

# Artificial Intelligence and Traumatic Brain Injury: Balancing Technological Advancement with Ethical Responsibility to Provide Equitable Care

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- Artificial intelligence (AI) has great potential for helping traumatic brain injury (TBI) patients in hospital settings by improving **diagnosis, treatment, and recovery** outcomes.
- However, it is important to note that the use of AI for TBI care also introduces challenges, such as perpetuating **implicit biases** related to **health disparities**, which could lead to inadequate and inequitable care.
- Healthcare systems are increasingly using AI to predict risk rates and healthcare prognosis, that impact **decision-making** in clinical settings.
- Many algorithms factor in **cost** when making healthcare recommendations, creating ratings that favor privileged racial and social groups.
- It is crucial to understand how **race and socioeconomic factors** are accounted for by AI algorithms, and whether it is ameliorating bias or exacerbating it.



- For example, AI systems that are trained on biased data sets with a lack of representation of persons of color and those from minority groups may present **inaccurate diagnoses or treatment recommendations**.
- The ethical issues surrounding AI's usage in TBI care need to be examined from a variety of standpoints – technological, social, educational, and global.
- Training AI systems with diverse data require extensive **data collection** efforts and examination of **electronic health records**.
- Healthcare providers, researchers, and technology companies must effectively and transparently **communicate** to address the unique needs and challenges faced by diverse patient populations.
- Furthermore, we must consider ways to spearhead **global equity** by incorporating AI into **telemedicine** and **remote monitoring** for patients from low- and middle-income countries.

## References

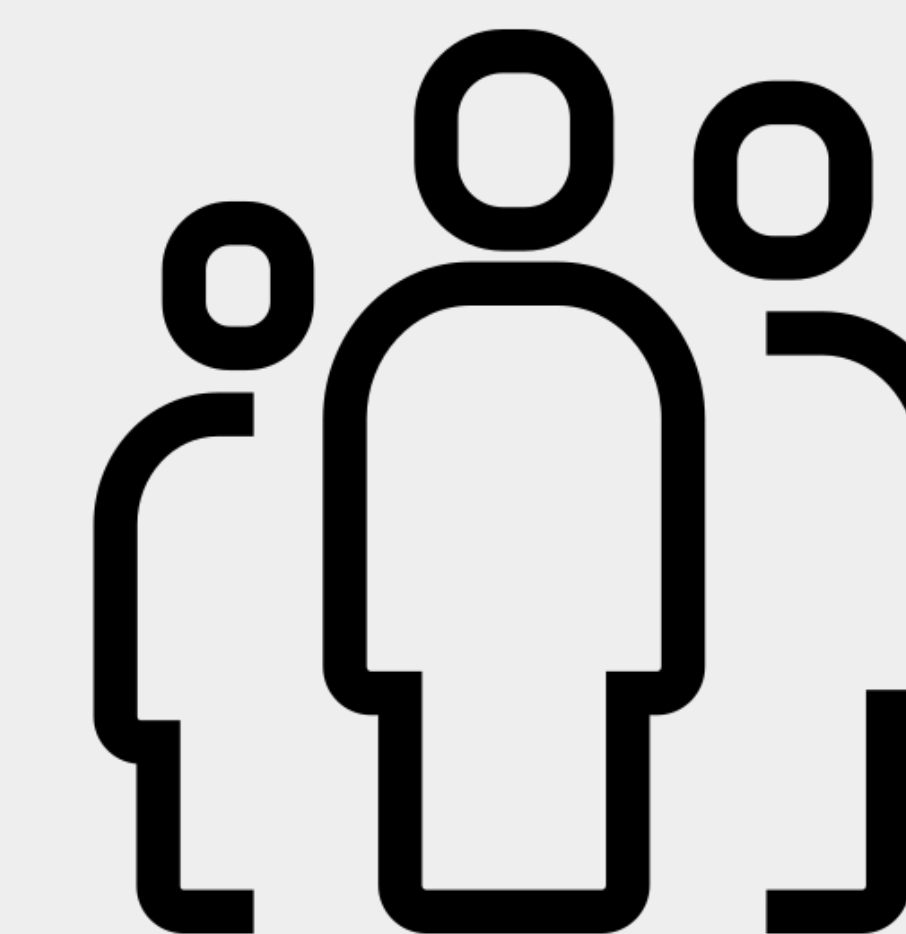
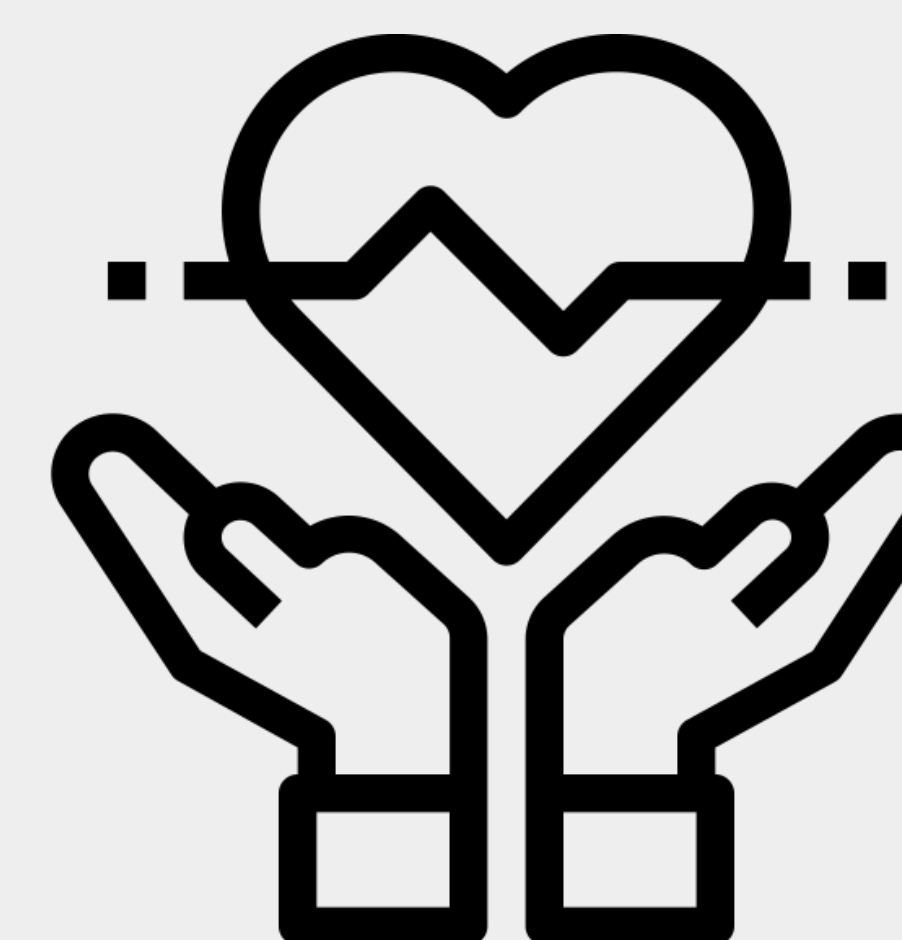
1. Obermeyer, Ziad, et al. "Dissecting racial bias in an algorithm used to manage the health of populations." *Science*, vol. 366, no. 6464, 2019, pp. 447–453, <https://doi.org/10.1126/science.aax2342>.
2. Maas, Andrew I, et al. "Traumatic brain injury: Progress and challenges in prevention, clinical care, and research." *The Lancet Neurology*, vol. 21, no. 11, 2022, pp. 1004–1060, [https://doi.org/10.1016/s1474-4422\(22\)00309-x](https://doi.org/10.1016/s1474-4422(22)00309-x).
3. Rajaei, Flora, et al. "AI-based decision support system for Traumatic Brain Injury: A survey." *Diagnostics*, vol. 13, no. 9, 2023, p. 1640, <https://doi.org/10.3390/diagnostics13091640>.
4. Johnson, Leslie W., and Isabella Diaz. "Exploring the social determinants of health and health disparities in traumatic brain injury: A scoping review." *Brain Sciences*, vol. 13, no. 5, 2023, p. 707, <https://doi.org/10.3390/brainsci13050707>.
5. Hibi, Atsuhiko, et al. "Automated identification and quantification of traumatic brain injury from CT scans: Are we there yet?" *Medicine*, vol. 101, no. 47, 2022, <https://doi.org/10.1097/md.00000000000031848>.

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## AI Applications for TBI Patients

- AI could **streamline** the **comprehensive data analysis** of patients' symptoms, laboratory values, radiology reports, and clinical assessments
- AI could provide prognosis and **personalized treatment** options that best fit the individual patient rather than following generalized guidelines
- AI holds potential for **standardizing** treatment protocols, **mitigating errors**, and **expediting** the clinical decision-making process
- Computer-aided image processing techniques could assess **diagnostic scans** (e.g. CT) of TBI-related abnormalities such as hematoma and midline shift measurements
- This could help reduce the possibility of **subjective interpretations** or natural **inter-personal variability** and **standardize** interpretations to improve patient outcomes



## Overview of TBI

- Due to TBI having the **highest incidence** among the most common neurological disorders, it poses a significant **public health concern**.
- Mild TBI and severe TBI affect **55.9 million** and **5.48 million** individuals annually, respectively.
- TBI can result in **short-term** memory and cognitive issues as well as increased risk of **long-term** mental illness and neurodegenerative disease onset.
- TBI is considered a **complex and heterogeneous** medical concern due to patients experiencing unpredictable symptoms.
- Being able to **precisely assess, diagnose, and treat** TBI in a **timely manner** is essential for patients' recovery.
- AI systems may be able to analyze large amounts of associated data to efficiently determine the severity of injury, especially **personalized** to individual patients' pathology.

## Ethical Considerations

- Sustained, **interdisciplinary** collaboration channels between healthcare providers, researchers, and technology innovators throughout the process leading up to clinical implementation is essential.
- Though relevant clinical tools are validated, AI interpretations of the data collected from these tools must be assessed for **accuracy and reliability**.
- In the midst of the AI revolution, ensuring **confidentiality and privacy** of patient data are most important, especially when electronic medical records are involved.
- **Informed consent** procedures need to be revised to reflect ongoing developments.
- **Governance and oversight** structures need to be established at hospital, institutional, as well as regional scales.



## Bias and Disparities

- Remedying bias in healthcare algorithms and predictive AI models is essential, especially for **vulnerable populations** at increased risk for TBI
- **Institutional barriers to open-access collaboration** poses challenge for **validating algorithms** with **diverse** patient populations and assessing biases in data interpretation
- Even with access to data from diverse populations, there is a critical need to ensure AI **training** occurs in an equal manner (as seen by past examples of negative AI views towards BIPOC communities)
- If caution is not exercised, AI could introduce biases that act on and add onto **existing** healthcare disparities

## Access and Equity

- Typically, AI research is conducted at highly funded institutions in **urban** regions.
- **Rural** hospitals with limited TBI care could benefit from AI applications -- time and resources need to be invested into developing these **partnerships**.
- AI research could be incorporated into growing **telemedicine** outreach efforts to assist healthcare providers treating TBI patients in the **Global South**.
- Even in settings with limited diagnostic and imaging equipment, AI's **predictive** analysis patterns could potentially guide providers based on reported patient symptoms and past medical history.
- Conducting longitudinal **neuro-epidemiological** TBI studies in **resource-limited settings** can provide a foundation for AI to learn from.