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# Orthopaedics trauma symposium 2025 reference list

## Evidence search report

## Completed: 7th February, 2025

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## A. Search terms and notes

**Sources searched (number of results in brackets):**  
British Orthopaedic Associatation (2)  
Google (5)  
Healthcare Improvement Scotland (1)  
National Institute for Health and Care Excellence (NICE) (1)  
Trip (1)  
TRIP Database (1)

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## B. How to access full content

Links are given to full text resources where available. For some of the papers, you will need an **NHS OpenAthens Account**. If you do not have an account you can [register online](https://openathens.nice.org.uk/).

You can then access the papers by simply entering your username and password. If you do not have easy access to the internet to gain access, please let us know and we can download the papers for you.

## C. Search results

## i. National and International Guidance

1. **Fractures (complex): assessment and management**  
   National Institute for Health and Care Excellence (NICE), 2022

This guideline covers assessing and managing pelvic fractures, open fractures and severe ankle fractures (known as pilon fractures and intra-articular distal tibia fractures) in pre-hospital settings (including ambulance services), emergency departments and major trauma centres. It aims to reduce deaths and long-term health problems by improving the quality of emergency and urgent care.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=737c0d14303ecba33ac2733704ca5410)

1. **Management of osteoporosis and the prevention of fragility fractures**  
   Healthcare Improvement Scotland, 2021

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=e339d6a24c78ba7d174a43ae682257c8)

1. **BOAST - Fracture Related Infections (FRI)**  
   British Orthopaedic Associatation, 2019

##### Background and justification

Co-morbidities, associated local soft tissue injury, open wounds and the use of implants all increase the vulnerability to infection of patients with surgically managed fractures. The consequences of infection can be serious for the patient and expensive for the service. Systems for the effective prevention, detection and management of infection should be a central component of an orthopaedic trauma service.

##### Inclusions

All patients with surgically managed fractures.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=fc0fceb3a4c5b97ee611333923eba911)

1. **Fractures (non-complex): assessment and management**  
   National Institute for Health and Care Excellence (NICE), 2016

This guideline covers assessing and managing non-complex fractures that can be treated in the emergency department or orthopaedic clinic. It aims to improve practice so that people with fractures receive the care that they need without unnecessary tests and treatments.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=abd278090053f21cf7503808c87ac47b)

## ii. Systematic Review

1. **A Systematic Review on Artificial Intelligence in Orthopedic Surgery**  
   International Information and Engineering Technology Association, 2024

This systematic review aims to assess the efficacy of Artificial Intelligence (AI) applications in orthopedic surgery, with a focus on diagnostic accuracy and outcome prediction. In this review, we expose the findings of a systematic literature review awning the papers published from 2016 to October 2023 where authors worked on the application of an AI techniques and methods to an orthopedic purpose or problem. After application of inclusion and exclusion criteria on the extracted papers from PubMed and Google Scholar databases, 75 studies were included in this review. We examined, screened, and analyzed their content according to PRISMA guidelines. We also extracted data about the study design, the datasets included in the experiment, the reported performance measures and the results obtained. In this report, we will share the results of our survey by outlining the key machine and Deep Learning (DL) techniques, such as Convolutional Neural Network (CNN), Autoencoders and Generative Adversarial Network, that were mentioned, the various application domains in orthopedics, the type of source data and its modality, as well as the overall quality of their predictive capabilities. We aim to describe the content of the articles in detail and provide insights into the most notable trends and patterns observed in the survey data.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=d3a693c321627ea343c68e1e86907579)

1. **Systematic review of machine-learning models in orthopaedic trauma**  
   Bone & joint open, 2024

**Aims:**Machine-learning (ML) prediction models in orthopaedic trauma hold great promise in assisting clinicians in various tasks, such as personalized risk stratification. However, an overview of current applications and critical appraisal to peer-reviewed guidelines is lacking. The objectives of this study are to 1) provide an overview of current ML prediction models in orthopaedic trauma; 2) evaluate the completeness of reporting following the Transparent Reporting of a multivariable prediction model for Individual Prognosis Or Diagnosis (TRIPOD) statement; and 3) assess the risk of bias following the Prediction model Risk Of Bias Assessment Tool (PROBAST) tool.

**Methods:**A systematic search screening 3,252 studies identified 45 ML-based prediction models in orthopaedic trauma up to January 2023. The TRIPOD statement assessed transparent reporting and the PROBAST tool the risk of bias.

**Results:**A total of 40 studies reported on training and internal validation; four studies performed both development and external validation, and one study performed only external validation. The most commonly reported outcomes were mortality (33%, 15/45) and length of hospital stay (9%, 4/45), and the majority of prediction models were developed in the hip fracture population (60%, 27/45). The overall median completeness for the TRIPOD statement was 62% (interquartile range 30 to 81%). The overall risk of bias in the PROBAST tool was low in 24% (11/45), high in 69% (31/45), and unclear in 7% (3/45) of the studies. High risk of bias was mainly due to analysis domain concerns including small datasets with low number of outcomes, complete-case analysis in case of missing data, and no reporting of performance measures.

**Conclusion:**The results of this study showed that despite a myriad of potential clinically useful applications, a substantial part of ML studies in orthopaedic trauma lack transparent reporting, and are at high risk of bias. These problems must be resolved by following established guidelines to instil confidence in ML models among patients and clinicians. Otherwise, there will remain a sizeable gap between the development of ML prediction models and their clinical application in our day-to-day orthopaedic trauma practice.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=2f087fa31ab0f373dd421a0fee430c9f)

## iii. Original Research

1. **Integrating artificial intelligence into trauma and orthopaedics: History, current state of AI in T&O and future perspectives**  
   British Orthopaedic Association, 2024

Artificial Intelligence (AI) aims to develop systems capable of executing tasks traditionally associated with human intelligence. Since its inception in the mid-20th century, AI has undergone significant evolution, transitioning from basic algorithms to complex artificial neural networks. The Dartmouth Conference of 1956 is widely recognised as a seminal event that marked the beginning of organised research efforts in AI1. Recent advancements in AI have been accelerated by innovations in cloud computing, which provide scalable computational resources, and improvements in processor technology, enhancing the speed and efficiency of complex algorithms and real-time analysis2,3.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=6284d72d956a43ec45a59da6be801a1c)

1. **Biological aspects to enhance fracture healing**  
   BioScientifica, 2023

The ability to enhance fracture healing is paramount in modern orthopaedic trauma, particularly in the management of challenging cases including peri-prosthetic fractures, non-union and acute bone loss.

* + Materials utilised in enhancing fracture healing should ideally be osteogenic, osteoinductive, osteoconductive, and facilitate vascular in-growth.
  + Autologous bone graft remains the gold standard, providing all of these qualities. Limitations to this technique include low graft volume and donor site morbidity, with alternative techniques including the use of allograft or xenograft.
  + Artificial scaffolds can provide an osteoconductive construct, however fail to provide an osteoinductive stimulus, and frequently have poor mechanical properties.
  + Recombinant bone morphogenetic proteins can provide an osteoinductive stimulus; however, their licencing is limited and larger studies are required to clarify their role.
  + For recalcitricant non-unions or high-risk cases, the use of composite graft combining the above techniques provides the highest chances of successfully achieving bony union.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=b5fdc2364d56da318aa08d061c523d02)

1. **Leeds-Genoa Non-Union Index: a clinical tool for asessing the need for early intervention after long bone fracture fixation**  
   International orthopaedics, 2019

### Aim of the study

The aim of this case-control study was to develop a clinical decision rule to support assessment of the risk of long-bone non-union and plan for appropriate early intervention.

### Methods

Two hundred patients (100 cases and 100 controls) were recruited. Risk factors identified to contribute to the development of non-union were recorded and analysed with a multivariable logistic regression model. Tabulation of the outcome (non-union/union) against each risk factor in turn (univariable analysis) was carried out. Odds ratios and confidence intervals were derived using Wald's method. A receiver-operator curve was calculated and the area under the curve was computed. Having established the eight most important risk factors, a non-union risk index was developed as the count of the risk factors present in each patient.

### Results

The five risk factors for non-union with greater effect size were post-surgical fracture gap > 4 mm (odds ratio (OR) = 11.97 95% CI (4.27, 33.53)), infection superficial/deep (OR 10.16 (2.44, 42.36)), not optimum mechanical stability (OR 10.06 (3.75, 26.97)), displacement > 75% of shaft width (OR 6.81 (2.21, 20.95)), and site of fracture—tibia (OR 4.33 (1.32, 14.14)). The ROC curve for the non-union index was 0.924, sensitivity 91%, specificity 77%.

### Conclusions

The non-union index derived from counting risk factors predicts union for 0-4 risk factors and non-union for 5-8 risk factors. It can be readily applied and can guide clinicians about the risk of development of long-bone non-union. It can become a powerful aid for assessing fracture fixation outcome and to support early intervention.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=ad61a72a8104f00eb43431095a44ef12)

1. **Risk factors for nonunion after intramedullary nailing of subtrochanteric femoral fractures**  
   Archives of orthopaedic and trauma surgery, 2019

### Introduction

Nonunion is a common complication after intramedullary nailing of subtrochanteric femoral fractures. A more detailed knowledge, particularly of avoidable risk factors for subtrochanteric fracture nonunion, is thus desired to develop strategies for reducing nonunion rates. The aim of the present study therefore was to analyse a wide range of parameters as potential risk factors for nonunion after intramedullary nailing of subtrochanteric fractures.

### Materials and methods

Seventy-four patients who sustained a subtrochanteric fracture and were treated by femoral intramedullary nailing at a single level 1 trauma centre within a 6-year period were included in this study. A total of 15 patient-related, fracture-related, surgery-related, mechanical and biological parameters were analysed as potential risk factors for nonunion. Furthermore, the accuracy of each of these parameters to predict nonunion was calculated.

### Results

Nonunion occurred in 17 of 74 patients (23.0%). Of the 15 potential risk factors analysed, only 3 were found to have a significant effect on the nonunion rate (p < 0.05): postoperative varus malalignment, postoperative lack of medial cortical support and autodynamisation of the nail within the first 12 weeks post-surgery. Accuracy of each of these 3 parameters to predict nonunion was > 0.70. Furthermore, the nonunion rate significantly increased with the number of risk factors (no risk factor: 2.9%, one risk factor: 23.8%, two risk factors: 52.9%, and three risk factors: 100% [Chi-square test, p = 0.001)].

### Conclusions

Our study indicates that intraoperative correction of varus malalignment and restoration of the medial cortical support are the most critical factors to prevent nonunion after intramedullary nailing of subtrochanteric femoral fractures. In addition, autodynamisation of the nail within the first 3 months post-surgery is a strong predictor for failure and should result in revision surgery.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=beee987b4e80fc090aad2f9cf2aa6da1)

1. **Single-stage treatment of infected tibial non-unions and osteomyelitis with bone marrow granulocytes precursors protecting bone graft**  
   International Orthopaedics, 2017

### Purpose

Infected non-unions present a clinical challenge, especially with risk of recurrent infection. Bone marrow contains granulocyte precursors identified in vitro as colony forming units-granulocyte macrophage (CFU-GM) have a prophylactic action against infection. We therefore tested the hypothesis that bone marrow concentrated granulocytes precursors added to a standard bone graft could decrease the risk of recurrence of infection when single-stage treatment of infected tibial non-unions is performed with bone graft.

### Methods

During a single-stage procedure 40 patients with infected tibial non-union received a spongious bone graft supercharged with granulocytes precursors after debridement (study group). A control group (40 patients) was treated in a single stage with local debridement and standard bone graft obtained from the iliac crest. The antibiotic therapy protocol was the same (60 days) in the two groups. CFU-GM progenitors were harvested from bone marrow aspirated on the opposite iliac crest of the site where the cancellous bone was obtained. Union (radiographs and CT scan), a recurrence of clinical infection, and need for subsequent surgery were evaluated.

### Results

Thirty-eight (95%) patients who received graft supercharged with granulocytes precursors achieved successful union without recurrence of infection during the seven-year follow-up versus 28 (70%) control patients; for the control group the mean graft resorption volume was 40%, while no bone graft resorption was found for the study group.

### Conclusion

Supercharging the cancellous bone graft with bone marrow granulocytes precursors protect the site of infected non-union from recurrence of infection and bone resorption of the graft.

[Available online at this link](https://www.knowledgeshare.nhs.uk/index.php?PageID=link_resolver&link=dad672ac535a2f38f6f65cb1d28c5716)

## D. Search strategy

## E. Disclaimer

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