

Original article

Orthopedic Trauma Care in Libya: Self-Reported Initial Fracture-Management Practices, Perceived Gaps, and Barriers to Definitive Treatment

Waled Faraj* , Saad Alzyani 

Surgery Department, Faculty of Medicine, University of Tripoli, Libya

Email: w.khalefa@uot.edu.ly**Abstract**

The initial management of orthopedic fractures requires systematic clinical assessment, appropriate immobilization, early management of open fractures, and timely access to definitive treatment. In resource-limited healthcare settings, however, variations in clinical practice and limitations in hospital resources may affect the quality and continuity of trauma care. This study assessed selected initial fracture-management practices and perceived barriers to definitive orthopedic treatment among orthopedic doctors in Libya. A cross-sectional descriptive survey was conducted among orthopedic doctors in different cities across Libya using an online questionnaire created with Google Forms and disseminated through social media platforms. The questionnaire was distributed between June and August 2026. A total of 186 completed responses were included. Six domains were assessed: neurovascular examination, reassessment following fracture reduction or splinting, early intravenous antibiotics for open fractures, initial fracture immobilization, access to timely surgery and necessary fracture implants, and perceived resource-related barriers. Responses were categorized as Yes, No, or Not sure. Descriptive statistics were used. Among 186 respondents, 137 (73.7%) reported routinely performing and documenting neurovascular examinations. Reassessment following fracture reduction or splinting was reported by 128 (68.8%). Early intravenous antibiotics for open fractures were routinely reported by 99 (53.2%). Initial immobilization was reported by 165 (88.7%). Only 72 respondents (38.7%) reported timely access to surgery and necessary fracture implants, whereas 90 (48.4%) reported inadequate access. Limited resources and hospital facilities were identified as major barriers by 145 (78.0%) respondents. The study demonstrates variation in selected aspects of initial fracture management among orthopedic doctors in Libya. Although immobilization was widely reported, important gaps were identified in neurovascular reassessment and early antibiotic administration for open fractures. Limited access to definitive treatment and resource constraints were prominent concerns. Standardized trauma protocols, reliable availability of essential medications and implants, and strengthened referral pathways may improve orthopedic trauma care in Libya.

Keywords: Orthopedic Trauma, Fractures, Open Fractures, Neurovascular Assessment, Immobilization.**Introduction**

Orthopedic trauma is an important component of emergency and surgical care and represents a substantial cause of disability worldwide. The burden of musculoskeletal trauma is particularly important in low- and middle-income countries, where the need for fracture treatment may exceed the available orthopedic resources [1,2,3]. The initial management of an acute fracture begins with systematic clinical assessment and stabilization. Assessment of the injured limb should include examination of the skin and soft tissues, evaluation of circulation and neurological function, and appropriate immobilization [4,5,6]. Neurovascular assessment is particularly important because fractures and dislocations may be associated with vascular or neurological compromise, which may threaten limb viability if not recognized promptly [5,6]. Documentation of neurovascular findings is also an important component of safe orthopedic practice. Clinical audit studies have demonstrated that neurovascular documentation may be incomplete in acute fracture care, suggesting that the presence of clinical recommendations does not necessarily translate into consistent documentation [7].

Reassessment following fracture reduction or splinting is another important component of acute fracture care. Manipulation, reduction, and immobilization may alter the relationship between injured structures and may affect circulation or neurological function. Consequently, reassessment after intervention is an important component of safe fracture management [4,5,6]. Initial immobilization is widely recognized as an essential component of fracture management. Appropriate stabilization can reduce pain, minimize further movement at the fracture site, and protect surrounding soft tissues while definitive treatment is being arranged [4,8]. Open fractures require particular attention because of the risk of contamination and infection. Early appropriate antimicrobial therapy forms an important component of the initial management of open extremity fractures [9,10,11]. Contemporary guidelines emphasize appropriate antibiotic coverage while avoiding unnecessarily prolonged or excessively broad-spectrum therapy [11].

Despite the availability of guidelines, variation in the management of open fractures has been reported. An international survey of orthopedic trauma surgeons demonstrated substantial variation in antibiotic selection and timing [12]. Another large international survey involving 1,197 orthopedic trauma surgeons found considerable variation in antibiotic prophylaxis practices and uncertainty regarding optimal duration [13]. These findings highlight an important distinction between recommended practice and actual reported practice. A clinical guideline may provide a clear recommendation, while implementation in individual hospitals may be affected by medication availability, institutional protocols, staffing, and other system-level factors [11,13]. Access to definitive fracture treatment is another important component of orthopedic trauma care. Definitive treatment may require operating-room availability, trained orthopedic and anesthesia personnel, imaging facilities, appropriate surgical equipment, and fracture implants.

Recent evidence demonstrates that inadequate access to orthopedic trauma resources remains a major problem in low- and middle-income countries. A systematic review published in 2026 included 11 studies covering 488 healthcare facilities in eight low- and middle-income countries. It identified inadequate availability of fracture-fixation equipment and implants, high implant costs, insufficient funding, and weaknesses in trauma-system organization as important barriers [14]. Interestingly, the review also found variation between facilities, with tertiary and private hospitals generally better equipped than smaller hospitals [14]. Previous research from Africa has similarly demonstrated limitations in orthopedic trauma capacity, including shortages of equipment, implants, trained personnel, and operative resources [15]. In Uganda, limited surgical capacity was identified as an important barrier to definitive treatment of long-bone fractures [16]. At the broader health-system level, barriers to surgical care in low- and middle-income countries include inadequate infrastructure, equipment, financial resources, trained personnel, transportation, and referral systems [17,18]. The Libyan context is also relevant. Published reports concerning orthopedic trauma related to the Libyan conflict have described complex open fractures and severe musculoskeletal injuries requiring staged damage-control and definitive orthopedic management [19]. More recent Libyan health-system information also demonstrates the presence of emergency and orthopedic services in different hospitals, although the availability and level of resources may vary between institutions.

Despite the clinical importance of fracture care, there remains limited published evidence specifically assessing the reported initial fracture-management practices of orthopedic doctors across Libya and their perceptions of barriers to definitive treatment. Therefore, this study aimed to assess selected initial fracture-management practices among orthopedic doctors working in public and private hospitals in different cities across Libya and to examine perceived barriers to timely definitive orthopedic treatment.

Methods

Study Design

A cross-sectional descriptive survey study was conducted to assess self-reported practices and perceived health-system challenges related to the initial management of acute fractures among orthopedic doctors in Libya. The study focused on selected components of early fracture care and access to definitive treatment.

Study Setting and Participants

The study was conducted among orthopedic doctors in different cities across Libya. The questionnaire was administered online using Google Forms and disseminated through social media platforms. The target population comprised orthopedic doctors involved in the assessment and management of patients with acute fractures.

Data were collected between June and August 2026 using an online questionnaire created with Google Forms. The questionnaire link was disseminated through social media platforms to eligible orthopedic doctors in different cities across Libya. A total of 186 completed questionnaires were obtained and included in the final analysis.

Questionnaire Development and Content

To evaluate selected aspects of initial orthopedic fracture management and to explore perceived barriers to definitive treatment, a structured six-item questionnaire was developed. The instrument was designed to capture both clinical practices and health-system constraints relevant to acute fracture care. Specifically, it addressed the routine performance of neurovascular assessment in patients with acute fractures, as well as reassessment following reduction or splinting. It further examined adherence to early intravenous antibiotic administration in cases of open fractures, and the practice of initial fracture immobilization prior to definitive management.

In addition, the questionnaire explored issues related to timely surgical access and the availability of essential fracture implants, alongside respondents' perceptions of hospital resource limitations as barriers to optimal care. Each item was presented with three response options—Yes, No, and Not sure—allowing for a concise yet informative assessment of prevailing practices and systemic challenges.

Data Management and Statistical Analysis

Data were analyzed using descriptive statistical methods. Categorical variables were summarized using frequencies and percentages for each response category. Percentages were calculated using the total number of completed questionnaires ($n = 186$) as the denominator. No inferential statistical analysis was performed because the available dataset consisted primarily of categorical responses and did not include sufficient demographic, institutional, or patient-level outcome variables for meaningful subgroup or outcome-based analysis. Accordingly, the analysis was limited to describing the distribution of responses across the six survey domains.

Ethical Considerations

Participation in the study was voluntary. All responses were collected anonymously, and no personally identifiable information was obtained. Participants were informed of the purpose of the study, and completion of the questionnaire was considered to indicate informed consent.

Results

A total of 186 orthopedic doctors working in public and private hospitals across different cities in Libya completed the questionnaire. The survey assessed six aspects of initial fracture management, including neurovascular assessment, reassessment after reduction or splinting, early antibiotic administration for open fractures, initial fracture immobilization, access to definitive treatment, and perceived resource limitations.

Neurovascular Assessment

Among the 186 respondents, 137 (73.7%) reported routinely performing and documenting a neurovascular examination in patients with acute fractures. Thirty-one respondents (16.7%) reported that they did not routinely perform this assessment, while 18 (9.7%) were unsure.

Reassessment After Reduction or Splinting

A total of 128 respondents (68.8%) reported routinely repeating the neurovascular examination after fracture reduction or splinting. In contrast, 35 (18.8%) reported that they did not routinely repeat the examination, while 23 (12.4%) were unsure.

Early Intravenous Antibiotics for Open Fractures

Regarding early intravenous (IV) antibiotic administration for open fractures, 99 respondents (53.2%) reported routinely administering IV antibiotics according to their hospital protocol. Forty-eight respondents (25.8%) reported that they did not routinely administer early IV antibiotics, while 39 (21.0%) were unsure.

Initial Fracture Immobilization

Initial fracture immobilization was the most frequently reported clinical practice among the six assessed domains. Overall, 165 respondents (88.7%) reported routinely immobilizing acute fractures before definitive treatment. Fifteen respondents (8.1%) reported that they did not routinely immobilize fractures, while 6 (3.2%) were unsure.

Access to Definitive Treatment

Regarding access to definitive fracture treatment, 72 respondents (38.7%) reported having timely access to surgery and the necessary fracture implants. In contrast, 90 respondents (48.4%) reported inadequate access, while 24 (12.9%) were unsure.

Perceived Resource Limitations

Resource limitations were frequently identified as a major barrier to fracture management. A total of 145 respondents (78.0%) considered limited resources and hospital facilities to be major barriers to the initial management of fractures in Libya. Twenty-four respondents (12.9%) did not consider these limitations to be major barriers, while 17 (9.1%) were unsure.

Table 1. Distribution of responses to the six survey questions among orthopedic doctors in Libya (n = 186)

Survey domain	Yes, n (%)	No, n (%)	Not sure, n (%)
Neurovascular assessment	137 (73.7)	31 (16.7)	18 (9.7)
Reassessment after reduction/splinting	128 (68.8)	35 (18.8)	23 (12.4)
Early IV antibiotics for open fractures	99 (53.2)	48 (25.8)	39 (21.0)
Initial fracture immobilization	165 (88.7)	15 (8.1)	6 (3.2)
Timely access to surgery/implants	72 (38.7)	90 (48.4)	24 (12.9)
Limited resources as a major barrier	145 (78.0)	24 (12.9)	17 (9.1)

Note: Percentages are based on the total sample of 186 respondents. IV, intravenous. *

Discussion

This study provides an overview of selected aspects of initial fracture management among 186 orthopedic doctors working in different healthcare settings across Libya. Overall, initial immobilization was the most consistently reported practice, whereas neurovascular assessment and reassessment after fracture reduction or splinting were less consistently reported. Considerable variation was also observed in the reported use of early intravenous (IV) antibiotics for open fractures. At the health-system level, limited access to definitive fracture treatment, implants, equipment, and other hospital resources emerged as important perceived barriers to optimal orthopedic trauma care. In the present study, 73.7% of respondents reported routinely performing and documenting a neurovascular examination in patients with acute fractures. This finding is broadly consistent with established principles of fracture assessment, which emphasize the importance of evaluating vascular and neurological status during the initial examination [4,5,6]. Nevertheless, 26.4% of respondents either reported that they did not routinely perform the assessment or were unsure, indicating that this practice may not be consistently integrated into routine fracture care. This finding is clinically relevant because previous audit research has demonstrated deficiencies in the documentation of neurovascular assessment among patients with fractures [7]. Although the majority of respondents in the present study reported appropriate practice, the remaining proportion highlights an opportunity to strengthen standardized assessment and documentation. Incorporating a structured neurovascular assessment into

institutional fracture-management protocols and clinical documentation templates may improve consistency and reduce the risk of missed neurovascular compromise. However, these findings should be interpreted cautiously because the study assessed self-reported practice rather than directly observed clinical behavior. Consequently, the reported level of compliance may not necessarily reflect actual practice in clinical settings.

Reassessment of neurovascular status after fracture reduction or splinting was reported by 68.8% of respondents. This finding is consistent with established clinical principles recommending reassessment after interventions that alter fracture alignment or apply external pressure to the injured limb [4,5,6]. Despite this relatively high proportion, nearly one-third of respondents reported that they did not routinely perform reassessment or were unsure whether they did so. This finding suggests a potential gap between recommended practice and routine clinical implementation. Explicit documentation of pre- and post-reduction neurovascular findings should therefore be incorporated into local fracture-management protocols, particularly for injuries associated with a risk of vascular or neurological compromise.

The greatest variation in reported clinical practice was observed in relation to early IV antibiotic administration for open fractures. Only 53.2% of respondents reported routinely administering early IV antibiotics according to their hospital protocol. This proportion is lower than that reported in an international survey in which 86% of orthopedic trauma surgeons considered antibiotic administration within less than one hour to be optimal [12]. However, the findings should not be interpreted as directly contradictory because the two studies assessed different outcomes. The international study evaluated perceived optimal practice, whereas the present study assessed self-reported routine practice according to hospital protocols.

International literature also demonstrates variation in antibiotic selection, timing, and duration for open fractures [12,13]. Current Surgical Infection Society guidance supports antibiotic therapy for open extremity fractures while discouraging unnecessarily prolonged or excessively broad-spectrum antibiotic use when it is not clinically indicated [11]. Therefore, the variation observed in the present study may reflect differences in institutional protocols, antibiotic availability, clinical workload, injury severity, and the gap between recommended practice and actual implementation. These findings support the need for clear, standardized, and locally applicable open-fracture antibiotic protocols, including guidance on antibiotic selection, timing, duration, and documentation.

Initial immobilization was reported by 88.7% of respondents, making it the most consistently reported clinical practice evaluated in this study. This finding is compatible with the established role of early immobilization in reducing pain, limiting further injury, and protecting the injured limb while definitive management is arranged [4,8]. Nevertheless, the questionnaire assessed whether immobilization was routinely performed but did not evaluate the type, technique, duration, or appropriateness of immobilization for individual fracture patterns. Therefore, the finding should be interpreted as evidence of reported routine immobilization rather than confirmation that immobilization was consistently performed according to best-practice recommendations.

Access to definitive treatment represents an important health-system dimension of fracture care. In the present study, only 38.7% of respondents reported timely access to surgery and necessary fracture implants, whereas 48.4% reported inadequate access. This represents one of the most important findings because appropriate initial fracture management may not translate into optimal outcomes when definitive surgical treatment and essential implants are unavailable or delayed. The finding is consistent with evidence from low- and middle-income countries. A recent systematic review involving 488 healthcare facilities across eight low- and middle-income countries identified inadequate availability of fracture-fixation equipment and implants as a major barrier to orthopedic trauma care [14]. The review also identified high implant costs, dependence on imported implants, inadequate government funding, and weaknesses in trauma-system organization as important contributors to limited access [14]. Evidence from African healthcare systems has similarly documented limitations in orthopedic trauma capacity and surgical resources [15,16,20].

Importantly, the international literature suggests that resource availability is not necessarily uniform across healthcare facilities. Tertiary and private hospitals may have greater access to orthopedic equipment and implants than smaller or lower-level facilities [14]. Although the present study included physicians from different healthcare settings, detailed hospital-level characteristics were not collected. Therefore, it was not possible to determine whether inadequate access was concentrated within particular hospital categories or geographic areas. Future research should specifically examine differences in resource availability between public and private hospitals and between primary, secondary, and tertiary facilities.

The strongest health-system finding was that 78.0% of respondents identified limited resources and hospital facilities as major barriers to fracture management. This finding is consistent with broader evidence showing that inadequate infrastructure, equipment, trained personnel, funding, transportation, and referral systems can restrict access to timely surgical care in resource-constrained settings [17,18]. The recent review of orthopedic trauma resources similarly identified shortages of equipment and fracture implants as important barriers to definitive fracture fixation [14]. In addition, Libyan orthopedic literature has highlighted the complexity of managing severe traumatic injuries, particularly in the context of conflict-related trauma, where patients may require staged damage-control procedures followed by definitive orthopedic management [19].

Nevertheless, the 78.0% figure represents clinicians' perceptions of resource limitations rather than an objective assessment of hospital capacity. These perceptions are valuable because clinicians directly experience the practical constraints of delivering trauma care, but they should not be interpreted as a formal inventory of available resources. Future

research should place particular emphasis on the objective assessment of trauma resources across Libya. Such evaluations must systematically examine the availability and functionality of critical components of orthopedic care, including implants and fixation equipment, operating-room capacity, anesthesia services, diagnostic imaging, blood products, appropriate antibiotics, and the presence of qualified orthopedic specialists supported by trained nursing and ancillary staff. Undertaking these assessments will not only highlight existing resource gaps but also provide a robust evidence base for strategic planning aimed at strengthening trauma services nationwide.

Strengths

This study has several strengths. First, it specifically examined orthopedic doctors, providing direct insight into reported fracture-management practices among clinicians involved in trauma care. Second, participants were recruited from different cities across Libya, providing perspectives from different healthcare settings. Third, the questionnaire was concise and focused on clinically relevant components of initial fracture management, including neurovascular assessment, reassessment, immobilization, and antibiotic use. Finally, the study evaluated not only reported clinical practices but also perceived health-system barriers, allowing clinical and organizational aspects of fracture care to be considered together.

Limitations

Several limitations should be considered when interpreting the findings. First, the study relied on self-reported clinical practice, which may be affected by recall bias and social-desirability bias and may not accurately represent actual clinical behavior. Second, the six-item questionnaire provided only a limited assessment of orthopedic trauma management and did not capture the full complexity of fracture care. Third, demographic and professional characteristics of respondents were not available for detailed subgroup analysis. Fourth, the study did not collect patient-level clinical outcomes; therefore, the relationship between reported clinical practices and patient outcomes could not be evaluated. Fifth, perceived resource limitations were based on clinicians' reports rather than objective hospital inventories. Sixth, the study did not collect detailed hospital-level information, limiting the ability to compare resource availability across hospital types, levels, or geographic regions. Finally, because of the cross-sectional design, causal relationships cannot be established. These limitations highlight the need for future studies combining clinician surveys with direct clinical audits, objective resource assessments, hospital-level comparisons, and patient outcome data.

Conclusion

This study identified important variations in reported initial fracture-management practices among orthopedic doctors in Libya. Initial immobilization was widely reported, whereas neurovascular assessment and reassessment following fracture reduction or splinting were less consistently reported. The greatest variation among the clinical practices assessed was observed in the reported use of early IV antibiotics for open fractures. At the health-system level, fewer than half of respondents reported adequate access to timely definitive treatment and necessary fracture implants, while 78.0% identified limited resources and hospital facilities as major barriers to fracture care.

These findings highlight the need to strengthen standardized fracture-management practices in Libya, particularly through routine pre- and post-reduction neurovascular assessment and documentation, standardized open-fracture antibiotic pathways, improved availability of essential orthopedic implants and equipment, and strengthened referral and transfer systems. Future research should combine clinician-reported data with objective assessments of hospital resources, clinical audits, and patient outcomes to provide a more comprehensive evaluation of orthopedic trauma care in Libya.

Recommendations

This study emphasizes the need for comprehensive improvements in orthopedic trauma care. Key priorities include the development of standardized protocols for assessment, reduction, neurovascular evaluation, and definitive management, alongside the reinforcement of neurovascular documentation. Clear antibiotic guidelines for open fractures are essential, as is ensuring the availability of implants and equipment in hospitals providing fracture treatment. Strengthening referral and transfer pathways will improve timely access to specialist services, while periodic clinical audits can monitor adherence to protocols. Further multicenter studies are needed to identify disparities in trauma care, supported by a national assessment of resources to quantify operating capacity, implants, imaging, anesthesia, blood products, antibiotics, and specialist staff.

Conflict of interest. Nil

References

1. Cordero DM, Miclau TA, Paul AV, Morshed S, Miclau T 3rd, Martin C, et al. The global burden of musculoskeletal injury in low and lower-middle income countries: a systematic literature review. *OTA Int.* 2020;3(2):e062. doi:10.1097/OI9.0000000000000062.
2. Agarwal-Harding KJ, von Keudell A, Zirkle LG, Meara JG, Dyer GSM. Understanding and addressing the global need for orthopaedic trauma care. *J Bone Joint Surg Am.* 2016;98(21):1844-1853. doi:10.2106/JBJS.16.00323.
3. Martin RE. Initial assessment and management of common fractures. *Prim Care.* 1996;23(2):405-409. doi:10.1016/S0095-4543(05)70285-2.

4. Faraz A, Qureshi AI, Khan MNH, Yawar B, Malik M, Saghir M, et al. Documentation of neurovascular assessment in fracture patients in a tertiary care hospital: a retrospective review. *Ann Med Surg (Lond)*. 2022;79:103935. doi:10.1016/j.amsu.2022.103935.
5. National Institute for Health and Care Excellence. *Fractures (complex): assessment and management*. NICE guideline NG37. London: NICE; 2016. Updated 2022.
6. Spitler CA, Patch DA, McFarland GE, Smith WR. Assessment and interventions for vascular injuries associated with fractures. *J Am Acad Orthop Surg*. 2022.
7. Mayne AI, Perry DC, Stables G, Dhotare S, Bruce CE. Documentation of neurovascular status in supracondylar fractures and the development of an assessment proforma. *Emerg Med J*. 2013;30(6):480-482. doi:10.1136/emmermed-2012-201293.
8. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am*. 1976;58(4):453-458.
9. Obremsky W, Molina C, Collinge C, Nana A, Tornetta P 3rd, Sagi C, et al. Current practice in the management of open fractures among orthopaedic trauma surgeons. Part A: initial management. A survey of orthopaedic trauma surgeons. *J Orthop Trauma*. 2014;28(8):e198-e202. doi:10.1097/BOT.0000000000000033.
10. Buckman SA, Forrester JD, Bessoff KE, Parli SE, Evans HL, Huston JM. Surgical Infection Society guidelines: 2022 updated guidelines for antibiotic use in open extremity fractures. *Surg Infect (Larchmt)*. 2022;23(9):817-828. doi:10.1089/sur.2022.206.
11. Puetzler J, Zalavras C, Moriarty TF, Verhofstad MHJ, Kates SL, Raschke MJ, et al. Clinical practice in prevention of fracture-related infection: an international survey among 1197 orthopaedic trauma surgeons. *Injury*. 2019;50(6):1208-1215. doi:10.1016/j.injury.2019.04.013.
12. Messner J, Papakostidis C, Giannoudis PV, Kanakaris NK. Duration of administration of antibiotic agents for open fractures: meta-analysis of the existing evidence. *Surg Infect (Larchmt)*. 2017;18(8):854-867. doi:10.1089/sur.2017.108.
13. Gumbel D, Matthes G, Napp M, Lange J, Hinz P, Spitzmüller R, et al. Current management of open fractures: results from an online survey. *Arch Orthop Trauma Surg*. 2016;136(12):1663-1672. doi:10.1007/s00402-016-2566-x.
14. ORCA Study Group. Open tibial shaft fractures: treatment patterns in sub-Saharan Africa. *OTA Int*. 2023;6(2):e228. doi:10.1097/OI9.0000000000000228.
15. Tiondi HR, Kruse C, Yan JR, Bhandari M, Petrisor B. Access to operative fracture fixation resources and implants in orthopaedic trauma care in low- and middle-income countries: a systematic review. *OTA Int*. 2026;9(1):e461. doi:10.1097/OI9.0000000000000461.
16. Chokocho L, Jacobsen KH, Burgess D, Labib M, Le G, Lavy CBD, et al. Trauma and orthopaedic capacity of 267 hospitals in east, central and southern Africa. *Lancet*. 2015;385(Suppl 2):S17. doi:10.1016/S0140-6736(15)60812-1.
17. Stephens T, Mezei A, O'Hara NN, Potter J, Mugarura R, Blachut PA, et al. When surgical resources are severely constrained, who receives care? Determinants of access to orthopaedic trauma surgery in Uganda. *World J Surg*. 2017;41(6):1415-1419. doi:10.1007/s00268-017-3874-1.
18. Grimes CE, Bowman KG, Dodgion CM, Lavy CBD. Systematic review of barriers to surgical care in low-income and middle-income countries. *World J Surg*. 2011;35(5):941-950. doi:10.1007/s00268-011-1010-1.
19. Whitaker J, O'Donoghue N, Denning M, Poenaru D, Guadagno E, Leather AJM, et al. Assessing trauma care systems in low-income and middle-income countries: a systematic review and evidence synthesis mapping the Three Delays framework to injury health system assessments. *BMJ Glob Health*. 2021;6(5):e004324. doi:10.1136/bmjgh-2020-004324.
20. Khalefa WF, Alkasah AM. Strategies for Mitigating Complications in High-Risk Trauma: A Cross-Sectional Study of Surgical and Orthopaedic Decision-Making. *Alqalam Journal of Medical and Applied Sciences*. 2026 Jan 8:52-7.
21. Jin J, Akau'ola S, Yip CH, Nthumba P, Ameh EA, de Jonge S, et al. Effectiveness of quality improvement processes, interventions, and structure in trauma systems in low- and middle-income countries: a systematic review and meta-analysis. *World J Surg*. 2021;45(7):1982-1998. doi:10.1007/s00268-021-06065-9.
22. Meara JG, Leather AJM, Hagander L, Alkire BC, Alonso N, Ameh EA, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet*. 2015;386(9993):569-624. doi:10.1016/S0140-6736(15)60160-X.