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Quick Response Code:

Current status of implementation of trauma registries' in LMICs & facilitators to implementation barriers: A literature review & consultation

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***Background & objectives*: Many low- and middle- income countries (LMICs) have attempted to implement trauma registries with varying degrees of success. This study aimed to understand the registry implementation mechanism in LMICs better. Study objectives include assessment of the current use of trauma registries in LMICs, identification of barriers to the process and potential areas for intervention, and investigation of the registry implementation experience of key stakeholders in LMICs.**

***Methods*: An initial narrative review of articles on trauma registry use in LMICs published in English between January 2017 and September 2023 was conducted. Key findings identified in this review were used to establish a theoretical framework from which an interview guide was subsequently developed. Expert consultation with key stakeholders in trauma registry implementation in two LMICs was conducted to assess the experience of registry implementation further.**

***Results*: The presence of trauma registries in LMICs is limited. Key implementation barriers include funding concerns, uncoordinated administrative efforts, lack of human and physical resources *(i.e.*, technology, equipment), and challenges in data management, analysis, and quality. Stakeholder interviews highlighted the importance of trauma registry development but echoed some obstacles, notably funding and data collection barriers.**

***Interpretation & conclusions*: Barriers to registry implementation are ubiquitous and may contribute to the low uptake of registries in LMICs. One potential solution to these challenges is the application of the WHO International Registry for Trauma and Emergency Care. Future studies examining context-specific challenges to registry implementation and sustained utilization are required.**

Key words Implementation - injury surveillance–LMIC - low- and middle- income countries - trauma - trauma systems

Trauma registries are datasets that document the acute phase care of hospitals delivered to trauma victims[1]. Registries include demographic variables, clinical and injury characteristics, and pre-hospital and hospital care characteristics. Trauma registries play a crucial role in understanding the epidemiology of trauma and aim to improve patient care and outcomes[2]. They allow us to track quality indicators, advocate for injury prevention, benchmark trauma care, facilitate cost-effectiveness, and improve mortality[3]. These benefits culminate in risk-adjustment evaluation of injury and diagnoses, permitting the analysis of clinical interventions, redirecting resource allocation for pre and post-hospital care, and generating hypotheses and research[1].

Early registries started as institution-based datasets and progressed to national databases in most high-income countries (HICs)[2]. Implementation challenges described by HICs include the limited role in guiding real-time care decisions for individual patients and quality of data, which includes difficulties with data completeness, usability, timeliness, and cost-effectiveness[2,4]. Takeaway points from challenges HICs face include defining the shopping list of clinical information and operational requirements needed in trauma registries to improve trauma care, using this data to inform real-time patient-tailored interventions, and estimating predictors of outcomes of interest. After more than four decades of use, trauma registries have become a necessary component of mature trauma systems and have slowly but steadily appeared in the landscape of trauma care in low- and middle-income countries (LMICs)[2]. However, despite the known benefits of their use, implementation of trauma registries in LMICs remains challenging[5].

Literature is available on multiple attempts of different LMICs to create, implement, and sustain trauma registries[5-7]. Just like HICs, LMICs' initial efforts have started as institution-based datasets for the most part but have remained as isolated cases that do not seem to progress to national use or fail even within institutions[8-10]. Hence, barriers to the successful merging of trauma registries into trauma care systems for LMICs have stopped registries from becoming a constant part of trauma care[11]. Information on these specific barriers is so far scattered and outdated. This study delved into the current landscape of trauma registries in LMICs, focusing on the challenges impeding their implementation. With the overarching aim of enhancing comprehension of trauma registry implementation in LMICs, this study undertook to evaluate their current usage, identifying barriers to intervention, and exploring the experiences of key stakeholders involved in the implementation process.

Materials & Methods

The current status of trauma registry implementation in LMICs was assessed using a two-prong strategy. Initially, a narrative literature review of the available articles on PubMed, Embase, and MEDLINE was conducted. Papers written in English that aimed to describe the barriers and facilitators related to trauma registry implementation were included. The search strategy is shown in Supplementary Material as Appendix 1 (and literature guide as Appendix 2). Given that a systematic review had been previously conducted up to 2017[11], only papers published from January 2017 to September 2023 were included. We sought to identify recurrent themes on barriers and facilitators previously exposed, as well as find potential new elements that could play some role in implementing upcoming trauma registries.

A total of 72 manuscripts that narrated the implementation, barriers, and facilitators found when creating or adapting a trauma registry for adult populations to their context were assessed. We excluded 39 manuscripts (17 wrong outcomes, 19 wrong study design, 3 not registry-centered) for a total of 33 manuscripts included. Our search strategy was tailored to only include efforts done after the year 2017 in low- and middle- income contexts, to better adapt to the scope of this study. Similarly, the search strategy excluded manuscripts associated with high-income contexts, those published before 2017, and those primarily focusing on the utilization or reporting of outcomes or results from trauma registries. The stringent selection criteria aimed to ensure the relevance and timeliness of the research included in the analysis, providing a comprehensive and up-to-date description of the challenges and facilitators in implementing trauma registries in the specified demographic and thematic contexts.

Since it was anticipated that many trauma registries in LMICs might not have been published, an expert consultation was conducted to gain insights from first-hand experiences in establishing trauma registries or implementing the World Health Organization (WHO) International Registry for Trauma and Emergency Care (IRTEC) registry. LMIC stakeholders were identified based on their expertise in trauma surgical care and first-hand experience on implementation of trauma registries in their countries from a collaborative network. We contacted key stakeholders for expert consultation and performed interviews to identify qualitative themes regarding the barriers and facilitators of trauma registry implementation based on site-experience that might not be captured in literature. Participants were chosen based on their prior involvement in trauma registry implementation and their membership in our collaborative research network, and were invited to voluntarily participate in the discussion. The number of stakeholders was decided upon the number of participants who volunteered to participate. The selected stakeholders were consulted after recording their verbal consent to participate in this consultation exercise with an open declaration regarding their participation. An interview guide was first developed as per the theoretical framework established by several previously documented barriers and facilitators of registry implementation in LMICs identified in the initial literature review. Additional questions were added to investigate the registry implementation experience (Appendix 2, Supplementary Material). This tool facilitated consistency across data collection from expert consultants while allowing flexibility to explore unique aspects of each country's experiences. The consults were conducted through 60 min one-on-one video conferencing sessions using the Zoom platform and were audio-recorded, with prior verbal consent being obtained for audio-recording participants' answers. Subsequently, the recordings were transcribed using Otter.ai (*https://otter.ai*).

Results

Participants for the expert consultation were selected from the collaborative research trauma network based on their experience in prior implementation of trauma registries. From non-IRTEC registry implementation sites, two potential participants were approached (Chile, Nicaragua), out of which one (Nicaragua) was finally recruited and interviewed. Similarly, from IRTEC implementation sites, three potential participants were approached (Zimbabwe, Namibia, and Rwanda), out of which one (Zimbabwe) was finally recruited and interviewed. Barriers highlighted by both experts includeda lack of an established trauma care system and research infrastructure, difficulties persuading personnel to take up data collection and analysis, and financial support to ensure sustainability presented as the main challenges. On the other side, facilitators included the affordability of training and start-up costs, provision of software, and agreement on minimum dataset structure. Detailed relevant elements of barriers and facilitators of trauma registry implementation are further explained in Supplementary Material: Boxes 1 and 2.

Current state and common challenges and barriers of trauma registries in LMICs: Literature was assessed using the proposed research strategy. A total of 873 articles were evaluated looking for barriers and facilitators documented in LMIC trauma registry implementation between 2017-2023. For LMICs, recognizing the need for trauma registries has not been challenging, but their implementation has[2,4]. This reflects on the low number of trauma registry publications and literature from the United Nations Development Index (UNDI) group of LMICs, which is only about one per cent[12]. Literature suggests that multiple attempts to create and implement trauma registries have been initiated, particularly in the last decade[13-15]. Figure 1 depicts the geographical distribution of the limited LMICs with documented trauma registries. Previous barriers described in the literature up until 2017 included information management and data quality, lack of human resources, lack of technology/physical resources, organization/administrative concerns, and financing funding concerns[11]. Nonetheless, the heterogeneous distribution of LMIC throughout the world's geographically and culturally diverse regions imposes region and country-specific challenges when implementing trauma registries[10,16-19].

Data capturing concerns included a lack of pre-hospital data, long per-patient completion time, inappropriate injury assessment tools, incomplete or inaccurate records, underreporting, no standardized form for data collection, and the use of paper-based collection requiring to be transcribed into the registry. Data quality concerns included the compromise or loss of data when transcribed into a record, excessive variables to be collected, and incomplete clinical data, making missing data common[12,20]. After data collection, a rising issue in cases where the registry was successfully collected was the lack of expertise or personnel to analyze and use the data[5,21].

From an organizational standpoint, the reported challenges were in the context of data completeness when patients pass through the emergency department without being captured into the registry. Additional organizational challenges included discrepancies in injury coding, incomplete follow up data, and

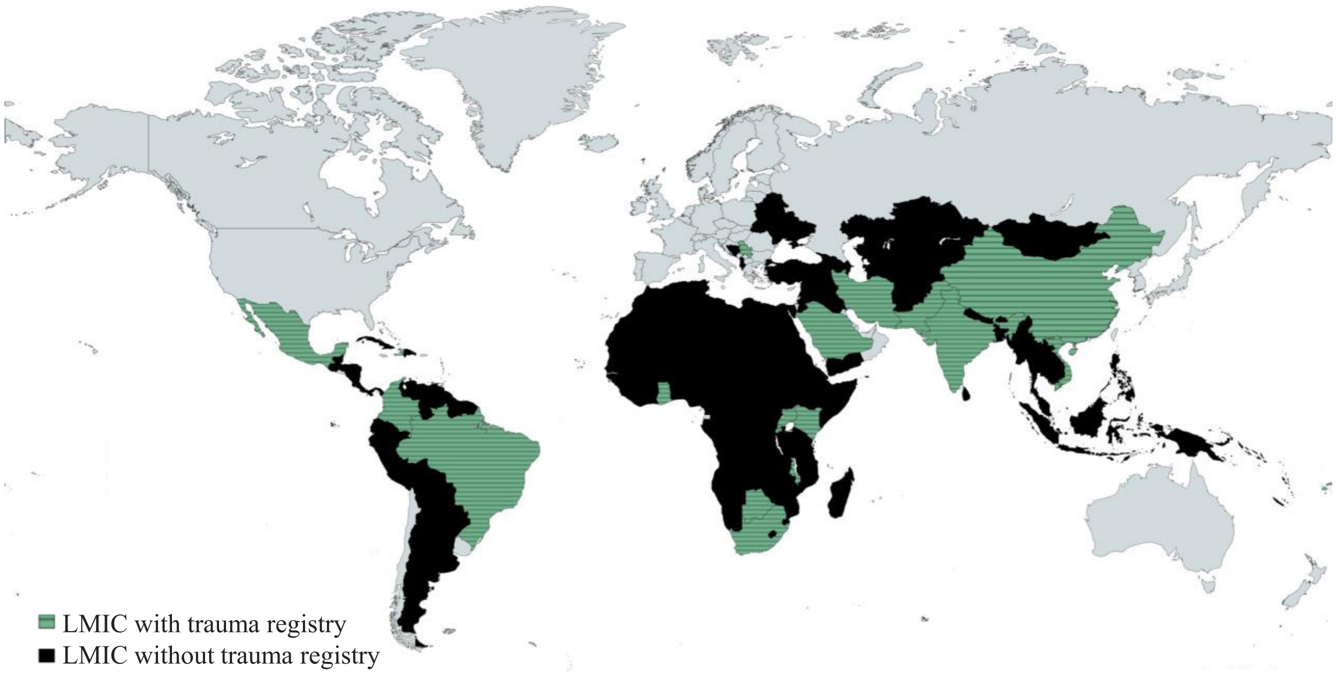

Fig. 1. Map of all the places where LMIC trauma registries exist (2018 systematic review + additionals). Maps generated using templates from *mapchart.net*. LMIC, low- and middle- income country.

the unavailability of geospatial mapping in some contexts[12,22].

The lack of human resources reflects the shortage of healthcare providers that many LMICs face[23]. This suggestively affected clinical care and translated to less capacity for registry maintenance and the requirement for additional personnel to sustain these registries, which often could not be paid for due to financial constraints. Overall available personnel, excessive workload, lack of training, and specialized dedicated staff were perceived as burdens that impede registries from succeeding[24].

Lack of technology and infrastructure included components that come on a national and facility level[23]. On a national level, a lack of pre-hospital care and systems, unfavorable health policies and resource allocation, and geographical difficulties could reportedly reduce registry success[25-27]. On a facility level, lack of equipment for basic clinical measurements, power loss, limited availability of electronic storage, lack of appropriate information in medical records, and unreliable and interrupted internet access, and inadequate information technology were suggestively common[12].

For funding concerns, there were a broad range of implications at various levels of implementation, and it might be the broadest category to affect registry implementation[28]. Although initial funding might be more easily acquired, most authors reported that the end of initial research funds stalled the use of the registries, which could not be sustained with national funds, and hence remained unused. A lack of investment in trauma systems and high implementation costs regarding infrastructure, software, and personnel requirements were noted as financial burdens to implementing trauma registries[12]. Hence, even if overcoming issues with initial funding, sustainability remains a major concern for most LMICs trying to maintain registries within their system. The challenges LMICs encounter during and after the implementation of trauma registries is encapsulated in Supplementary Material: Box 3, while Supplementary Material: Box 4 provides insights into Guatemala's specific experience in their implementation.

Potential solutions and WHO's IRTEC registry: Potential solutions for the challenges faced in implementing trauma registries in LMICs have been described[11]. For data collection, solutions included the implementation of automated hourly backups of

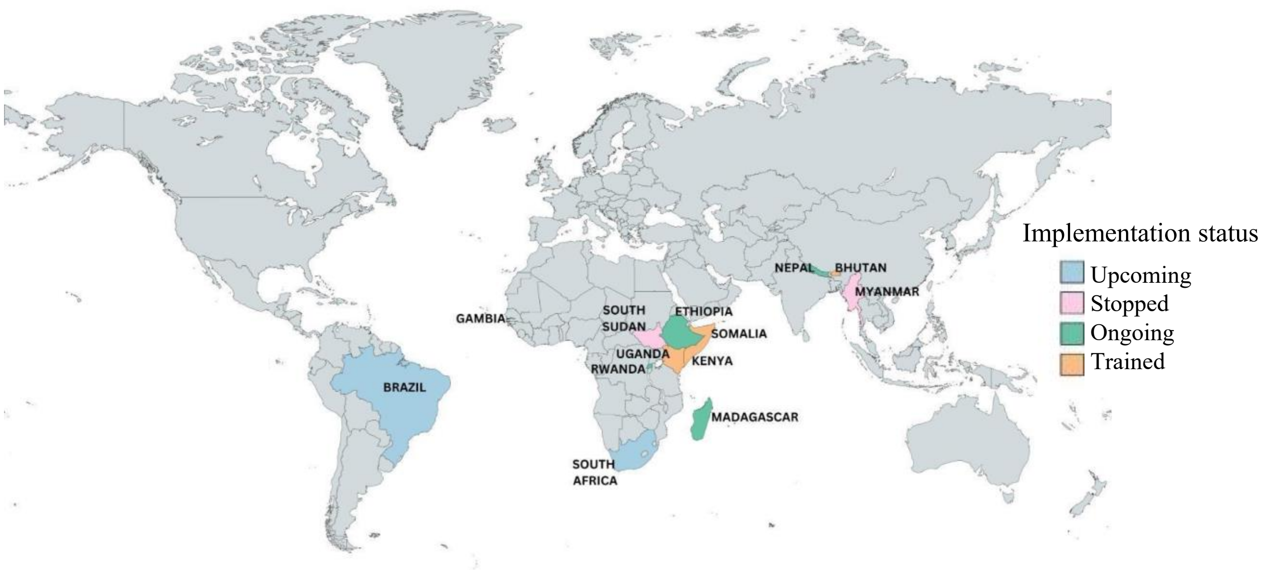

Fig. 2. Map of countries in various phases of IRTEC implementation (map created using a template from *mapchart.net*). IRTEC, international registry for trauma and emergency care.

electronic medical records and the use of electronic trauma registry software for data collection[11]. Solutions to overcome funding and human resource related difficulties included discussing research partnerships with HICs and simplifying data collection so the frontline physicians could complete registries. Regarding data quality, potential solutions included the standardization of variables[11]. Additionally, the WHO proposed IRTEC, a digital tool that presents a potential solution to overcome barriers in trauma registry implementation in LMICs. Through the standardization of data collection and identification of gaps in acute illness and injury care, IRTEC may tackle data quality, organizational and administrative concerns[29]. Figure 2 illustrates countries that have either implemented or are in the process of implementing IRTEC as of February 2023. However, like any other trauma registry, its implementation comes with challenges and potential difficulties. Supplementary Material: Box 1 summarizes the Zimbabwe case in implementing the WHO's IRTEC registry.

Discussion

Trauma registries are fundamental for the development of trauma systems and quality improvement[1]. By tracking epidemiological data, clinical and injury characteristics, and hospital care metrics, registries are key to improving cost-effectiveness and mortality by improving patient care and outcomes[30,31]. As internal quality control tools, these further allow hospital performance comparison and evaluation of effective clinical interventions to identify targeted strategies and resource allocation to optimize emergency trauma care[32,33]. This study summarizes the available literature describing trauma registry hurdles and enablers and provides information on first-hand experience of trauma registry implementers in LMICs. Furthermore, difficulties related to infrastructure, workforce, financing, leadership, and data management while implementing and sustaining an independent trauma registry in limited-resource settings were also identified from published literature. These findings were supported by the shared experience of expert stakeholders, who provided information from two different continents, yet described similar difficulties.

Many LMICs have previously attempted to use trauma registries with various levels of success, with well-documented barriers. The main barriers leading to failure of implementation often include concerns around funding, uncoordinated organization or administrative efforts, lack of human and physical resources (*i.e.*, technology, space, equipment), and data management, analysis, and quality challenges[21,34]. Nonetheless, initial donor aid for starting registry implementation seems to be a relatively common facilitator as supported by literature and the practical experience of the expert interviewees[30,32]. This initial funding for such initiatives were traditionally provided through non-governmental organizations (NGOs) and individual effort groups, which do not necessarily ensure sustainability. Although the mechanism for providing sustainability remain under discussion, IRTEC shows promise in addressing some of the challenges of trauma registry implementation and use.

The IRTEC tool was created in 2019 to provide a common platform for LMICs to collect data on trauma patients to identify gaps in care for acutely ill and injured patients and support systematic quality improvement[29]. Although IRTEC attempts to address several of the aforementioned barriers, ongoing challenges with implementation suggest a need to evaluate its efficacy and feasibility in LMICs.The IRTEC platform collects and analyzes variables specified in the WHO Dataset for Injury (DSI), using standardized clinical trauma forms to ensure adequate data collection in the emergency care units. IRTEC is a free platform that allows the storage, aggregation, analysis, and visualization of data collected. The use of this platform is the WHO's attempt to provide a feasible solution for the standardization of data collection in the setting of trauma registry heterogeneity, as well as to provide aid to administrative concerns regarding implementation and training of actors involved in data collection.

Barriers addressed by the international registry for trauma and emergency care: IRTEC provides a standardized mechanism for collecting and analyzing quality data around trauma and emergencies. Addressing both, affordability and accessibility, the tool is maintained by WHO free of charge with no subscription fee for users. The platform is built on the open-source DHIS-2 software developed by the University of Oslo and is currently used in approximately 60 countries to collect health data[35]. Although the provision of software and hardware through IRTEC partially mitigates the financial burden of the initial implementation, current and future research should aim to find a more long-term solution for financial constraints that allows sustainability of the registry.

The IRTEC platform collects and analyzes variables that are specified in the WHO Dataset for Injury (DSI). Determined by a team of global stakeholders, the DSI is a set of 46 core and 28 extended variables that cover the minimum set of recommended data elements for effective monitoring of injury care. Standardized clinical trauma forms that capture these data points are available to support data collection in the emergency care unit[35]. The centralized software allows for offline data entry and management. However, elements such as hardware availability and internet connectivity are still barriers that need to be handled by the implementation sites. The tool allows data and reports' visualization and breakdowns across individual and aggregate facility performance in a region, and provides internal data quality control and analysis, reducing the burden of information management.

Data can be used to identify facility-level gaps and high-yield targets for targeted quality improvement interventions. The outcome variables and audit filters in IRTEC allow analysis based on the quality of care (*e.g.*, flag deaths that should be rare or non-existent in a well-functioning emergency system), coverage (*i.e.*, facility-based proxies to determine coverage of pre-hospital care in surrounding catchment areas), timeliness (*i.e.*, 24h, 48h, 72h in-hospital mortality based on initial condition and injury mechanism), and system coordination (*i.e.,* referrals to the emergency unit). Thus, the platform seeks to ensure high quality in both data collection and analysis. Supplementary Material: Box 4 summarizes the solutions IRTEC offers for addressing prevalent obstacles.

Persistent challenges: While IRTEC provides a promising way forward that addresses many of the barriers in country-specific trauma registries, the implementation poses significant challenges. Hospitals must transition from their internal documentation systems to IRTEC, which requires modifying existing patient data collection tools to match the WHO Dataset for Injury or dealing with dual documentation. Facilities hoping to use IRTEC must also designate and train personnel to collect the data and appoint individuals to oversee the transition process. Financial concerns are a challenge, as payments must be made for data collectors and internet subscriptions to sync data. Structural issues, such as unreliable internet, device compatibility, and high provider turnover rate, pose further barriers.

The transition to IRTEC will also require significant administrative efforts, including bringing in the Ministry of Health for increased adoption, providing train-the-trainer courses, and facilitating employee buy-in to a new system. Sites using manual data must navigate using a digital platform and transcribe hand-written data into a compatible digital format. On the provider end, healthcare professionals must be convinced to consistently complete their documentation in the correct format and fill out all of the mandatory variables in readable writing. Quality checks must also be conducted internally by hospital personnel. However, the local Ministry of Health may provide additional oversight through data quality checks across hospital sites and supervisory site visits for quality improvement activities and implementation concerns. Although few countries have yet reached the data-analysis phase, the goal would be for in-country research officers to host morbidity and mortality conferences to discuss and create new trauma protocols based on the results.

Beyond administrative concerns, some are hesitant to implement a standardized registry. In particular, those hospitals with more advanced data collection systems may resist adopting a standardized registry that would limit the variables they are interested in exploring, as explained by the interviewees[30,32]. Supplementary Material: Box 5 summarizes the barriers yet to be overcome for successful IRTEC implementation.

Study limitations: This study had several limitations. First, this study synthesized the body of knowledge available on barriers to trauma registry implementation in LMICs, but it did not quantify elements that may be beneficial to account for specific implementation challenges at a local and national level in each LMIC. This may slightly underestimate the prevalence of independent trauma registries in LMICs.

An updated systematic review may be beneficial for further understanding of these elements. Second, the literature review failed to capture non-English articles, as well as papers published in local journals. This may have prevented the capture of additional insights that have made trauma registries fail in the past, and more specifically target these barriers to ensure better registry implementation. Additionally, the small sample size of expert consultants (only two) as well as the context diversity, limits the generalizability of our findings. Contacting trauma registry implementers from LMICs that are not in collaboration with the WHO was especially challenging, as this UNDI group of countries is represented only by one per cent of authorship on trauma registry publications, as evidenced by the results of our literature review. We, however, attempted to include an example of an independent registry implementation by including Guatemala in this work. This limitation emphasizes the importance of our proposed intervention of establishing a robust network of trauma registry implementers, that can capture LMIC implementers and listen to their experience. Such an initiative would broaden the pool of information by including more countries that have implemented their trauma registry.

Finally, our focus on WHO's IRTEC as the primary solution for the barriers faced by LMICs might limit our insight in learning about additional resources that can help tackle these barriers. Further research is needed on the efficacy of IRTEC to mitigate implementation barriers, as well as on other potential facilitators that are not captured in IRTEC.

Proposed interventions: Some of the proposed interventions to address the current challenges include establishing a robust network of trauma registry implementers to guide future efforts and elicit potential champions for IRTEC registry implementation. This network could systematically review the knowledge on trauma registry implementation in LMICs by updating prior published reviews and creating a contact list. Furthermore, it is important to establish best practices for IRTEC implementation based on existing efforts. As of 2023, thirteen countries are in the process of implementing IRTEC, with five actively collecting data[29]. An additional four countries have implemented IRTEC in the past but have since stopped data collection[29]. Information on context-specific motives for data collection cease are yet to be identified. These sites in various stages of IRTEC implementation can provide valuable information on facilitators and barriers to adopting IRTEC as a national trauma registry across contexts. Lastly, it is important to understand the feasibility of IRTEC implementation across a diverse range of settings. It would be important to assess clinicians' and administrators' perspectives on the acceptability, appropriateness, and feasibility of IRTEC at their site, including the ability to integrate WHO standardized clinical data entry forms into the workflow.

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Declaration: We declare that individuals identified as expert stakeholders for the purpose of being interviewed verbally consented to participate in video-recorded interviews to discuss their experience in trauma registry implementation and discuss barriers and facilitators for their work. The experts also agreed to allow their responses to be shared in this manuscript under the condition of anonymity.

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Conflicts of Interest: None.

***Use of Artificial Intelligence (AI)-Assisted Technology for manuscript preparation*:** The authors confirm that there was no use of AI-assisted technology for assisting in the writing of the manuscript and no images were manipulated using AI.

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