Artificial intelligence assistance in deciding management strategies for polytrauma and trauma patients

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ABSTRACT: Introduction: Artificial intelligence (AI) is an emerging technology with vast potential for use in several fields of medicine. However, little is known about the application of AI in treatment decisions for patients with polytrauma. In this systematic review, we investigated the benefits and performance of AI in predicting the management of patients with polytrauma and trauma.

Methods: This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Studies were extracted from the PubMed and Google Scholar databases from their inception until November 2022, using the search terms “Artificial intelligence” AND “polytrauma” AND “decision”. Seventeen articles were identified and screened for eligibility. Animal studies, review articles, systematic reviews, meta-analyses, and studies that did not involve polytrauma or severe trauma management decisions were excluded. Eight studies were eligible for final review.

Results: Eight studies focusing on patients with trauma, including two on military trauma, were included. The AI applications were mainly implemented for predictions and/or decisions on shock, bleeding, and blood transfusion. Few studies predicted death/survival. The identification of trauma patients using AI was proposed in a previous study. The overall performance of AI was good (six studies), excellent (one study), and acceptable (one study).

Discussion: AI demonstrated satisfactory performance in decision-making and management prediction in patients with polytrauma/severe trauma, especially in situations of shock/bleeding.

Importance: The present study serves as a basis for further research to develop practical AI applications for the management of patients with trauma.

KEYWORDS: Artificial intelligence, deep learning, machine learning, polytrauma, prediction, trauma

ABBREVIATIONS
AI – artificial intelligence
AUC – area under the curve
CNN – convolutional neural networks
ISS – injury severity score
ML – machine learning
NISS – new injury severity score
PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SENTENCE OF RECOMMENDATION
Artificial intelligence has demonstrated satisfactory performance in decision-making and management prediction in patients with polytrauma/severe trauma.

INTRODUCTION
Artificial intelligence (AI), which is developed using machine learning (ML) and deep learning (DL) techniques [1], is an emerging technology with significant potential for use in several fields of medicine. More recently, the further development of AI has been widely achieved through the use of deep learning with convolutional neural networks (CNN) [2]. These technologies can rapidly produce analyses using multiple factors to predict outcomes of various scenarios. Several studies have been conducted to demonstrate the uses of AI performance in predicting important changes in patients in the fields of orthopedics, osteoarthritis, and hip fracture [3, 4].

Trauma is a critical condition leading to morbidity and mortality. Over 5 million people worldwide die annually due to traumatic injury [5]. Although AI has been used in the field of trauma and orthopedics for some time [3, 4], little is known about its application in treatment decisions for polytrauma and severe trauma patients. To address this knowledge gap, the present systematic review investigated the benefits and performance of AI in predicting and/or decision-making in the management of patients with polytrauma and trauma.

METHODS
This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Fig. 1.) [6]. It focused on studies investigating the management of trauma patients with the application...
of AI. Studies were extracted from the PubMed and Google Scholar databases from their inception until November 2022, using the search terms "Artificial intelligence" AND "polytrauma" AND "decision". Seventeen articles were identified and screened for eligibility. Animal studies, review articles, systematic reviews, meta-analyses, and studies that did not involve polytrauma or severe trauma management decisions were excluded. Eight studies were finally deemed eligible for the final review (Tab. I.) [7–14].

Each study was reviewed and all important data were extracted, including types of patients (nonmilitary vs. military personnel), types and performance levels of AI models (e.g., deep learning-based methods, machine learning, natural language processing, etc.), injury outcomes (bleeding/shock, sepsis, and mortality), management decisions (blood transfusion), and other related applications of AI. All data were collected and analyzed through a systematic review by two independent reviewers.

RESULTS

Eight studies focusing on patients with trauma, including two on military trauma, were included in this systematic review (Tab. I., II.). In total, ~25,795 patients were included. The types of AI models used were ML (four studies), DL (one study), and natural language processing (one study). As demonstrated in Tab. II., the AI applications in the six reports were mainly implemented for predictions and/or decisions on shock, bleeding, and blood transfusion. A study using big data by Lammers et al. showed that machine learning techniques can facilitate more optimal and rapid identification of combat trauma patients at the highest risk of massive transfusion [7]. Several studies further predicted death/survival (Tab. II.). The identification of trauma patients using AI was also proposed in one study (Tab. II.). Based on the area under the curve (AUC), the overall performance of AI was good (six studies), excellent (one study), and acceptable (one study) (Fig. 2.).

DISCUSSION

The present systematic review highlights the performance of AI in the management and related predictions in patients with polytrauma and/or injury. The overall results showed that the AI's performance was good to excellent in predicting the aforementioned issues, which supports the current/future application of AI in clinical practice and promotes the performance of further studies. Our results are consistent with a previous study which demonstrated that an AI model could outperform human or conventional predictions using the injury severity score (ISS) or new ISS (NISS).
for predictions regarding trauma patients [15]. These results are understandable since AI models can integrate a greater number of related parameters in addition to the conventional scores. Thus, they can analyze more holistic data, allowing predictions that are comparable or superior to traditional methods. Not only can AI models perform better than human or traditional methods, but they can also be used to dynamically predict the critical outcomes following initial management in trauma patients (e.g., from baseline to 72 hours post-injury) [10].

Regarding the AI models in this systematic review, most were developed using ML. Although their performance was satisfactory, ML may perform poorly at predicting low-frequency conditions with an incidence of <10% [16]. For these situations, DL models may be further developed to predict outcomes and decide related management to a level that is superior to previous models [15]. As such, there is still room for improvement of AI in trauma care in the future.

The limitations of this study include the limited number of searchable papers in the databases and the heterogeneity of subjects in the papers reviewed. However, based on the large number of patients from all eligible studies in this systematic review, we propose that the present study can serve as a basis for further research on developing practical AI applications for the management of patients with trauma.

**REFERENCES**


**CONCLUSIONS**

Overall, the results of this systematic review show that AI can achieve satisfactory performance in decision-making and management prediction in patients with polytrauma or severe trauma, especially in situations of shock/bleeding.

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