) undergoing elective hip or knee arthroplasty with preoperative ASB (including if a subset of total study population) 3) primary or secondary outcome measure was rate of PJI or SSI.

Review and opinion articles, case reports and foreign language papers were excluded. Studies addressing only emergency arthroplasties, symptomatic UTI or postoperative ASB were also excluded. Absence of recognised definitions for ASB or PJI/SSI was accounted for in qualitative assessments rather than precluding inclusion.

Data Extraction

A single reviewer (KS) extracted data from eligible full text articles, using a customised form [see Appendix 2] to collate information on study characteristics, outcome measures and information for qualitative assessment.

Data Synthesis

Significant study heterogeneity precluded meta-analysis. Therefore a textual narrative synthesis was conducted according to established methodological standards [20], structured around study design, population characteristics and reported outcomes. This was complemented with tabular summaries of results.

Quality Assessment

Full text articles were evaluated for quality in domains of selection, performance, detection and attrition, based on the Cochrane Collaboration Risk of Bias Tool [21]. Studies were considered at low risk of bias if all quality components were adequate, moderate risk if one or more component was unclear, and high risk if one or more component was inadequate. Additionally a quality score was calculated based on a validated checklist for health care intervention studies [22].

RESULTS

Search Results

One hundred and one articles were identified from the electronic and hand search (Figure **1**). No records were identified from grey literature sources. Following application of exclusion criteria 33 full text articles were obtained for detailed evaluation. Following examination of full text, 22 articles did not fulfil inclusion criteria. Ultimately 11 articles were included in this systematic review. One of these articles [23] was included following consensus meeting with the third reviewer (JD).

Study Characteristics

One randomised control trial [24], three quasiexperimental trials [25-27], three prospective observational [28-30] and four retrospective observational studies [23, 31-33] were included. Apart from one multicentre trial, [24] the study settings were single centre urban institutions.

Study populations included patients undergoing both hip and knee arthroplasty, with the exception of four studies (three only knee [27,29,32]; one only hip [24]). Orthopaedic procedures were a subgroup of the total study population in one study [23].

Ten studies included a control group, comparing rates of PJI/SSI in patients with and without ASB. One study only included patients with ASB, focusing on whether antibiotic treatment of ASB reduced the incidence of PJI [27]. Three studies reported on rates of SSI only [23, 28,29], six studies reported on rates of PJI only [24-27, 30, 31], and two studies reported on both [31, 33]. PJI and SSI was a secondary outcome in four studies [23, 26, 30, 33], and a primary outcome in the remaining seven. Three studies explored whether preoperative treatment of ASB modified rates of PJI [24-25, 27].

The number of participants in each trial ranged from 128 to 19735, with the mean age of study subjects ranging from 53-84 years. Study characteristics are summarised in Table **1**.

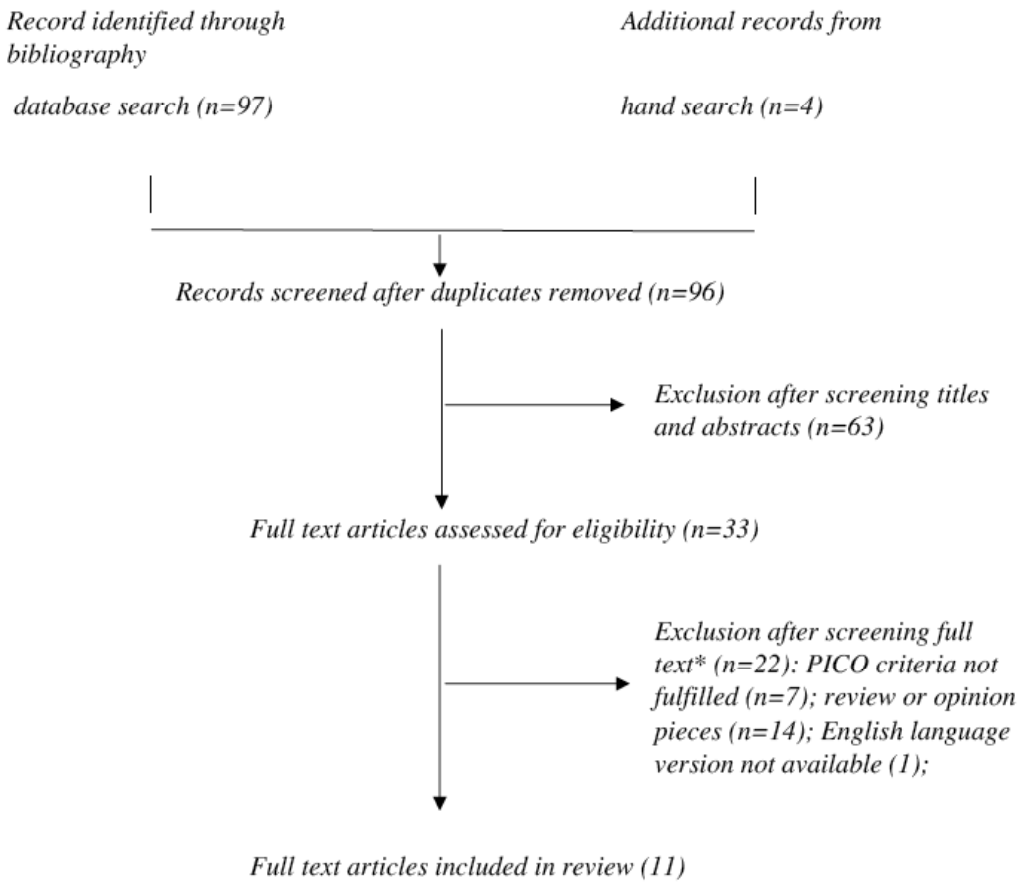

Figure 1: Flow diagram of included and excluded trials.

*Further exclusion at full text screening required due to insufficient information in abstract.

Table 1: Summary of Included Studies

Author/ Year	Setting	Study Design	Study Period	Population (n)/ Mean age	Exposure/ Bacteriuria % (n)	Intervention if Present (n)	Comparator (n)	Reported Outcome	Author Conclusion	Risk of Bias Quality Score
Randomised Control Studies										
Cordero-Ampuero *et al.*; 2013	Spain; single centre	Prospective randomised	Apr 2009-Nov 2010; FU for 12 months at external offices (interview, bloods, X-rays)	471 undergoing THA (228) & HA (243) Age 84yrs	ASB (10^5 CFU per mL) / urine taken 12hrs before surgery/ 9.8 (46)	7 days antibiotics for ASB & standard surgical antibiotic prophylaxis (26 –all with ASB)	Standard surgical antibiotic prophylaxis only (425 - 20 with ASB)	Prevalence of PJI 12 cases in non-ASB group; 1 in treated ASB group; 0 in untreated ASB group	No association between ASB & PJI; preoperative treatment of ASB does not modify risk	Overall: high Selection high Performance low Detection low Attrition low Score: 22/32
Quasiexperimental Studies										
Sousa *et al.*; 2014	Portugal, Spain and UK; multi centre	Prospective non randomised	Jan 2010-Dec 2011; FU for 12 months (methods not reported)	2497 undergoing THA (1248) or TKA (1247) Age 68yrs	ASB (10^5 CFU per mL) / unclear urine sampling time/ 12.1 (303)	8 days antibiotics for ASB 1 week before surgery, & standard surgical antibiotic prophylaxis (154)	Standard surgical antibiotic prophylaxis only (2342 - 149 with ASB)	Rate of PJI (43 cases): 1.3% in non-ASB group infection rate 3.9% in treated ASB; 4.7% in non-treated ASB	Association present between ASB & PJI; preoperative treatment of ASB does not modify risk	Overall: high Selection high Performance unclear Detection unclear Attrition unclear Score: 15/32
Martinez-Velez *et al.*; 2016	Spain; single centre	Prospective non randomised	Apr 2009-Nov 2010; FU for 60 months at external offices (interview, bloods, X-rays)	215 TKA – analysis of 11 with ASB; Age 73.4yrs	ASB (10^5 CFU per mL) / urine taken 12hrs before surgery/ 5.1 (11)	7 days antibiotics for ASB & standard surgical antibiotic prophylaxis (4)	Standard surgical antibiotic prophylaxis only (7)	Prevalence of PJI with and without treatment of ASB (1 PJI in treated ASB group)	Preoperative treatment of ASB does not modify risk	Overall: high Selection high Performance low Detection low Attrition low Score: 18/32
Lamb *et al.*; 2016	Canada; single centre	Interrupted time series analysis	May 2013-June 2016; 24 month control period & 12 month intervention period	5414 undergoing hip (2118) and knee (3024); other arthroplasty (272) Age 66-67yrs	ASB (10^5 CFU per mL) / urine cultured at preoperative assessment / 11.5 (352)	Routine urine culture processing discontinued; therefore ASB not treated (1891)	Routine urine culture at preoperative assessment; (3523- 352 with ASB of which 42 treated (12.2%)	Rate of PJI secondary outcome: (4 PJI – 1/3523 in control period, 3/1891 in intervention period)	Discontinuation of preoperative urine culture did not increase rate of PJI	Overall: high Selection high Performance unclear Detection high Attrition unclear Score: 17/32
Observational Studies										
Bouvet *et al.*; 2014	Switzerland; single centre	Prospective	Nov 2011-Sept 2012; FU for 12 months (questionnaires to GP and patient)	510 undergoing THA (386) or TKA (229); Age 69.1yrs	ASB (10^3 CFU per mL)/urine cultured on admission/ 35.7 (182)	N/A	Standard surgical antibiotic prophylaxis in all patients	Rate of PJI secondary outcome (0 cases)	No association between ASB & PJI	Overall: moderate Selection low Performance low Detection unclear Attrition low Score: 23/32
Singh *et al.*; 2015	India; single centre	Prospective	June 2012- Nov 2012; FU for 3months (methods not reported)	128 females undergoing bilateral TKA (89) & unilateral TKA (39) ; mean age not reported	ASB (definition not specified)/ urine cultured say before surgery/ 35.9 (46)	N/A	Standard surgical antibiotic prophylaxis in all patients	Delayed wound healing (1 case in non-ASB group)	No association between ASB & delayed wound healing	Overall: high Selection unclear Performance high Detection high Attrition unclear Score: 14/32

Ollivere *et al.*; 2009	UK; single centre	Prospective	Recruitment period not reported; no FU after discharge	558 undergoing elective arthroplasty (type of surgery not specified); Age 62yrs	ASB (10^5 CFU per mL)/ urine cultured at preoperative assessment / 7 (39)	N/A	All ASB treated with antibiotics via GP. All patients received standard surgical antibiotic prophylaxis.	Rate of SSI (15/39 with ASB; 83/519 without ASB)	ASB associated with SSI despite preoperative treatment	Overall: high Selection high Performance high Detection high Attrition unclear Score: 9/32
Koulouvaris *et al.*; 2009	USA; single centre	Retrospective case control	Jan 2000-Dec 2004; FU for 12 months (methods not reported)	19735 participants – 58 undergoing hip (23) or knee (36) arthroplasty developed postoperative wound infection Age 66.7yrs	ASB (definition not specified) but also included UTI / urine cultured 1 week before surgery/ 9.5 (11)	N/A	ASB treated with 5-8 days of antibiotics; all received standard surgical antibiotic prophylaxis (11 with ASB; 105 without ASB)	Rate of PJI /SSI in those with and without ASB/UTI (3/11 with ASB; 55/105 without ASB)	No association between ASB/UTI & PJI/SSI	Overall: moderate Selection unclear Performance unclear Detection low Attrition low Score: 23/32
Glynn *et al.*; 1984	Ireland; single centre	Retrospective	9 months recruitment; FU for 3months (at routine postoperative clinic)	299 undergoing total joint arthroplasty with less than 10% TKA (exact figures not reported); mean age not reported	ASB (10^5 CFU per mL)/ urine cultured day after admission/ 19.1 (57)	N/A	ASB treated inconsistently (39 did not complete antibiotics preoperatively); surgical antibiotic prophylaxis not given consistently	Rate of PJI/SSI secondary outcome (Nil PJI cases; 2/57 SSI with ASB; nil SSI without ASB)	No association between ASB & PJI/SSI	Overall: high Selection unclear Performance high Detection high Attrition unclear Score: 14/32
Gou *et al.*; 2014	China; single centre	Retrospective	June 2008-June 2010; FU for 36 months (methods not reported)	739 undergoing THA (540) or TKA (455); Age 53.7yrs	ASL (over 10 leucocytes per high-power field at ×400 magnification in 2 samples/ urine cultured day of admission/ 17.7 (131)	N/A	Standard surgical antibiotic prophylaxis in all patients	Rates of PJI (1/131 with ASL; 6/608 without ASL)	No association between ASL & PJI	Overall: low Selection low Performance low Detection low Attrition low Score: 22/32
Drekonja *et al.*; 2013	US; single centre	Retrospective	2010; FU not reported	1291 participants undergoing orthopaedic procedures (sub group of total study population of 19344) Age 61.8yrs	ASB (10^5 CFU per mL)/ inconsistent urine sampling – only in 25%/ 13 (absolute number not reported for orthopaedic subgroup, 54 in total study population)	N/A	Practice not reported; number of ASB in orthopaedic subgroup treated preoperatively not reported (11 in total study population)	Rates of SSI secondary outcome (orthopaedic subgroup not individually reported; total study population: 20% with ASB – 45% in treated & 14% in untreated; 16% without ASB)	No association between ASV & SSI	Overall: high Selection high Performance high Detection high Attrition unclear Score: 11/32

Abbreviations: THA – total hip arthroplasty; HA –hemi arthroplasty; TKA – total knee arthroplasty; FU – follow up; ASB – asymptomatic bacteriuria; PJI – prosthetic joint infection; CFU – colony forming units

Quality Assessment

Meta-analysis was precluded by significant heterogeneity in study methodology and outcome reporting. Within eligible studies the overall risk of bias [21] was high in eight studies, [23-29,33] moderate in two studies [30-31] and low in one study [32]. The

mean quality score [22] across included studies was 17 (range 9 to 23; median 17).

Outcome Measures

Is preoperative asymptomatic bacteriuria in patients awaiting elective hip and knee arthroplasty associated with increased risk of PJI and SSI?

Randomised Control and Quasiexperimental Studies

In a randomised control trial, Cordero-Ampuero *et al.* recruited 471 patients undergoing hip arthroplasty [24]. All patients were randomised to either group A or B, with urinalysis being performed 12 hours prior to surgery and subsequent urine culture if abnormal. All patients received standard surgical prophylactic antibiotics. Urine cultures returned several hours after surgery. Patients with negative urine cultures in both groups received no further antibiotics. Patients in group A with confirmed ASB received an additional seven days of antibiotics, whilst those with ASB in group B received no further antibiotics. Follow up was undertaken at external offices with subsequent comparison of PJI rates between both patients with ASB and sterile urine culture, and between those with ASB who were treated with and without further antibiotics (the results of which are discussed later). There was no significant difference in incidence of PJI among patients with negative urine cultures (12/425; 2.82%) and those with ASB (1/46; 2.17%).

Similar results were described by Lamb *et al.* in an interrupted time series analysis which recruited 5414 participants undergoing predominantly elective hip and knee arthroplasty (5% were other limb arthroplasties) [26]. Preoperative urinalysis for ASB was standard practice at this Canadian centre, with positive results being treated with outpatient antibiotics. The intervention instigated was the cessation of routine preoperative urine culture processing by the laboratory unless telephone confirmation was received by the requesting clinician. There was no statistically significant change in the rates of PJI, which was measured as a secondary outcome during the 24 month control period (1/3523; 0.03% PJI per 100 EJA; 95% CI, 0.001-0.2) and the 12 month intervention period (3/1891;0.2% PJI per 100 EJA;95% CI, 0.05-0.5;p=0.1).

In contrast, Sousa *et al.* concluded that ASB was an independent risk factor for PJI. Urine cultures were sent in 2497 participants undergoing total hip and knee arthroplasty across three European centres [25]. Collection of demographic data was incomplete in one centre and catheterised patients were not explicitly excluded. Whilst 149 cases of ASB were not treated, 154 received an eight day course of antibiotics according to surgeon's preference. Twenty six of these had repeat urine cultures sent to ensure preoperative eradication. Forty three PJIs were diagnosed over 12 months. Patients with ASB were reported to have a significantly higher rate of PJI compared to those with normal urine cultures (4.3% vs 1.4%, OR 3.23; 95% CI 1.67–6.27;p =0.001).

In all three studies the pathogens cultured from joint and urine differed.

Observational Studies

Only one observational study reported an association between ASB and SSI. In a prospective consecutive case series, Ollivere *et al.* analysed medical records of 558 patients undergoing elective arthroplasty at a UK centre [28]. All 39 patients with ASB at preoperative assessment were treated with outpatient antibiotics. MSU was not resent prior to surgery. Following discharge, patients were allocated to three cohorts according to their wound status during hospital admission: uneventful wound healing; superficial wound infection but with negative cultures; superficial wound infection with positive cultures. Fifteen patients with ASB developed superficial wound infections with a reported relative risk of 2.4 ($p<0.02$). Four cases grew the same microorganism in urine and wound culture.

Contrary to this, two further prospective observational studies found no association between ASB and PJI/SSI. Singh *et al.* examined SSI in 128 females undergoing total knee arthroplasty where all 46 cases of preoperative ASB were untreated with antimicrobial agents [29]. Despite a high prevalence of both diabetes (38%) and obesity (53%) within the study population, there was only a single case of delayed wound healing in the cohort, occurring in a patient with negative urine cultures. In a Swiss study, Bouvet *et al.* assessed rates of PJI as a secondary outcome in 615 patients undergoing hip and knee arthroplasty [30]. One hundred and eighty two patients had preoperative ASB. Patients with prolonged catheterisation (two) and who were already established on antibiotics (11) were excluded. No cases of PJI were identified during the study period. Additionally on retrospective analysis of their joint replacement registry, the authors reported that none of the 71 infected prostheses over a 12 year period had preoperative bacteriuria.

Four retrospective studies have reported a similar lack of association between preoperative ASB and PJI/SSI [23, 31-33]. A four year case control study used robust methodology to identify and compare 58 cases of infective wound complications with controls matched to demographic and surgical criteria [31]. No association between ASB and prosthetic joint or deep surgical site infection was reported (OR 0.341; CI 0.086-1.357;p=0.127).

Using leucocyturia as a marker for ASB, Gou *et al.* reported a prevalence of ASB of 17.7% in a study population of 739 patients awaiting primary total hip and knee arthroplasty [32]. Only one of the seven cases who developed PJI had preoperative leucocyturia. On logistic regression analysis preoperative ASB was not found to be a risk factor for the development of early PJI.

Two studies examined the association between ASB and SSI as a secondary outcome. Glynn *et al.* analysed the records of 299 patients undergoing hip and knee arthroplasty [33]. Thirty-nine of the 57 cases with ASB underwent surgery before completing antibiotic therapy. Only two patients developed superficial wound infections with different urinary and wound pathogens cultured. No cases of PJI occurred. Drekonja *et al.* analysed the medical records of all patients undergoing orthopaedic, cardiothoracic or vascular surgery at the Minneapolis Veterans Association Medical Centre [23]. Due to retrospective analysis of routinely collected data not all patients had a preoperative urine culture sent. Despite this the prevalence of ASB was 13% within the subgroup of 1291 patients awaiting orthopaedic procedures. Data was not reported according to surgical subspecialty, but within the entire study population, wound infection rates were comparable between those with and without ASB (20% vs 16%, p=0.56).

Does Treatment of ASB Preoperatively Modify this Association?

Three trials specifically explored whether treatment of ASB affected rates of PJI [24-25, 27].

A non-randomised control trial recruited 215 patients undergoing total knee arthroplasty [27]. Eleven patients were diagnosed with ASB, four were allocated to receive standard surgical antibiotic prophylaxis only and seven cases, according to the surgeon's preference, received an additional seven days of sensitive antibiotics to treat ASB. The only PJI identified was within the treated group. Similarly in two previously described trials [24-25] there was no reported difference in PJI between the treated and untreated group. The authors of all three trials concluded that identification and treatment of preoperative ASB was not justified in the prevention of PJI.

DISCUSSION

This narrative synthesis suggests there is no association between preoperative ASB and postoperative PJI/SSI. Furthermore there is no evidence that treatment of ASB reduces the risk of PJI/SSI.

Eight studies reported no association between ASB and PJI/SSI. These included a randomised study [24], two quasiexperimental studies [26-27] and six observational studies (two prospective [29-30] and four retrospective [23, 31-33]). Two of these eight studies reported on rates of SSI only, [23, 29] five on rates of PJI only, [24, 26-27, 30, 32] and two on rates of both [31, 33]. Rates of PJI/SSI were secondary outcomes in four of these studies [23, 26, 30, 31] and primary outcomes in the remainder. The mean quality score [22] across these eight studies was 18 (range 11 to 23; median 18).

Two studies found a positive relationship between ASB and PJI/SSI, which were primary outcomes in both [25, 28]. However these studies should be interpreted with caution as both have quality assessment scores [22] below the mean. In the multicentre trial performed by Sousa *et al.*, participants were non-randomised with inclusion of catheterised patients, and a lack of clarity regarding practice variance between international study centres [25]. Additionally statistical analyses of confounders are somewhat diminished by incomplete data collection from the UK centre regarding diabetes mellitus, an important risk factor for PJI [4]. Similarly in the prospective cohort study by Ollivere *et al.* [28] there were high levels of bias in all domains and the lowest quality assessment score (9/32). There was poor reporting of baseline characteristics, ambiguity regarding standardisation of wound assessment, lack of blinding, short follow up, and poorly reported statistics with no confidence intervals.

Notably neither author (Sousa nor Ollivere) attributes direct causality of infective wound complication to ASB. This conclusion is supported by the fact that in only four [28] of the 239 cases of wound infection across all studies was the same pathogen isolated from preoperative urine and from the

postoperative wound. Sousa *et al.* in particular reflect that ASB may be an indicator of a patient's vulnerability to infection, and emphasizes that routine preoperative urinalysis is not proposed as antibiotic therapy did not modify the risk of infective complications. [25] This finding is echoed in the two further studies addressing this question [24, 27].

The strengths of this review lie in the robust and comprehensive methodology employed to identify and evaluate all relevant trials. Attempts to minimise publication bias were addressed by searching grey literature, although this did not yield any further material of interest. Due to resource limitations, we restricted results to English language papers only, which may exclude some potentially relevant items.

A limitation of this systematic review is the small sample size within included studies, stemming from the low incidence of PJI, a constraint some authors commented on when developing their study methodology [30]. Additionally there were potentially high levels of bias within included studies, especially with regards to subject selection, with a mean quality score [22] of only 17 out of 32 across included studies. The heterogeneity in study populations, standardised care and outcome measures could be considered a further limitation but in practical terms does reflect the variability observed in routine clinical practice.

With financial pressures in healthcare provision, NICE guidelines outline that preoperative tests should only be undertaken if an abnormal result would change perioperative management or influence decision to operate [34]. This review suggests that not only is there is insufficient evidence of a relationship between ASB and PJI/SSI, but treatment of ASB does not impact on rates of PJI/SSI. Furthermore Lamb *et al.* estimated that national annual savings of $ 3,202,500 USD could be effected from simply reducing preoperative urine culture requests prior to elective joint arthroplasty, even without consideration of additional savings from reduced antimicrobial prescriptions [26]. Similarly an economic analysis study found that routine urinalysis prior to joint procedures was economically unsound [35].

Moreover treatment of ASB confers no morbidity or mortality benefits [6-7], with an estimated number needed to harm of three when treating ASB in older women [17]. Adverse antimicrobial events and multiresistant bacteria has also raised the awareness amongst health professionals of antibiotic stewardship [7].

ASB continues to be treated in a variety of settings, contrary to the established evidence base [19]. This systematic review has identified inadequate evidence for a causal relationship between preoperative ASB and increased rates of PJI/SSI following elective joint arthroplasty. Given the proven financial cost and adverse outcomes associated with the treatment of ASB, we propose there is necessity to have quality randomised and controlled trials into this topic prior to preoperative urinalysis and culture in asymptomatic patients becoming routine practice before elective joint arthroplasty. This sentiment is echoed by expert opinion within the orthopaedic community, [14, 19, 36] including delegates at the 2013 international periprosthetic joint consensus meeting, also suggesting that routine urine screening prior to arthroplasty is not warranted in the absence of urinary symptoms [4].

CONFLICT OF INTEREST STATEMENT

Each author certifies that he or she has no commercial associations that might pose a conflict of interest in connection with the submitted article

ETHICAL APPROVAL

This article does not contain any studies with human participants or animals performed by any of the authors.

APPENDIX 1: Pre-Specified Search Strategy for Systematic Review (Formulated in Collaboration With Helen Elwell, Senior Medical Librarian, Search Services, Bma Library.)

Database: Embase <1974 to 2017 Week 04>, Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) <1946 to Present>, HMIC Health Management Information Consortium <1979 to November 2016>

1. exp Arthroplasty/ (116982)
2. (arthroplasty or arthroplasties).mp. (154922)
3. bone graft$.mp. (62719)
4. ((ankle or elbow or knee or hip or shoulder or finger or disc or joint) adj3 (replace$ or reconstruct$ or prosthes#s)).mp. (181221)
5. orthop?edic.mp. (201088)
6. joint.mp. (789628)
7. su.fs. (3810314)
8. surg$.mp. (5553534)
9. procedure$.mp. (3112185)
10. 5 or 6 (949918)
11. 7 or 8 or 9 (8269025)
12. 10 and 11 (403295)
13. 1 or 2 or 3 or 4 or 12 (583863)
14. urinary tract infections/ or bacteriuria/ or pyuria.mp.

[mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fs, nm, kf, px, rx, ui] (89823)

15. (urinary tract infection$ or bacteriuria or pyuria).mp. (163441)
16. 14 or 15 (163441)
17. (asymptomatic or covert).mp. (336010)
18. 16 and 17 (7407)
19. asymptomatic bacteriuria/ (1591)
20. Urine/an, ch, cy, di, mi [Analysis, Chemistry, Cytology, Diagnosis, Microbiology] (14880)
21. Urinalysis/ (91957)
22. exp urinalysis/ or urine culture/ (100099)
23. (urinalys$s or urin$ culture$).mp. (18316)
24. 20 or 21 or 22 or 23 (120394)
25. ((abnormal$ or positive) adj5 (Urine or Urinalysis or (urinalysis or urine culture) or (urinalys$s or urin$ culture$))).mp. (17412)
26. 18 or 19 or 25 (24278)
27. 13 and 26 (139)
28. remove duplicates from 27 (97)

REFERENCES

[1] Kurtz SM, Röder C, Lau E, Ong K, Widmer M, Maravic M *et al*. International Survey of Primary and Revision Total Hip Replacement. International Orthopaedics 2011; 35(12): 1783-9. https://doi.org/10.1007/s00264-011-1235-5

[2] National Joint Registry for England, Wales, Northern Island and Isle of Man: 13th Annual Report 2016. http://www.njrcentre.org.uk/njrcentre/Reports, PublicationsandMinutes/Annualreports/tabid/86/Default.aspx (date last accessed 3 May 2017)

[3] Gomez MM, Parvizi J. Periprosthetic joint infection in total knee arthroplasty: current concepts. Curr Orthop Pract 2015; 26(3): 247-251. https://doi.org/10.1097/BCO.0000000000000236

[4] Parvizi J, Gehrke T, Chen AF. Proceedings of the international consensus on periprosthetic joint infection.

APPENDIX 2: Customised Data Collection Form

GENERAL INFORMATION		
Citation		
Competing interests/ funding		
Publication type		
Country of origin		
STUDY CHARACTERISTICS		
Study aim/objective		
Study design		
Eligibility criteria		
Study setting		
Study period		
Exposure		
Intervention / comparator		
Specified outcome measure		
RESULTS		
Patient numbers		
Patient characteristics		
Statistical methods		
Outcome in intervention group		
Outcome in comparator group		
Authors discussion		
COCHRANE ASSESSMENT OF BIAS	**Support for Judgement**	**Bias Outcome**
Selection Bias:		
Performance Bias:		
Detection Bias:		
Attrition Bias:		
OVERALL BIAS		
QUALITY SCORE		

Bone Joint J 2013; 95-B: 1450-2.
https://doi.org/10.1302/0301-620X.95B11.33135

[5] Cai T, Mazzoli S, Lanzafame P, Caciagli P, Malossini G, Nesi G *et al*. Asymptomatic Bacteriuria in Clinical Urological Practice: Preoperative Control of Bacteriuria and Management of Recurrent UTI. Pathogens 2016; 5(4).
https://doi.org/10.3390/pathogens5010004

[6] Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM *et al*. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. Clin Infec Dis 2005; 40(5): 643-54.
https://doi.org/10.1086/427507

[7] Ninan S, Walton C, Barlow G. Investigation of suspected urinary tract infection in older people. BMJ 2014; 348: g4070.
https://doi.org/10.1136/bmj.g4070

[8] Nicolle LE, Mayhew WJ, Bryan L. Prospective randomized comparison of therapy and no therapy for asymptomatic bacteriuria in institutionalized elderly women. Am J Med.-1987; 83: 27-33.
https://doi.org/10.1016/0002-9343(87)90493-1

[9] Nicolle LE, Bjornson J, Harding GK, MacDonell JA. Bacteriuria in elderly institutionalized men. N Eng J Med 1983; 309: 1420-5.
https://doi.org/10.1056/NEJM198312083092304

[10] Abrutyn E, Mossey J, Berlin JA, Boscia J, Levison M, Pitsakis P *et al*. Does asymptomatic bacteriuria predict mortality and does antimicrobial treatment reduce mortality in elderly ambulatory women? Ann Intern Med 1994; 120: 827-33.
https://doi.org/10.7326/0003-4819-120-10-199405150-00003

[11] Ouslander JG, Schapira M, Schnelle JF, Uman G, Fingold S, Tuico E *et al*. Does eradicating bacteriuria affect the severity of chronic urinary incontinence in nursing home residents? Ann Intern Med 1995; 122: 749-54.
https://doi.org/10.7326/0003-4819-122-10-199505150-00003

[12] Mckenzie R, Stewart MT, Bellantoni MF, Finucane TE. Bacteriuria in individuals who become delirious. Am J Med 2014; 127(4): 255-257.
https://doi.org/10.1016/j.amjmed.2013.10.016

[13] Potts L, Cross S, MacLennan WJ, Watt B. A double-blind comparative study of norfloxacin versus placebo in hospitalised elderly patients with asymptomatic bacteriuria. Arch Gerontol Geriatr 1996; 23: 153-161.
https://doi.org/10.1016/0167-4943(96)00715-7

[14] Mayne AIW, Davies PSE, Simpson JM. Screening for asymptomatic bacteriuria before total joint arthroplasty. BMJ 2016; 354: i3569.
https://doi.org/10.1136/bmj.i3569

[15] Finnigan TKP, Bhutta MA, Shepard GJ. Asymptomatic bacteriuria prior to arthroplasty: How do you treat yours? Orthopaedic Proceedings 2012; 94-B(SUPP XXIX)58;

[16] Primary total hip replacement: a guide to good practice. 3rd ed. British Orthopaedic Association, 2012.https://www.britishhipsociety.com/uploaded/Blue%20Book%202012%20fsh%20nov%202012.pdf (date last accessed 3 May 2017)

[17] Scottish Intercollegiate Guidelines Network. Guideline 88.Management of suspected bacterial urinary tract infection in adults.2012. http://www.sign.ac.uk/guidelines/-fulltext/88/recommendations.html (date last accessed 3 May 2017)

[18] National Institute of Clinical Excellence.Guidelines QS90. Urinary Tract Infections in Adults.2015. https://www.nice.org.uk/guidance/qs90 (date last accessed 3 May 2017)

[19] Duncan RA. Prosthetic Joint Replacement: Should orthopaedists check urine because it's there? Clin Infect Dis 2014; 59(1): 48-50.
https://doi.org/10.1093/cid/ciu243

[20] Systematic Reviews. CRD's guidance for undertaking reviews in health care. 2009. https://www.york.ac.uk/-media/crd/Systematic_Reviews.pdf (date last accessed 3 May 2017)

[21] Higgins JPT, Green S. Cochrane Handbook for Systematic Reviews of Interventions: The Cochrane Collaboration; 2011. www.cochrane-handbook.org (date last accessed 3 May 2017)

[22] Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomized and non-randomized studies of health care interventions. J Epidemiol Community Health 1998; 52(6): 377-84.
https://doi.org/10.1136/jech.52.6.377

[23] Drekonja DM, Zarmbinski B, Johnson J. Preoperative urine cultures at a Veterans Affairs Medical Centre. JAMA Intern Med 2013; 173(1): 71-2.
https://doi.org/10.1001/2013.jamainternmed.834

[24] Cordero-Ampuero J1, González-Fernández E, Martínez-Vélez D, Esteban J. Are antibiotics necessary in hip arthroplasty with asymptomatic bacteriuria? Seeding risk with/without treatment. Clin Orthop Relat Res 2013; 471(12): 3822-9.
https://doi.org/10.1007/s11999-013-2868-z

[25] Sousa R, Munoz-Mahammud E, Quayle J, Dias da Costa L, Casals C, Scott P *et al*. Is asymptomatic bacteriuria a risk factor for prosthetic joint infection? Clin Infect Dis.2014; 59(1): 41-7.
https://doi.org/10.1093/cid/ciu235

[26] Lamb MJ, Baillie L, Pajak D, Flynn J, Bansal V, Simor A *et al*. Elimination of screening urine cultures prior to elective joint arthroplasty. Clin Infect Dis 2017; 64(6): 806-809.
https://doi.org/10.1093/cid/ciw848

[27] Martínez-Vélez D, González-Fernández, Esteban J, Cordero-Ampuero J. Prevalence of asymptomatic bacteriuria in knee arthroplasty patients and subsequent risk of prosthesis infection. Eur J Orthop Surg Traumatol 2016; 26(2): 209-14.
https://doi.org/10.1007/s00590-015-1720-4

[28] Ollivere BJ, Ellahee N, Logan K, Miller-Jones JCA, Allen PW. Asymptomatic urinary tract colonisation predisposes to superficial wound infection in elective orthopaedic surgery. Int Orthop 2009; 33(3): 847-850.
https://doi.org/10.1007/s00264-008-0573-4

[29] Singh H, Thomas S, Agarwal S, Arya SC, Srivastav S, Agarwal N. Total knee arthroplasty in women with asymptomatic urinary tract infection. J Orthop Surg (Hong Kong) 2015; 23(3): 298-300.
https://doi.org/10.1177/230949901502300307

[30] Bouvet C, Lubbeke A, Bandi C, Pagani L, Stern R, Hoffmeyer P *et al*. Is there any benefit in pre-operative urinary analysis before elective total joint replacement? Bone Joint J.2014; 96-B(3): 390-4.
https://doi.org/10.1302/0301-620X.96B3.32620

[31] Koulouvaris P, Sculco P, Finerty E, Sculco T, Sharrock NE. Relationship Between Perioperative Urinary Tract Infection and Deep Infection After Joint Arthroplasty. Clin Orthop Relat Res.2009; 467(7): 1859-1867.
https://doi.org/10.1007/s11999-008-0614-8

[32] Gou W, Chen J, Jia Y, Wang Y. Preoperative asymptomatic leucocyturia and early prosthetic joint infections in patients undergoing joint arthroplasty. J Arthroplasty.2014; 29(3): 473-6.
https://doi.org/10.1016/j.arth.2013.07.028

[33] Glynn MK, Sheehan JM. The significance of asymptomatic bacteriuria in patients undergoing hip/knee arthroplasty. Clin Orthop Relat Res.1984;(185): 151-4.
https://doi.org/10.1097/00003086-198405000-00026

[34] National Institute of Clinical Excellence. Guidelines NG45. Routine preoperative tests for elective surgery. 2016. https://www.nice.org.uk/guidance/ng45.(date last accessed 3 May 2017)

[35] Lawrence VA, Gafni A, Gross M. The unproven utility of the

preoperative urinalysis: economic evaluation. J Clin Epidemiol.1989; 42(12): 1185-92. https://doi.org/10.1016/0895-4356(89)90117-0

[36] Sendi P, Borens O, Wahl P, Clauss M, Uçkay I. Management of Asymptomatic Bacteriuria, Urinary Catheters and Symptomatic Urinary Tract Infections in Patients Undergoing Surgery for Joint Replacement: A Position Paper of the Expert Group 'Infection' of swissorthopaedics. J Bone Joint Infect 2017; 2(3): 154-159. https://doi.org/10.7150/jbji.20425

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