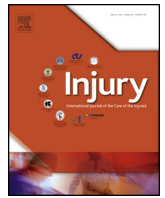




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International survey among orthopaedic trauma surgeons: Lack of a definition of fracture-related infection

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ABSTRACT

Introduction: Fracture-related infection (FRI) is one of the most challenging musculoskeletal complications in orthopaedic-trauma surgery. Although the orthopaedic community has developed and adopted a consensus definition of prosthetic joint infections (PJI), it still remains unclear how the trauma surgery community defines FRI in daily clinical practice or in performing clinical research studies. The central aim of this study was to survey the opinions of a global network of trauma surgeons on the definitions and criteria they routinely use, and their opinion on the need for a unified definition of FRI. The secondary aims were to survey their opinion on the utility of currently used definitions that may be at least partially applicable for FRI, and finally their opinion on the important clinical parameters that should be considered as diagnostic criteria for FRI.

Methods: An 11-item questionnaire was developed to cover the above-mentioned aims. The questionnaire was administered by SurveyMonkey and was sent via blast email to all registered users of AO Trauma (Davos, Switzerland).

Results: Out of the 26'563 recipients who opened the email, 2'327 (8.8%) completed the questionnaire. Nearly 90% of respondents agreed that a consensus-derived definition for FRI is required and 66% of the surgeons also agreed that PJI and FRI are not equal with respect to diagnosis, treatment and outcome. Furthermore, "positive cultures from microbiology testing", "elevation of CRP", "purulent drainage" and "local clinical signs of infection" were voted the most important diagnostic parameters for FRI.

Conclusion: This international survey infers the need for a consensus definition of FRI and provides insight into the clinical parameters seen by an international community of trauma surgeons as being critical for defining FRI.

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Introduction

The operative fixation of skeletal fractures can be highly complex due to the unpredictable nature of the bone and soft-tissue damage as well as the multitude of concomitant injuries [1]. One of the most challenging musculoskeletal complications in

orthopaedic trauma surgery is fracture-related infection (FRI). FRI poses severe consequences for patients and healthcare systems, due to protracted treatment course with considerable rates of recurrent infections and with reported treatment success rates of only 70 to 90% [2–6].

Despite its relevant incidence and tremendous impact, a clear definition of FRI is lacking [2,7–9]. In a systematic review, Metsemakers et al. noted the lack of a clear definition of FRI by showing that FRI is not defined in a large majority of the fracture-related literature [10]. In contrast, for periprosthetic joint infection

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(PJI), the importance of the issue was recognized and led, after convening a panel of experts, to a consensus-derived definition [11], which has provided uniformity across studies, improving not only patient care but also the value of clinical research [9]. Although FRI and PJI do have similarities, there are important distinctions between the elective arthroplasty patient and the patient suffering from (musculoskeletal) injuries in terms of infection susceptibility, diagnostic modalities and treatment options [1]. Therefore, using the PJI consensus definition and translating it to the FRI patient would be inappropriate. The guidelines for surgical site infection (SSI) published by the Centers for Disease Control and Prevention (CDC), which distinguish between superficial incisional, deep incisional and organ/space infections are surveillance guidelines and were not developed specifically for fracture patients [12–14].

Due to the lack of a clear definition for FRI, the central aim of this study was to survey the opinion of a global network of trauma surgeons on the definitions (if any) they routinely use, and their opinion on the need for a unified definition of FRI. This need was assessed by an email survey, which is a useful tool to gather valuable information from a representative sample of respondents [15]. The secondary aims of the survey were to inquire the respondents' opinions on other definitions applicable to FRI and on important diagnostic parameters that should be included in a consensus-derived definition.

Our hypothesis is that trauma surgeons desire a specific definition of FRI to aid in their routine clinical and research activities.

Material and methods

Questionnaire development

A questionnaire was designed and drafted by the authors. Amongst the authors, were orthopaedic trauma surgeons, infectious disease specialists and basic science researchers, all with clinical and/or scientific expertise in the field of bone infections and orthopaedic device-related infections (ODRI). In terms of a multi-staged development strategy, previous literature on definition, classification and diagnosis related to FRI, osteomyelitis and ODRI, such as PJIs was reviewed prior to questionnaire development. Recommendations for survey development were followed [16]. To allow specific answers to the study objectives, the questions were designed to be unambiguous and uni-dimensional. Two types of multiple-choice questions were used. One type included statements with an associated Likert Scale Ranking from strongly disagree to strongly agree to demonstrate trends among respondents; in the other type, a most appropriate answer(s) had

to be chosen [16]. The questions were generated by a modified Delphi process (via planned videoconferences or email communication), wherein items were nominated and rated by the authors until consensus was achieved [16,17]. The questions, which were formulated to answer the above-mentioned aims are listed in Table 1 and were divided into four sections: 1. Demographics, working experience and experience with FRI; 2. Available definitions for FRI; 3. Difference between PJI and FRI; 4. Need for a specific definition for FRI and composition of such a definition. It is recommended to incorporate general and demographic questions in surveys such as this one, in order to ease respondents into the questionnaire, encourage completion of the questionnaire and to allow interpretation of the demographics of the respondents, e.g. if there is an influence of working experience on the answers [16,18].

The draft of the questionnaire was pretested by an independent international cohort of ten orthopaedic trauma surgeons, who were not involved in the development of the questionnaire. They checked reproducibility, redundancy, wording and understanding and gave written feedback after review. Respondents judged the appropriateness of each question and interpreted them in a consistent manner, as intended by the investigators.

Questionnaire distribution

The questionnaire was distributed by SurveyMonkey (www.surveymonkey.com, Palo Alto, California, USA) and was sent via blast email to all AO Trauma registered users (Davos, Switzerland) worldwide. In total, 88'807 email addresses were available in the AO Trauma user registry. SurveyMonkey is an anonymous platform for online surveys, which can be easily customized by the administrator and offers a user-friendly interface for participants. The email contained a text, which highlighted the study objectives, emphasized the confidentiality of the survey and stated that completion would take a maximum of five minutes. The questionnaire completion was voluntary and the link could only be opened once by a single IP address. The response was anonymous and the questionnaire was closed four weeks after distribution.

Statistical analysis

Descriptive statistical analysis was performed for all data, whereby variables were reported as counts and percentage. Response rate was defined as the number of individuals who completed the survey in relation to those who verifiably received and open the email invitation. Statistical differences were tested using the paired T-test for independent variables, to analyse

Table 1
Items of questionnaire with answers in brackets.

Item	Question/Statement
1	How many years have you been practicing as a trauma surgeon? (Resident/<5 years/5–10 years/>10 years)
2	In what area of the world are you practicing trauma surgery? (Africa/Asia/Europe/Oceania/Central-, North-, South America)
3	Do you personally treat fracture-related infection (FRI) within your hospital? (yes/no/only in emergency cases)
4	Does your hospital have a separate septic unit to treat FRI? (yes/no)
5	There is NO clear definition of FRI! ^a
6	Are any of the following definitions/guidelines applicable to FRI? (CDC guidelines [12–14], New definition for PJIs [18], IDSA guidelines for PJIs [19], and Cierny-Mader classification of osteomyelitis [20])
7	Fracture stability, fracture healing and soft tissue damage have an influence on FRI! ^a
8	FRI and periprosthetic joint infection (PJI) are equal regarding diagnosis, treatment and outcome! ^a
9	I believe a consensus-derived definition of FRI is necessary to aid in clinical decision-making and to standardize musculoskeletal trauma research! ^a
10	A definition of FRI should be subdivided into superficial and deep infection! ^a
11	A consensus definition of FRI should include the following diagnostic criteria (select the four most important answers): Purulent drainage; Fistula; Redness, swelling and/or heat; Pain of the affected limb; Elevation of C-reactive protein; Elevation of erythrocyte sedimentation rate; Elevated white blood cell count; Radiological signs; Operative debridement; Microbiology; Histology; PCR testing;

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