Research Paper

Prosthetic Joint Infection: Report on the One versus Two-stage Exchange EBJIS Survey

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Abstract

Background: Prosthetic Joint Infection (PJI) is one of the most challenging problems in orthopaedic surgery and musculoskeletal infections specifically. Some very important controversies remain and strong evidence-based recommendations are still lacking in many clinical aspects. Therefore, an undisputed methodology of treatment does not exist yet and there are many different valid approaches.

Purposes: To draw a picture of the different practice patterns around Europe and understand the motivations of the European Bone & Joint Infection Society (EBJIS) members in choosing between one- or two-stage revision surgery in treating chronic PJI.

Methods: The participants of the 34th EBJIS Annual Meeting were surveyed through an online questionnaire. The survey assessed the main philosophy in the treatment of chronic PJI, personal and institutional information as well as the importance of different factors in choosing two-stage or one-stage procedures.

Results: One hundred and forty-three participants responded to the survey, including a significant group of skilful orthopaedic surgeons with large experience in treating musculoskeletal infections. Primarily two-stage was the most common philosophy regrading treatment of chronic PJI (60.1%), followed by two-stage or one-stage accordingly (34,8%) and primarily one-stage (5,1%). Significant soft tissue compromise, failure of previous revision surgery attempts, highly resistant or unclear infective microorganism(s) preoperatively and patient presenting with sepsis or immunosuppression, were considered the more relevant factors in choosing two-stage instead one-stage procedures.

Interpretation: Treatment of chronic PJI is challenging and demanding. An open dialogue to share the different experiences and a collective effort to plan a major multicentre research in order to establish standardized protocols are essential.

Key words: Prosthetic Joint Infection; One-stage Exchange; Two-stage Exchange.

Introduction

Prosthetic Joint Infection (PJI) is a devastating complication with significant impact on patients and healthcare systems. Despite recent advances, the orthopaedic community recognizes that essential aspects are still controversial and further studies are needed to establish firm evidence-based guidelines.

One such controversial issue is whether to revise a chronically infected total joint in one or two stages. Some centres advocate to do it primarily in two-stages, others choose to do it one- or two-staged according to specific criteria and some believe it

should (almost) always be performed in one single surgery.

The purpose of this paper is to report the results of a survey made to participants of the 34th European Bone and Joint Infection Society (EBJIS) Annual Meeting, held in Estoril - Portugal in 10-12 September 2015. We aimed to draw a portrait of the actual standard of care around Europe as well as understand the preferences and opinions of the participating experts in choosing between one- or two-stage revision surgery. The results of this survey were already made

public during the crossfire session held at the last day of the meeting.

Material and Methods

The authors created a questionnaire using an online tool: http://freeonlinesurvey.com. This questionnaire was previously reviewed and approved by EBJIS board members including its president at the time, Dr Heinz Winkler. The final format of the survey was then sent via e-mail to all 34th EBJIS Annual Meeting participants one week before the event. Participants were explained the motives of the survey and asked to participate by anonymously answering the online survey.

The survey comprised 30 questions, divided in two groups: 10 multiple-choice questions [personal, institutional and treatment choice information] and 20 questions containing a series of factors with influence on PJI revision procedures which were graduated by importance according with a 5-point Likert scale.

Main descriptive statistics will be presented. We also sought associations between main philosophy in revision PJI surgery and remaining variables. Categorical variable associations were dealt using Pearson's Chi-Squared test and Likert scales using either Student's t-test or Analysis of Variance (ANOVA) with post-hoc analysis, assuming both parametric tests as adequate according to the central limit theorem. Data processing was performed with IBM SPSS Statistics version 20.0.0, with the assumption of statistical significance for a p-value under 0.05.

Results

In total 502 delegates from 51 countries participated in the congress, of which 143 or 28% (from 35 different countries) responded this survey. Figure 1 shows the geographical distribution of respondents. Personal and institutional information of the respondents are presented in Table 1. One can observe the vast majority of respondents are very skilful orthopaedic surgeons with a large experience in treating musculoskeletal infections. They are evenly distributed among high and low volume hospitals. Even in this highly specific group of experts most of them work in institutions who treat less than 50 prosthetic joint infection cases yearly.

Table 1. Personal and Institutional information.

Medical expertise	Orthopaedics	Infectious Diseases	Microbiology	Other
	114 [81.4%]	15 [10.7%]	7 [5.0%]	4 [2.9%]
Medical degree	Head of Department	Consultant	Attending	Resident
	28 [20.0%]	64 [45.7%]	16 [11.4%]	32 [22.9%]
Years of practice in MSK infections	0-2 years	3-5 years	6-10 years	>10 years
	20 [14.3%]	40 [28.6%]	24 [17.1%]	50 [35.7%]
Institution of practice	University Hospital	Public Health System	Private Hospital	Other
	75 [53.6%]	51 [36.4%]	12 [8.6%]	2 [1.4%]
TJA per year in institution	< 200	200-500	500-1000	>1000
	28 [20.4%]	50 [36.5%]	29 [21.2%]	30 [21.9%]
PJI cases per year in institution	< 20	20-50	50-100	> 100
	43 [31.2%]	60 [43.5%]	24 [17.4%]	11 [7.9%]

MSK – Musculoskeletal; TJA – Total Joint Arthroplasty; PJI – Prosthetic Joint Infection.

Out of Europe
Africa:
Egypt: 1
South Africa: 1
Tunisia: 1
America:
Argentina: 2
Brazil: 1
Canada: 1
Chile: 1
United States of America: 2
Asia:
India: 3
Indonesia: 1
Taiwan: 2

AT-Austria; BE-Belgium; CH-Switzerland; CZ-Czech Republic; DE-Germany; DK-Denmark; ES-Spain; FI-Finland; FR-France; GR-Greece; HR-Croatia; HU-Hungary; IE-Ireland; IT-Italy; LV-Latvia; NL-The Netherlands; NO-Norway; PL-Poland; PT-Portugal; RU-Russian Federation; SE-Sweden; SI-Slovenia; UA-Ukraine; UK-United Kingdom

Figure 1. Geographical distribution of respondents.

A dedicated bone and joint infection unit is part of the practice in about half of the cases and infectious diseases or microbiology experts are the most common medical specialty cooperating with orthopaedic surgeons (Table 2).

Predominantly two-stage is the most frequent choice for revision surgery of a chronically infected total joint arthroplasty. About one-third answer they perform two- or one-stage according to the conditions of each specific case and only about 5% primarily perform one-stage. Table 3 further details this information. It is noteworthy that among those selectively choosing two- or one-stage surgery the estimated proportion of one-stage is clearly under 50%.

In respect to the degree of importance of different factors to choose a two-stage and not one-stage procedure, respondents pointed out as most relevant: *1)* the presence of significant soft-tissue compromise (median 4.0,interquartile range 2.0); *2)* failure of previous (single or staged) revision surgery attempts (median 4.0,interquartile range 1.5); *3)* unclear infective microorganism(s) preoperatively (median 4.0,interquartile range 2.0); *4)* highly resistant infective microorganism: Methicilin-Resistant *S.aureus*, Vancomycin-Resistant Enterococci, ESBL Gram negative (median 4.0,interquartile range 2.0); *5)* infective microorganism: Methicilin-resistant coagulase-negative staphylococci (median 4.0,interquartile range 2.0); *6)* patient presenting with concurrent sepsis/systemic infection (median 4.0,interquartile range 2.0); *7)* patients presenting with immunosuppression (median 4.0,interquartile range 2.0). Overall results can be seen in further detail in Table 4A and Table 4B.

Figures 2A and B explore the answer results according to the chosen philosophy for revision surgery. Those who advocate for one-stage systematically seem to give less importance to certain factors that are more consensual among the other two philosophies (e.g soft tissue compromise, infection spreading to the neurovascular bundle, failure of previous revision surgery attempts, infection by methicillin-resistant coagulase-negative staphylococci or gram negatives). On a secondary and curious analysis, heads of department clearly demonstrated greater agreement than the rest of the respondents.

Table 2. Bone & Joint Infection Unit.

Presence of a dedicated B&J Infection Unit		YES		NO		
		72 [51.8%]		67 [48.2&]		
Medical Specialties regularly involved						
Orthopaedics	Infectious Diseases	Microbiology	Anaesthesiology	Internal Medicine	Plastic surgeon	Other
128 [92.9%]	93 [86.9%]	104 [74.8%]	59 [42.5%]	51 [36.7%]	59 [42.5%]	17 [12.2%]

B&J – Bone and Joint.

Table 3. Philosophy regarding chronic PJI requiring revision surgery.

Chosen philosophy for revision	Primarily Two-stage		Two-stage or One-stage accordingly	Primarily One-stage	
		83 [60.1%]	48 [34,8%]	7 [5,1%]	
Overall estimated proportion of one-stage	Residual	<20%	20-50%	50-80%	>80%
	52 [44.4%]	33 [28.2%]	22 [18.8%]	5 [4.3%]	5 [4.3%]
Primarily Two-stage institutions – estimated proportion of one-stage	Residual	<20%	20-50%	50-80%	>80%
	46 [54.1%]	20 [23.5%]	0 [0.0%]	0 [0.0%]	1 [1.2%]
Two-stage or One-stage accordingly institutions - estimated proportion of one-stage	Residual	<20%	20-50%	50-80%	>80%
	7 [14.6%]	13 [27.1%]	21 [43.5%]	4 [6.9%]	0 [0.0%]
Primarily One-stage institutions - estimated proportion of one-stage	Residual	<20%	20-50%	50-80%	>80%
	0 [0.0%]	1 [12.5%]	1 [12.5%]	1 [12.5%]	4 [50.0%]

PJI – Prosthetic Joint Infection

Table 4A. Delegates voting on importance of several factors in their choice for <u>Two-stage and NOT One-stage</u> procedures

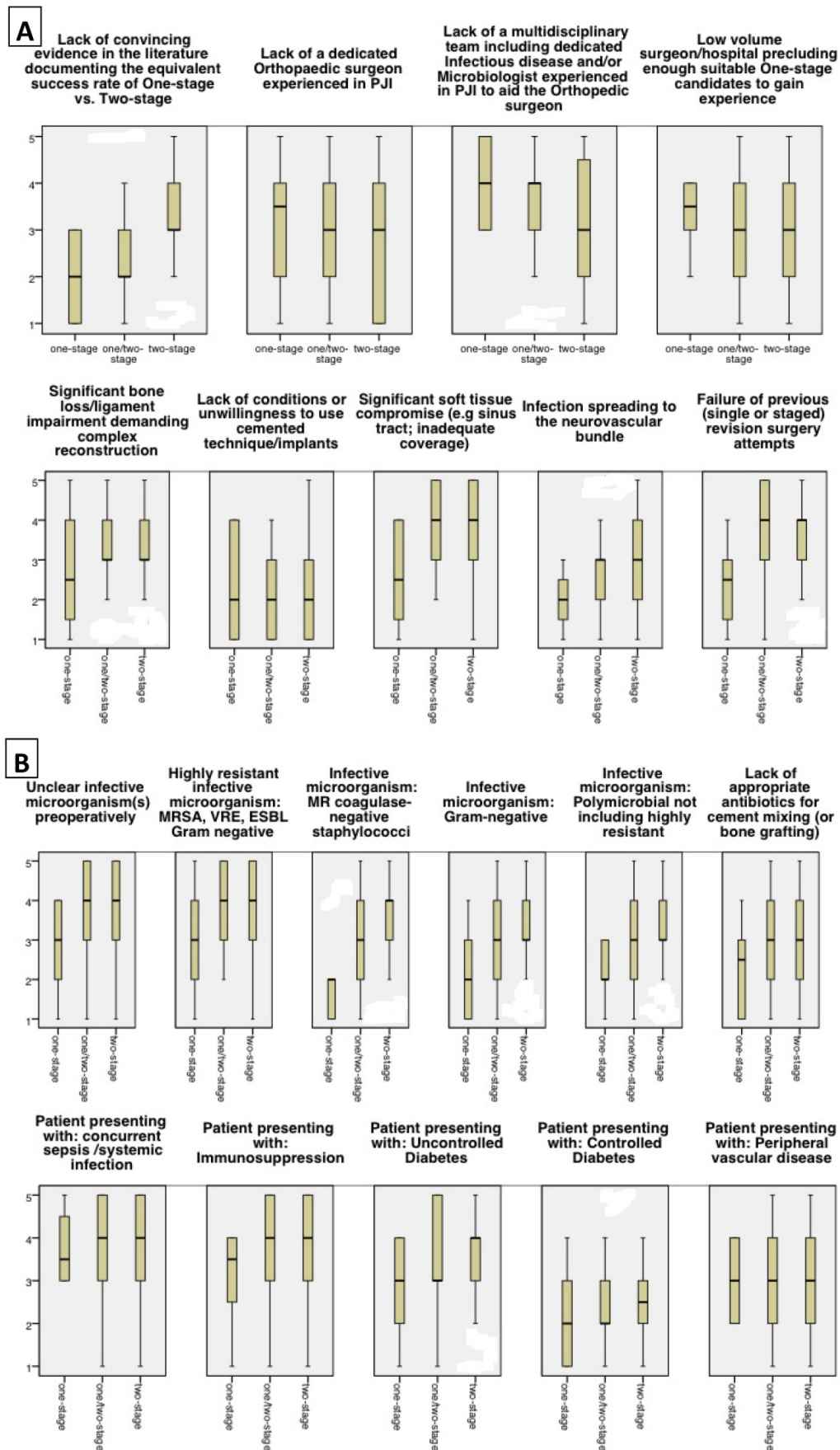|	1- Not Important	2- Somewhat Important	3- Important	4- Very Important	5- Extremely Important	Average score
Lack of convincing evidence in the literature documenting the equivalent success rate of One-stage *vs.* Two-stage	16 [11.5%]	30 [21.6%]	52 [37.4%]	26 [1870%]	15 [10.8%]	3.0/5
Lack of a dedicated Orthopaedic surgeon experienced in PJI	32 [22.9%]	20 [14.3%]	35 [25.0%]	35 [25.0%]	18 [12.9%]	3.0/5
Lack of a multidisciplinary team including dedicated Infectious disease and/or Microbiologist experienced in PJI to aid the Orthopaedic surgeon	26 [18.6%]	16 [11.4%]	29 [20.7%]	37 [26.4%]	32 [22.9%]	3.2/5
Low volume surgeon/hospital precluding enough suitable One-stage candidates to gain experience	21 [15.2%]	27 [19.6%]	41 [29.8%]	32 [23.2%]	17 [12.3%]	3.0/5
Significant bone loss/ligament impairment demanding complex reconstruction	14 [10.2%]	20 [14.6%]	41 [29.9%]	49 [35.8%]	13 [9.5%]	3.2/5
Lack of conditions or unwillingness to use cemented technique/implants	42 [30.7%]	39 [28.5%]	32 [23.4%]	22 [16.1%]	2 [1.5%]	2.3/5
Significant soft tissue compromise (e.g. sinus tract; inadequate coverage)	5 [3.6%]	19 [13.8%]	27 [19.6%]	48 [34.8%]	39 [28.3%]	3.7/5
Infection spreading to the neurovascular bundle	20 [14.6%]	30 [21.9%]	48 [35.0%]	21 [15.3%]	18 [13.1%]	3.0/5
Failure of previous (single or staged) revision surgery attempts	8 [5.8%]	16 [11.7%]	36 [26.3%]	45 [32.9%]	32 [23.4%]	3.6/5

PJI – Prosthetic Joint Infection

Figure 2. A. Importance of different factors according to the philosophy of revision. **B.** Importance of different factors according to the philosophy of revision.

Table 4B. Delegates voting on importance of several factors in choosing <u>Two-stage and NOT One-stage</u> procedures.

	1- Not Important	2- Somewhat Important	3- Important	4- Very Important	5- Extremely Important	Average score
Unclear infective microorganism(s) preoperatively	9 [6.5%]	11 [8.0%]	27 [19.6%]	37 [26.8%]	54 [39.1%]	3.8/5
Highly resistant infective microorganism: MRSA, VRE, ESBL Gram negative	10 [7.3%]	10 [7.3%]	25 [18.3%]	37 [27.0%]	55 [40.2%]	3.9/5
Infective microorganism: MR coagulase-negative staphylococci	16 [11.6%]	25 [18.1%]	32 [23.2%]	39 [28.3%]	26 [18.9%]	3.3/5
Infective microorganism: Gram-negative	16 [11.6%]	22 [15.9%]	39 [28.3%]	46 [33.3%]	15 [10.9%]	3.2/5
Infective microorganism: Polymicrobial not including highly resistant	16 [11.7%]	28 [20.4%]	42 [30.7%]	27 [19.7%]	24 [17.5%]	3.1/5
Lack of appropriate antibiotics for cement mixing (or bone grafting)	25 [18.4%]	23 [16.9%]	42 [30.9%]	24 [17.7%]	22 [16.2%]	3.0/5
Patient presenting with: concurrent sepsis /systemic infection	6 [4.4%]	9 [6.6%]	30 [22.1%]	43 [31.6%]	48 [35.3%]	3.9/5
Patient presenting with: Immunosuppression	9[6.6%]	15 [11.0%]	32 [23.4%]	45 [32.9%]	36 [26.3%]	3.6/5
Patient presenting with: Uncontrolled Diabetes	10 [7.4%]	17 [12.5%]	43 [31.6%]	42 [30.9%]	24 [17.7%]	3.4/5
Patient presenting with: Controlled Diabetes	23 [17.0%]	52 [38.5%]	41 [30.4%]	16 [11.9%]	3 [2.2%]	2.4/5
Patient presenting with: Peripheral vascular disease	12 [8.8%]	37 [27.2%]	36 [26.5%]	32 [23.5%]	19 [14.0%]	3.1/5

MRSA – Methicillin Resistant *S.aureus*; VRE – Vancomicyn Resistant Enterococci; ESBL– Extended Spectrum Beta Lactamase; MR - Methicillin Resistant.

Regarding the influence of several personal, local or institutional factors influence on chosen philosophy for revision surgery it was possible to find a significant trend towards more selective one- or two-stage approach in higher volume centres. No other collected variables seem to influence the choice of philosophy including the number of PJI cases treated yearly or the presence of a dedicated bone and joint infection unit (table 5).

Table 5. Personal, Local and Institutional Factors influence on chosen philosophy for revision surgery

	Primarily Two-stage	Two-stage or One-stage accordingly	Primarily One-stage	P value
Medical degree				
Head of Department	12 [44.4%]	12 [44.4%]	3 [11.1%]	0.328
Consultant	38 [59.4%]	23 [35.9%]	3 [4.7%]	
Attending	13 [81.2%]	3 [18.8%]	0 [0.0%]	
Resident	21 [63.6%]	10 [30.3%]	2 [6.1%]	
Years of practice in MSK infections				
>0-2 years	12 [70.6%]	5 [29.4%]	0 [0.0%]	0.604
2-5 years	26 [65.0%]	13 [32.5%]	1 [2.5%]	
6-10 years	12 [50.0%]	10 [41.7%]	2 [8.3%]	
>10 years	28 [56.0%]	18 [36.0%]	4 [8.0%]	
Place of practice				
University Hospital	48 [62.4%]	26 [33.8%]	3 [3.9%]	0.309
Public Health System	28 [54.9%]	20 [39.2%]	3 [5.9%]	
Private Hospital	9 [69.2%]	2 [15.4%]	2 [15.4%]	
TJA per year in hospital				
< 200	21 [77.8%]	6 [22.2%]	0 [0.0%]	0.020
< 200-500	30 [57.7%]	15 [28.8%]	7 [13.5%]	
500-1000	17 [46.7%]	12 [40.0%]	1 [3.3%]	
>1000	15 [50.0%]	15 [50.0%]	0 [0.0%]	
PJI cases per year in hospital				
< 20	29 [69.0%]	12 [28.6%]	1 [2.4%]	0.655
20-50	33 [53.2%]	24 [38.7%]	5 [8.1%]	
50-100	17 [68.0%]	7 [28.0%]	1 [4.0%]	
>100	6 [54.5%]	4 [36.4%]	1 [9.1%]	
Presence of B&J Infection Unit				
Yes	47 [63.5%]	22 [29.7%]	5 [6.8%]	0.551
No	38 [57.6%]	25 [37.9%]	3 [45.4%]	

MSK – Musculoskeletal; TJA – Total Joint Arthroplasty; PJI – Prosthetic Joint Infection; B&J – Bone and Joint

Discussion

Prosthetic joint infection (PJI) is one of the most challenging and frequent complications after total joint arthroplasty [1,2]. A wide spectrum of uncertainties surrounding the best way to diagnose and treat this condition still persist despite the recent focus on this condition. Several attempts have been made lately to try and produce guidelines or even worldwide consensus [3,4]. Although these documents should be considered as a support for physicians managing PJI cases according to the best known practices in the present, they do acknowledge that much is yet unclear.

One such ambiguous topic is whether revision surgery of the chronic infection should be made in one or two stages. Two-stage exchange consists of debridement of all non-viable tissues, resection of the infected implant with or without placement of a temporary antibiotic-impregnated cement spacer and delayed reimplantation of a new prosthesis in a separate surgery after infection is deemed to be eradicated. In a one stage exchange, reimplantation of the new prosthesis occurs in the same single surgical procedure.

Although two-stage surgery is traditionally considered to be the safest option in regard to the chance for successful eradication of infection there are those who disagree and advocate similar success rates using a one-stage approach [5,6,7,8,9]. In fact, there are several potential advantages of a successful one-stage revision. It is better for both the patient (only one surgery; no disability period between stages and subsequent increased quality of life; and perhaps improved final functional outcomes) and for the healthcare systems (reduced costs and workload). On the other hand, there are also potential disadvantages even if you assume a similar success rate in infection eradication. These disadvantages are chiefly related to the more "aggressive" bone and soft tissue debridement that is required and the technical alternatives for

reconstruction necessary that may in some cases compromise a future re-revision procedure if it should become necessary.

For these reasons there is a third alternative philosophy that advocates a more selective approach to the problem [10,11,12]. It is considered that some clinical scenarios may be addressed in one-stage and depending on different patient local and systemic factors, the infecting pathogen(s) and its antibiotic susceptibility a two-stage approach may be indicated. Although this third way is gaining momentum, we are still a long way from a wide agreement on the specific indications for such an approach [3,4].

The results of this survey are in no way intended to serve as a review or consensus paper on this controversial and difficult topic but only as a contribution in helping us understand the current state of the art around Europe. The strength of these results is that they reflect the opinion of a sample of very experienced group of people (including 28 heads of department) with many years of dedication to bone and joint infections. It is also relevant that even among the participants of a very specialized conference such as the European Bone and Joint Infection Society annual meeting, almost half work without the support of a multidisciplinary dedicated team. One can only hypothesize that the vast majority of orthopaedic surgeons dealing with PJI will face a similar problem. This is of course a potentially negative factor for a successful outcome.

Two-stage approach continues to be the most commonly performed procedure around Europe with only a small percentage of respondents acknowledging primarily one-stage as their chosen philosophy for revision. There is nonetheless a significant proportion of people choosing to do a one- or two-stage approach according to the specific clinical scenario.

Several factors may play a role in this decision. Personal factors such as medical degree or even years of experience in dealing with musculoskeletal infections seem not to play a role in the chosen philosophy. Although a slight preference for a selective one- or two-stage approach could be found in centres preforming more total joint replacements per year, the same trend was not found in those treating more infection cases per year. Other institutional variables such as the type of institution you work on or even the presence or absence of support by a multidisciplinary team seem to have no influence.

Host medical conditions, either local such as inadequate soft tissue envelope or systemic such as concurrent sepsis, immunosuppression or even uncontrolled diabetes seem to be much more important determinants. Pathogen related issues such as unclear infective microorganism(s) preoperatively or highly resistant microorganisms such as methicillin resistant *S. aureus*, vancomycin resistant Enterococci or ESBL-producing Gram negative are also voted as very important factors.

There is a clear need of further research to help establish the relative importance of each host and pathogen factor. To determine the individual impact of each variable on the final outcome could help find out which specific case of infection will benefit the most from a specific treatment approach. Such a standardized staging and prognosis system may ultimately enlighten the choice between one- or two-stage approaches. A collective effort in conducting rigorous multicentre studies should be considered a priority as they would necessarily lead to improved patient outcomes.

Competing Interests

The authors have declared that no competing interest exists.

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