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THE ROLE OF ARTIFICIAL INTELLIGENCE IN BURN CARE

Znamerovskyi S., Alieksieieva O.,Savytskyy I.
Ukrainian Research Institute of Transport Medicine of the Ministry of Health of Ukraine

РОЛЬ ШТУЧНОГО ІНТЕЛЕКТУ В ЛІКУВАННІ ОПІКІВ

Знамеровський С., Алєксєєва О., Савицький І.
Український науково-дослідний інститут медицини транспорту МОЗ України

“Whoever saves one life, it is as if he had saved the entire world.”
(Talmud, Sanhedrin 37a)

Summary/Резюме

Background: Burns are currently a serious problem for countries, especially for LMICs where the acute issues remain: lack of funding and medical staff, dependence on foreign investment, poor infrastructure and access to health care, lack of equipment. Treating burns is very burdensome. AI offers an inexhaustible potential for improving clinical decision-making with cost optimization and improvement of treatment standards with outcomes.

Methods: When analyzing the use of AI in medicine, especially in burns, it is possible to find the application of AI in the evaluation of the affected areas, especially in depth, the development of treatment algorithms, predictive modelling of clinical cases with personalization, and prognoses of outcome from burns.

Results: AI demonstrated high accuracy in the classification of burns using databases based on the archiving of the affected skin. Models using AI have shown their effectiveness

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in predicting complications, such as infection and outcome of injury. AI-supported telemedicine platforms have shown promise for future use in remote selection and subsequent observation. The effectiveness has been particularly evident in the context of limited-resource countries. However, data heterogeneity, limitation of verification in different population groups, and ethical issues need to be refined and implemented.

Conclusion: AI is quickly becoming a valuable addition in the treatment of burns, improving the accuracy of diagnosis, prediction, adjustment of treatment, and personalization. Future research should focus on integrating AI into clinical processes, ensuring ethical and regulatory decision-making to make full use of the potential for improving outcomes in the treatment of burn victims.

Keywords: *Artificial intelligence, Healthcare, Burns Surgery, Public Health, Limitation Resources*

Передумови: Опіки наразі є серйозною проблемою для країн, особливо для країн з низьким і середнім рівнем доходу, де гострими залишаються такі проблеми: брак фінансування та медичного персоналу, залежність від іноземних інвестицій, погана інфраструктура та доступ до медичної допомоги, брак обладнання. Лікування опіків є дуже обтяжливим. Штучний інтелект пропонує невичерпний потенціал для покращення прийняття клінічних рішень з оптимізацією витрат та покращенням стандартів лікування з урахуванням результатів.

Методи: При аналізі використання ШІ в медицині, особливо при опіках, можна знайти застосування ШІ в оцінці уражених ділянок, особливо в глибині, розробці алгоритмів лікування, прогнозному моделюванні клінічних випадків з персоналізацією та прогнозуванні результатів опіків.

Результати: ШІ продемонстрував високу точність у класифікації опіків з використанням баз даних на основі архівування ураженої шкіри. Моделі, що використовують ШІ, показали свою ефективність у прогнозуванні ускладнень, таких як інфекція та результат травми. Платформи телемедицини, що підтримуються ШІ, виявилися перспективними для майбутнього використання в дистанційному відборі та подальшому спостереженні. Ефективність була особливо очевидною в контексті країн з обмеженими ресурсами. Однак, неоднорідність даних, обмеження верифікації в різних групах населення та етичні питання потребують удосконалення та впровадження.

*Висновок:*Штучний інтелект швидко стає цінним доповненням до лікування опіків, покращуючи точність діагностики, прогнозування, коригування лікування та персоналізації. Майбутні дослідження повинні бути зосереджені на інтеграції ШІ в клінічні процеси, забезпеченні етичного та регуляторного прийняття рішень, щоб повною мірою використати потенціал для покращення результатів лікування постраждалих від опіків.

Ключові слова: *Штучний інтелект, Охорона здоров'я, Хірургія опіків, Громадське здоров'я, Обмежені ресурси*

1.Introduction

This article is written to demonstrate the possibility of using AI in medical practice, especially in its critical and topical area—burn injuries, which are particularly relevant in LMICs. Medicine and technology are areas of science that are constantly evolving and, with the use of new successful progressive research and development, allow us to preserve human life, which is the most valuable and important on Earth.

Burns are still one of the most serious forms of injury in global practice and often lead to long-term hospitalization, disability, long-term rehabilitation measures, and economic costs. This phenomenon is especially significant for countries with low and medium levels of development (LMICs). Unfortu-

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nately, these countries experience an acute shortage not only in consumables but also in human resources. Comprehensive measures for the treatment of burn patients are quite complex events and require coordination in multidisciplinary teams. During the acute phase, rapid and accurate decision-making becomes especially crucial. Due to rapid progress in electronic technologies, especially in the medical field, artificial intelligence (AI) has emerged as an auxiliary tool in various areas of healthcare. In the field of burn treatment, in particular, AI has unlimited potential to improve clinical and diagnostic assessment and treatment. It can also help the distribution of all resources, which is especially important for LMICs. The presence of an auxiliary resource such as AI will significantly ease the burden on staff and hospital infrastructure, especially when considering the issues that greatly affect both the treatment process and its outcomes.

2. Background and Rationale

If we analyze the WHO's statistics (latest data from October 2023) on deaths from burns (180,000 adults and children), two-thirds of all cases occur in low- and middle-income countries, specifically in Africa and Southeast Asia. According to the International Monetary Fund's extended estimate, the total population is about 6.9 billion. In these same countries, child mortality is still 7 times higher than in the highly developed countries. The number of children dying in these countries has increased by 10%. The economic component allows us to identify that direct care costs for burns vary widely but tend towards being generally expensive, with a 2014 systematic review finding a mean total healthcare cost per burn patient of US$ 88 218 (range US$ 704 - 717 306). In South Africa, an estimated US$26 million is spent annually on burns from kerosene (paraffin) cookstove incidents. Indirect costs, such as lost wages, prolonged care for deformities and emotional trauma, and commitments to family resources, also contribute to the socioeconomic impact. The plans of the WHO also include plans for the development of preventive medicine. WHO is promoting interventions that have been shown to be successful in reducing the incidence of burns. The organization is also supporting the development and use of a global burn registry for globally harmonised data collection on burns and increased collaboration between global and national networks to increase the number of effective programs for burn prevention. [1,19]

The involvement of other parts of the healthcare chain in treatment and rehabilitation increases the economic costs of full recovery. A lot of disciplined teams are needed in each case. Unfortunately, these capabilities are very limited, especially in countries with LMICs. The issue particularly affects highly skilled staff and the availability of specialized burn departments. Getting the necessary help and advice is essential in critical situations. Burns are the competence of Emergency Medicine and Trauma, as a frontline, and fall under the prerogative of the treatment of urgencies. In recent years, with the development of AI in the world and in medicine, in particular, there has been a significant positive dynamic in the diagnosis, investigation, and treatment of severe clinical cases. Using treatment plans and carefully following them in urgent situations, where quick and accurate decisions are crucial, helps prevent mistakes and lower death rates. The human factor remains an important component and cannot be overestimated. In the treatment of burns, AI will optimize many automatic processes and improve the outcome of the patient's treatment, which will eventually affect mortality rates and prognosis. This factor is especially important in the analysis and management of critical patients. Application areas of AI at this time are possible when analyzing many parameters in burn management.

3. Current Applications of AI in Burn Care:

3.1 Burn Depth Assessment

The most important in clinical practice is the depth of skin lesions. Depending on the depth and nature of the burn, a further treatment algorithm is adopted. When using

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AI, a lesion analysis can be performed with a clear measurement of the affected surface and depth. Interesting data can be found using convolutional neural networks (CNNs), which have been tuned to thermal and visible light images capable of distinguishing the thickness of burns with an accuracy of up to 90% [2]. Implementation of such a system in practice will allow the identification of affected areas that need primary surgical treatment more clearly.

3.2 Wound Healing Prediction

In the construction of individual plans of the treatment process for the patient (change of dressing and debridement), the ability to make a prediction of the healing rate of wounds allows better planning of management of treatment and timing of discharge from the hospital. At this time, various AIs with different software that be used in the construction of algorithms this clinical indicators and visualization (images of wounds in dynamics), have demonstrated the prospect of use. The study by Lu et al. demonstrated an analysis model that allows to estimate recovery time and withdrawal with an average absolute error of less than 2 days [3].

3.3 Triage and Resource Allocation

In cases of mass casualty and huge hospital admissions, the most important is the urgency and accuracy of decision-making, with rapid triage of victims. AI can also be used in this case to develop algorithms for the classification of victims using different selection criteria (area of the affected body, depth, associated diseases, inhalation exposure, etc.). The Baux score, which includes patient age, % of affected areas, has been improved with ML models for more accurate mortality prediction [4].

3.4 Rehabilitation and Functional Outcome Prediction

Rehabilitation activities after burns are very expensive and long. The AI can approach this question individually, taking into account individual characteristics, the nature of the wounds received, the surgical treatment carried out and the complications obtained after the burns. Natural language processing (NLP) methods can also be used to analyze all patient data and extract information about the treatment performed and further planning of treatment for each patient individually [5,6].

4. Technological Considerations:

4.1 Data Acquisition and Management

AI in its analysis uses different data depending on the task (different data, models, algorithms, also makes estimates and conclusions). For burn injuries, data from the analysis of images of the affected surface in dynamics, microbiological analysis of the wound flora, which skin substitutes were used and oil bandages with which composition were used can be used. Efforts are currently being made to create centralized databases of all burn injuries based on anonymity. The 'Burn AI' initiative in Europe has begun to address this problem by aggregating standard image datasets [7].

4.2 Model Development and Validation

Different AI models in the development of analysis should include the most complete and adequate data with various variations to build solution algorithms. For example, the color of the skin in the analysis is important because it can distort the accuracy of the determination of the depth of burns in the analysis of images. Therefore, AI should be "trained" in the ethnic characteristics of skin. Active communication between doctors and engineers is necessary to create meaningful algorithms taking into account all possible errors. Transparent reporting, explainability, and reproducibility must be prioritized and prevent any possible issues [8].

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4.3 Integration with Clinical Workflows

The integration of AI should be carried out without particular difficulties in electronic documentation, mobile devices and doctors' database. This requires intuitive interfaces, low computational demands, and clinician

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training [9].

5. Ethical, Legal, and Social Implications:

5.1 Bias and Equity

AI errors can't be ignored, especially if the data collection of the indicators needed to interpret and provide the result is incomplete. Too much bias or ignoring other important clinical factors when assessing affected skin areas or other key parameters can cause problems in managing treatment, which may sometimes lead to permanent consequences. AI developers should take into account these errors as well [10].

5.2 Data Privacy, Ethics and Consent

With its unique mandate, UNESCO has led the international effort to ensure that science and technology develop with strong ethical guardrails for decades. Rapid changes in the use of AI in various areas of everyday life give rise to profound ethical concerns. These concerns arise from the potential of AI systems to embed biases, contribute to climate degradation, threaten human rights, and more. This is especially critical in medicine, where the ethical aspect is paramount. Such risks associated with AI have already begun to compound on top of existing inequalities, resulting in further harm for already marginalised groups. The ethical approach to the creation and storage of personal data should be a priority when using AI for clinical cases. This provision should be respected at the state level and protected by law with particular care [11].

5.3 Accountability and Clinical Responsibility

When using AI, cases of misdiagnosis should receive special attention. The guidelines should define the role of AI as an auxiliary tool rather than autonomous, because the final decision must be made by a physician taking into account all ethical nuances, clinical aspects, and patient conditions.

The purpose of using AI in medical practice is for AI to help improve treatment outcomes. We also need to realise that not all AIs can accurately interpret all clinical outcomes and are perfect at the final point of decision. The AI can make recommendations, but these are not suitable for this patient, and errors were made during a software crash. Subsequently, there is a potential risk of harm to patients due to such human and computer errors [12].

5.4 Research Gaps and Future Directions

Despite the genuine interest in these new technologies, the future view should focus on the following points:

- Multimodal systems that allow analysis based on clinical data and images from monitors and sensors to provide a complete picture and assessment of the patient's condition
- Development of various mobile applications for remote assessment and recommendation
- Ease of use and explanation will increase confidence among doctors with self-assessment and review recommendations.
- Evaluation and monitoring of longitudinal results, which allow building algorithms on trajectories and dynamically adjusting recommendations.
- Evaluation of the real impact of AI on treatment outcomes, process efficiency, and cost analysis in the health care system.

6. Case Study: AI in Remote Burn Assessment

The use of AI may be particularly valuable in LMICs, where there are still significant issues regarding access to qualified personnel and limited options for burn treatment. Telemedicine platforms, using their AI modules, will help medical staff in real time when downloading images of burns, receiving automated assessments and recommendations for further treatment.

A pilot project in India demonstrated that an AI-based mobile app improved triage accuracy and reduced unnecessary transfers by 35% [13].

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7. The following is a comprehensive overview of systematic reviews of AI's role in treating burns:

1. **Taib et al. (2022/23)** – Systematic Review & Diagnostic Test Accuracy Meta analysis

Scope: 35 studies (1990–2021); 12 eligible for diagnostic test meta analysis [14].

Applications: Burn depth classification: 68.9–95.4% accuracy; sensitivity ~90.8%, specificity ~84.4%

Burn segmentation: 76.0–99.4% accuracy; sensitivity ~97.9%, specificity ~97.6%

Mortality prediction: >90–97.5% accuracy; sensitivity ~92.9%, specificity ~93.4%

Algorithms: Neural networks in 69% of studies

Limitations: Significant heterogeneity in methodology (QUADAS 2 flagged major variability)

Technical diversity (image capture differences, algorithm choice

Conclusion: AI helps to determine the diagnostic accuracy and compare it with current practice. The heterogeneity of indicators and methodological inconsistencies point to the need for standardization in this approach. [14].

2. **Moura et al. (2021)** – Updated Systematic Review

Scope: 46 observational studies (up to 2021)

Key Findings: Main focus: burn depth (26 studies)

Common algorithms: SVMs (in 19 studies), neural networks also prevalent

Frequent use of 10 fold cross validation (11 studies)

Conclusion: This audit shows great potential in assessing the affected skin surface with a recommended evidence base and a single level of verification [15].

3. **Huang et al. (2021)** – ML & Automation in Burn Wound Evaluation

Scope: Systematic review focusing on ML for wound evaluation.

Conclusion: AI allows an objective analysis of the affected skin. Based on these data, a standardized process is required [16].

4. **Implementation Study:** Prognostic AI Models in Taiwan

Scope: Retrospective cohort (2010–2019), 224 patients.

Predictive Outcomes: Prolonged hospital stay (>14 days)

Application: Integrated into a hospital information system to support clinical decisions [17].

5. **Comparative Analysis (2025**) – AI vs. Surgeons

Scope: J Clin Med study comparing models (e.g., ChatGPT 4o) with plastic surgeons across 10 burn images.

Findings: The analysis carried out by AI was compared with the expert evaluation of a group of doctors. Also, the variability of recommendations and solutions revealed a need to refine this model before practical implementation in medical practice [18].

8. Conclusion

Based on the promising capabilities of AI, it is possible to predict improvements in evaluation, treatment, and care for burns with a more accurate diagnosis, a personalised treatment approach, a significant increase in the efficiency of available resources, and an improved outcome.

However, the realisation of these capabilities requires an accessible and reliable data infrastructure, ethical approaches and safeguards, and interdisciplinary communication.

By investing in the development and implementation of AI in medical practice, especially in the care system and treatment of burns, it is possible to increase survival, reduce disability, and optimise and personalise the approach.

Overall outcomes:

- Performance: AI demonstrates high diagnostic accuracy and prognostic recommendations when performing a large number of tasks in a short period of time in patients with burns.

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- Clinical integration: AI can be an auxiliary tool, but not a complete substitute for doctors. This is especially important in sorting, forecasting, and telemedicine.
- Problems: Standardisation of existing databases and clinical studies, with the possibility of re-checking discrepancies with reference points, accessibility in data interpretation, ethical support, acceptance by clinicians into practical activities
- Next steps: large prospective multicenter clinical trials comparing AI+ clinician and clinician-only work processes, common structured data and standards for interaction between them, and focussing on accessibility to ensure user trust.

As technology evolves, it is possible to expect a new era of precision medicine in the treatment of burns, where data-driven data will help doctors deliver the right treatment to the right patient at the right time.

Deciding based on the emotional component of AI cannot yet be done, and, unfortunately, if the decision is made to do palliative treatment (high percentage of surface damage or brain death), it can only be done by the medical professional staff.

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