Artificial intelligence may enhance emergency triage and management

To the Editors:

We read with great interest the article by Garwe and colleagues[1] concerning triage and correct management of injured older adults (55 years or older).

In this retrospective prognostic study, the authors used data reported between 2009 and 2019 for developing a transfer risk score that may potentially simplify secondary triage of injured older adults to tertiary trauma centers.

The investigated outcome of interest was either mortality or serious injury (Injury Severity Score, ≥16) requiring an interventional procedure at the receiving facility. In developing the model, machine-learning techniques including random forests were used to reduce the number of candidate variables recorded at the initial facility. Of the 5,913 injured older adults, the final prognostic model (area under the curve, 75.4%; 95% confidence interval, 74–76%) included the following top 4 predictors and scores: airway intervention, traffic-related femur fracture, spinal cord injury, and need to hemodynamic support. The authors concluded that the secondary triage of injured older adults to major tertiary trauma centers could be enhanced by use of a risk score.[1]

Timing of intervention is often crucial in influencing outcomes of patients diagnosed with surgical emergencies. Facing the challenge of multiple patients requiring emergency surgery or of limited resource availability, the acute care surgeon must triage patients according to their disease process and physiological state. Emergency operations from all surgical disciplines should be scheduled by an agreed time frame that is based on accumulated data of outcomes related to time elapsed from diagnosis to surgery. Although literature exists regarding the optimal timing of various surgical interventions, implementation strategies of protocols for triage of these patients and diseases have not been sufficiently developed. For institutions of a repetitive triage mechanism, further discussion on optimal timing of surgery in diverse surgical emergencies should be encouraged. Standardizing timing of interventions in surgical emergencies will promote clinical investigation and a commitment by administrative authorities to proper operating theater provision for acute care surgery.[2] It is from the extrahospital settings especially in emergency conditions that it is necessary to intervene to anticipate the clinical and therapeutic pathways. An example may be uncontrolled posttraumatic hemorrhage that is an important cause of mortality that may be reduced. This interesting study intends to use machine learning (ML) to build an algorithm based on data collected from an electronic health record system to predict the risk of delayed bleeding in trauma patients in the intensive care unit. Demographic features, clinical presentations, and laboratory data were collected. The algorithm was designed to predict hemoglobin dropping 6 hours before it happened and evaluated the performance with 10-fold cross-validation. Two ML algorithms were used to predict ongoing hemorrhage events. The logistic model tree and the random forest algorithm achieved an area under the curve of 0.816 and 0.809, respectively.[3]

It must also be considered that operating theaters are responsible for a high amount of costs and profits as well. A large part of the interventions is carried out urgently; therefore, surgical planning is an essential element of peri-operative organization, as well as the clinical management of the patient. With the advancement of technologies and the growth of BigData systems, arises the possibility of being able to use artificial intelligence and ML systems to optimize not only costs and resources but also clinical choices. Technological precision and the ML system may increasingly guarantee an appropriate choice by the doctor, who is thus assisted in his diagnostic and therapeutic pathways. Artificial intelligence is based on algorithms that give to machines the ability to analyze big amount of data and perform functions such as problem-solving, object and word recognition, inference of world states, and decision making.[4] Moreover, machines have the possibility to learn from previous analysis and perfectionate the results during the process progressing.

This would be applicable through the creation of input-output algorithms that can be updated in real time and readily consulted by using tablets.

The Internet of Things now has a subset, which is the Internet of Medical Devices, and is becoming more and more important, which permits a much more in-depth dive into patient procedures and outcomes. Internet of Things devices are now being used to enable remote health monitoring, in-hospital treatment, and guide therapies.[5]

In conclusion, it is true that there is still much to be explored regarding artificial intelligence and ML especially in application to the medical field and, in this case, to emergencies and urgencies, but the path traced is promising to guarantee more and more clinical and therapeutic appropriateness for patients' health and health care professionals' safety. Moreover, the application of continuous advanced analysis systems to institutional, regional, national, and international data accrual systems may allow to answer to many unanswered issues in emergency surgery and trauma management. In conclusion, this will lead to patient care improving together with costs-benefit balance optimization.

DISCLOSURE

The authors declare no conflicts of interest.

Michelangelo Craca, MD
Anesthesiology
Critical Care and Pain Medicine Division
Department of Medicine and Surgery
University of Parma
Parma, Italy

Federico Coccolini, MD
General
Emergency and Trauma Surgery Department
Pisa University Hospital
Pisa, Italy

Elena Bignami, MD
Anesthesiology
Critical Care and Pain Medicine Division
Department of Medicine and Surgery
University of Parma
Parma, Italy

REFERENCES

1. Garwe T, Newgard CD, Stewart K, Wan Y, Cody P, Cutler J, Acharya P, Albrecht RM. Enhancing utility of Interfacility triage guidelines using machine learning: development of the Geriatric Interfacility Trauma Triage Score (GITTS). *J Trauma Acute Care Surg*. 2022;93(6):11–19.
2. Kluger Y, Ben-Ishay O, Sartelli M, Ansaloni L, Abbas AE, Agresta F, Biffl WL, Baiocchi L, Bala M, Catena F, Coimbra R, Cui Y, Di Saverio S, Das K, El Zalabany T, Fraga GP, Gomes CA, Gonsaga RA, Kenig J, Leppäniemi A, Marwah S, Junior GA, Sakakushev B, Siribumrungwong B, Sato N, Tranà C, Vettoretto N, Moore EE. World society of emergency surgery study group initiative on Timing of Acute Care Surgery classification (TACS). *World J Emerg Surg*. 2013;8(1):17; 2–6.
3. Lee SW, Kung HC, Huang JF, Hsu CP, Wang CC, Wu YT, Wen MS, Cheng CT, Liao CH. The clinical application of machine learning–based models for early prediction of hemorrhage in trauma intensive care units. *J Pers Med*. 2022; 12(11):1901; 5–8.
4. Bellini V, Rafano Carnà E, Russo M, Di Vincenzo F, Berghenti M, Baciarello M, Bignami E. Artificial intelligence and anesthesia: a narrative review. *Ann Transl Med*. 2022;10(9):528; 2–11.
5. Merle G, Miclau T, Parent-Harvey A, Harvey EJ. Sensor technology usage in orthopedic trauma. *Injury*. 2022;53(Suppl 3):59–63.

The intranasal route for ketamine administration may be a simple way to improve battlefield analgesia

To the Editor:

This report aims to briefly review the intranasal administration of ketamine, particularly in combat situations. Recently, Cohen et al.[1] described the opioid sparing effect of ketamine use in prehospital military settings. From a prehospital military trauma registry, including military and non-military events, the authors retrospectively analyzed 382 trauma patients with severe pain scores (>5/10), requiring opioids or ketamine analgesia. Ninety-two patients (24%) received ketamine as part of their analgesia treatment, and 21% of them received unique analgesia therapy. In the univariable multinomial logistic regression, ketamine was associated with an odds ratio of 0.28 (95% confidence interval, 0.15–0.5) when treated with the medium dose of morphine equivalent (11–20 mg) compared with the low dose (0–10 mg). These results may be useful for understanding and improving analgesia in military combat settings. To support this, we want to highlight the specific advantages of the intranasal route for ketamine administration.

First, optimal pain management is challenging in tactical combat casualty care (TCCC), particularly in remote and austere settings. Furthermore, the appropriate treatment for prehospital analgesia can be limited or delayed because of a lack of intravenous access. Thus, the TCCC guidelines already include an intranasal route for pain control because it can be relatively more accessible and noninvasive.[2]

Second, at doses of 0.5 mg/kg to 0.75 mg/kg, intranasal ketamine is considered to be a rapid and effective drug for acute pain control.[2] Specifically, ketamine is detectable in the blood after 2 minutes, a maximum concentration is reached after 30 minutes, and it is estimated to be effective for 3 hours. Moreover, the average bioavailability of ketamine delivered via the intranasal route is 40%, within a range of 33% to 71%. However, only a few randomized controlled trials have been conducted to evaluate the effectiveness of intranasal ketamine in emergency rooms or prehospital settings.[3,4] For example, Shimonovich et al.[3] showed similar clinical efficacy for intranasal ketamine compared with intravenous and intramuscular morphine. In addition, the PAIN-K study demonstrated the efficacy of intranasal ketamine to control acute pain in civilian prehospital settings.[4]

Third, Dubecq et al. reported the use of intranasal ketamine for pain management in a case series of combat casualties in the Middle East, which revealed reasonable results and no significant side effects (article in press). As part of the deployment, medical teams from the French Military Medical Service were deployed for four-month rotations from August 2017 to March 2019 and treated 259 casualties. Seventy-six of them received 50 mg of intranasal ketamine alone or concomitantly with a 10-mg subcutaneous morphine injection from personal first aid kits before placement of peripheral venous access. Fifty-nine of those patients (77.6%) reached a Wong-Baker Faces Pain Rating Scale (W-BFPRS)* < 3 after 10 minutes and did not need intravenous access for analgesia, which is particularly convenient in triage situations. Nine casualties were treated with intranasal ketamine alone, while 50 casualties also received 10 mg of subcutaneous morphine simultaneously. In the intranasal ketamine group, the required doses of intravenous morphine and intravenous ketamine to achieve a W-BFPRS <3 were lower than in the subcutaneous/intravenous group.

Finally, the French Military Central Pharmacy is currently developing a ketamine pulverization device for intranasal analgesia at the point of injury. This device could soon be available as a means of autoadministration for all servicemen and women, in addition to the French syrette of morphine, a 10-mg subcutaneous morphine dose provided in the combat first aid kit.[5]

In conclusion, intranasal ketamine administration may be an effective way to improve analgesia in austere conditions. Although the TCCC guidelines already recommend this route, and the first results in the case series are encouraging, the literature on this topic is still lacking. Further studies are necessary to validate these results and develop the application of intranasal ketamine in combat situations.

AUTHORSHIP

M.R. and N.P. participated in the drafting of the article. D.C. participated in the revision of the article. All the authors read and approved the final article.

ACKNOWLEDGMENTS

The authors would like to thank all participants for their time and interest. This work is dedicated to all deployed military healthcare personnel.

DISCLOSURE

The opinions or assertions expressed herein are the private views of the authors and are not to be considered as reflecting the views of the French Military Health Service. Financial disclosure: The authors have indicated they have no financial relationships relevant to this article to disclose.

Romain Montagnon, MD
171th Armed Forces Medical Center
Quartier LCL Normand, 82160
Caylus, France

Nicolas Py, MD
Department of Anesthesiology and Intensive Care, Percy Military Training Hospital
Clamart, France

Christophe Dubecq, MD
4th Specialized Medical Unit
Bayonne, France