Continuity of Operating Room Services during the 2023-2025 War on Gaza - A Qualitative Case Study of Al-Ahli Arab Hospital

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DOI: https://doi.org/10.51244/IJRSI.2026.1315PH00147

Received: 19 July 2026; Accepted: 24 July 2026; Published: 31 July 2026

ABSTRACT

War conditions pose substantial and critical challenges to the healthcare system, especially in resource-limited settings. Based on the importance of operating rooms as critical and lifesaving health services, particularly in conflict settings characterised by mass casualties, resource shortages, infrastructure disruption, and difficulties in referral and coordination. This study aimed to explore the continuity of operating room services at Al-Ahli Arab Hospital during the 2023 to 2025 war on Gaza. It employed a qualitative approach and relied on semi-structured interviews with six selected participants associated with operating room services and related support positions. The data were analysed using thematic analysis to identify the main patterns and themes related to the continuity of surgical services during the war.

This study contributes to the literature by demonstrating that surgical continuity in conflict settings is not merely a technical medical issue but fundamentally a health economics challenge involving extreme scarcity, opportunity cost, and resource allocation under pressure. The findings reveal that while agile resilience and human endurance kept the operating room functioning, this was achieved through daily improvisation, task-shifting, and the repurposing of non-clinical spaces—raising critical questions about the sustainability of relying on heroic staff efforts as a substitute for systemic preparedness.

The results suggest that the operating room services were neither normal nor stable. In contrast, it was fragile and conditional on the ability of health teams to adapt to resource scarcity, security pressure, and operational constraints. The operating room shifted from a relatively scheduled surgical service to an emergency war-response service focused mainly on lifesaving cases. Shortages of fuel, electricity, anaesthesia medications, blood, oxygen, surgical supplies, sterilisation materials, and staff emerged as central factors shaping critical operational decisions. We conclude that the continuity of operating room services in conflict settings requires an integrated preparedness system. It should control critical resources, develop surgical triage protocols, improve referral and communication systems, support health workers, and strengthen infection prevention and control. Crucially, true service continuity cannot depend indefinitely on the adaptive capacity and suffering of health workers; it must be built on robust systemic protocols that remove the ethical burden from individual clinicians and ensure that surgical capacity is sustained through institutional preparedness rather than individual heroism.

Keywords: Health Service Continuity, Operating Room, War On Gaza, Al-Ahli Arab Hospital, Health Economics, Qualitative Research, Resource Allocation, Health Emergencies.

INTRODUCTION

Background

The continuity of health services during wars and prolonged crises is a central issue in health system management. It is not only about whether health institutions remain open, but also about their ability to provide essential and lifesaving services under unstable conditions, limited resources, and ongoing security risks (WHO, 2024; UN,

2024). This issue becomes even more important when it involves surgical services and operating rooms, which are among the most sensitive and complex components of health care. Operating room services depend on an interconnected system that includes surgeons, anaesthesia, nursing, sterilisation, blood, oxygen, electricity, fuel, surgical supplies, and continuous coordination with emergency departments, administration, and supply units (International Committee of the Red Cross, 2013).

During the 2023 war on Gaza, the health system faced exceptional pressure due to damage to health facilities, disruption of parts of the infrastructure, shortages of medical supplies, limited electricity and fuel, difficulty in referral, population displacement, and increased demand for emergency and surgical services. The reality of the Gaza health sector during this period reflects a systemic collapse masked by the heroic efforts of remaining health workers (Migdad et al., 2025; Jaser et al., 2026).

In May 2025, the WHO reported that only a limited number of hospitals in the Gaza Strip remained functional and that a large proportion of hospitals had been damaged or destroyed. This reflects the scale of structural and operational pressure placed on the health system (WHO, 2025).

The broader public health impact of the war, including the destruction of health infrastructure, displacement of populations, and disruption of preventive services, has created unprecedented challenges that require comprehensive recovery pathways (Al Bakri et al., 2025). Under such conditions, the continuity of operating room services is not merely a technical issue. It becomes an administrative, ethical, and humanitarian challenge, as health teams are forced to make complex decisions regarding case prioritisation, resource rationing, protection of patients and staff, and maintenance of a minimum level of surgical capacity.

Al-Ahli Arab Hospital represents an important case for studying this phenomenon, given its continued provision of health services in Gaza City during a period marked by insecurity, evacuation pressures, and documented incidents affecting the hospital and its surroundings. Although international reports have documented several aspects of damage to the health system in Gaza, they do not sufficiently explain how surgical services continue inside operating rooms in daily practice, nor how health workers and administrators adapt to resource shortages, security pressure, and the heavy burden of emergency cases. Alkhaldi et. al. (2026)

Problem Statement and Main Research Question

The war on Gaza created a highly complex health environment in which hospitals were forced to continue providing life-saving services despite damage to health infrastructure, evacuation pressures, insecurity, staff shortages, and severe restrictions in fuel, electricity, medications, and medical supplies. In this environment, operating room services became among the most vulnerable services (WHO, 2024).

International reports have documented attacks on Gaza's healthcare facilities and the rapid decline in hospital operational capacity. In contrast, there remains limited knowledge about how critical hospital departments such as the operating rooms maintain their essential services in daily practice. This gap is particularly clear where service continuity requires rapid and ethically complex decisions regarding the prioritisation of surgical cases, resource rationing, infection prevention, staff safety, and emergency response under intense pressure, Alkhaldi et. al. (2026). The main research question is: How was the continuity of operating room services maintained at Al-Ahli Arab Hospital during the 2023 to 2025 war on Gaza?

The following sub-questions guided our investigations:

1. What were the main operational challenges that affected the continuity of operating room services during the war?

2. How were emergency surgical cases prioritised and managed during mass casualties, overcrowding, insecurity, and resource scarcity?

3. What coping strategies and temporary solutions were used to maintain operating room services?

4. What professional, psychological, and ethical challenges did health workers face while maintaining surgical services during the war?

Significance of the Study

This study focused on a critical health service in the context of a prolonged war. At the scientific level, the study contributes to the literature on health service continuity in conflict settings by providing a focused qualitative analysis of sensitive surgical services continuity in the operating room under exceptional conditions. Furthermore, the findings can help hospital administrations, emergency planners, health organisations, humanitarian actors, and decision-makers understand the critical requirements for surgical service continuity. From a health economics perspective, it examines how priorities are set and how scarce health resources are managed during crises.

Study Objectives and Research Questions

The general objective of this study was to explore the continuity of operating room services at Al-Ahli Arab Hospital during the 2023 to 2025 war on Gaza, with a focus on operational challenges, resource constraints, coping strategies, decision-making mechanisms, and lessons learned for maintaining surgical service continuity in armed conflict and disaster settings.

The specific objectives are:

- To identify the main operational challenges that affected the continuity of operating room services.
- To explore the impact of shortages in essential resources on the delivery of surgical care.
- To understand how emergency surgical cases were prioritised under conditions of scarcity.
- To describe the coping strategies and temporary solutions used by staff.
- To develop practical recommendations to strengthen operating room preparedness during crises.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

The literature on health service continuity in conflict settings emphasises the ability of health facilities to maintain a minimum level of essential functions despite security and logistical shocks. In conflict contexts, the question is not only whether a health facility is open, but also whether it can provide safe and effective care despite disrupted supplies, staff shortages, movement restrictions, referral difficulties, and high numbers of casualties. The literature on health emergency and disaster risk management also emphasises that preparedness, response, and recovery must be part of an integrated system designed to protect health and save lives during emergencies (WHO, 2019).

Operating rooms are among the most resource-dependent hospital services. They require continuous availability of electricity, fuel, anaesthesia medications, oxygen, blood, sterile instruments, antibiotics, surgeons, anaesthesia teams, nursing staff, and coordination with emergency departments. During war, any disruption in these inputs can reduce surgical capacity, delay life-saving interventions, or force medical teams to make difficult decisions regarding priorities (International Committee of the Red Cross, 2013). The disruption extends beyond surgical services to other critical lifelines; for example, the collapse of cardiac catheterization services during the war demonstrates how the loss of specialised interventional capabilities creates cascading effects on surgical and emergency care systems (Alaff et al., 2026).

From a health economics perspective, the operating room represents a clear site of scarcity and resource allocation. When the demand for surgery exceeds available capacity, clinical decisions become linked to economic and ethical questions at the same time. Which patient should receive the resource first? Which case can be delayed? How can fuel, anaesthesia, or blood be used to achieve the greatest possible health benefit? How can fairness and patient safety be preserved under severe resource shortages?

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue XV July 2026 | Issue on Public Health

The study emphasises the concept of health system resilience, which refers to the ability of a health institution to absorb shocks, adapt to changing conditions, and continue delivering essential services. In this study, resilience appears through work reorganisation, use of temporary alternatives, priority adjustment, role redistribution, and coordination between departments. However, resilience does not mean the absence of fragility. In some cases, it reflects the ability of health workers to endure and adapt despite weak resources.

Accordingly, the conceptual framework of this study assumes that the continuity of operating room services during war is influenced by five interconnected elements: security and environmental constraints, resource constraints, organisational and administrative capacity, coping strategies, and decision-making under pressure (WHO, 2025). Together, these elements affect the level of surgical service continuity, whether through maintaining emergency surgeries, reducing interruptions, reorganising services, or experiencing partial disruption in some functions.

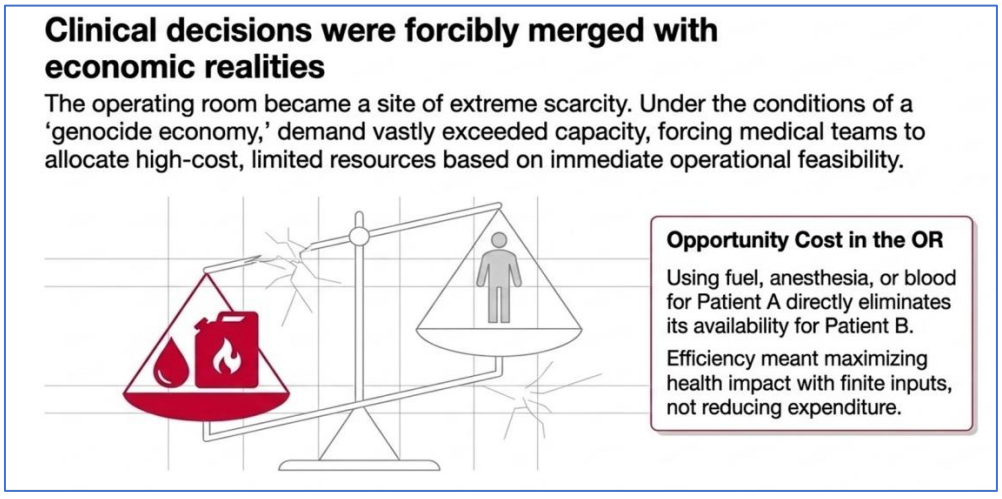
Health Economics Implications of The Study

This study has particular importance from a health economics perspective because it examines the operating room as one of the health services most dependent on scarce and high-cost resources. The continuation of surgical work during war does not depend on a medical decision alone. It also depends on the availability of a chain of critical resources, including fuel, electricity, anaesthesia medications, blood, oxygen, surgical supplies, sterilisation materials, and specialised staff. When these resources become limited, the operating room becomes a clear space for applying health economics concepts, especially resource allocation, priority setting, efficiency, equity, and opportunity cost (Drummond, M. F., et al., 2015).

In the context of war, the demand for surgical interventions was greater than the available capacity. This forced health teams to make difficult decisions about how to use limited resources. For example, using fuel, blood, or anaesthesia medications for one case may reduce their availability for another case. This reflects the concept of opportunity cost. Prioritising lifesaving and limb-saving cases also represents a practical application of maximising health benefit under scarcity, while attempting to preserve fairness and patient safety (International Committee of the Red Cross, 2013).

Figure (1) shows that during genocide on Gaza's operating rooms, clinical decisions were forcibly merged with economic realities as extreme scarcity turned every surgical intervention into a high-stakes resource allocation problem. Under the conditions of a 'genocide economy,' using fuel, anaesthesia, or blood for one patient carried an immediate opportunity cost—eliminating its availability for another—forcing teams to maximise health impact with finite inputs rather than simply reducing expenditure.

Figure (1)



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The efficiency of resources during crises does not simply mean reducing expenditure. Rather, it means using limited resources in a way that achieves the greatest possible health impact. Therefore, the continuity of operating

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue XV July 2026 | Issue on Public Health

room services in conflict settings requires decisions based on clinical need, the likelihood that the patient will benefit from the intervention, resource availability, and the team's ability to provide safe care. In this sense, the results not only describe an operational experience during war but also provide insight into how scarce health resources are managed in an environment where demand exceeds available capacity.

METHODOLOGY

Study Design

This study used a single qualitative case study design because it aimed to understand a complex phenomenon within its real-life context: the continuity of operating room services at Al-Ahli Arab Hospital during the 2023 to 2025 war on Gaza. The case study design was appropriate because it allowed an in-depth understanding of how surgical services continued within a specific health institution exposed to severe security, operational, and humanitarian pressures.

The interviews were conducted at Al-Ahli Arab Hospital in Gaza City, with a focus on the operating room and directly related supporting services, such as anaesthesia, sterilisation, medical supplies, pharmacy support, coordination with the emergency department, blood availability, oxygen, electricity, fuel, and operational administration. The study did not aim to measure the number of operations or quantitatively evaluate surgical outcomes. Instead, it sought to understand the operational experience from the perspective of workers who participated in providing or supporting surgical services during the war.

Sample and Data Collection

The study population included all the healthcare providers who worked in the operation department at AL Ahli Arab Hospital in Gaza during the Gaza war in 2023. On the other hand, the sample included surgeons and anaesthetists. Some of the participants conducted both clinical and administrative perspectives. Participants were selected based on their direct practical experience in the operating room supporting operating room services during the war and were exposed to daily challenges, using a convenience sampling method. The sample size was considered depending on the aim, which was to obtain an in-depth understanding of a specific experience within its real-life context.

Semi-structured interviews were used as the main data collection tool. The interview guide included open-ended questions about the participant's role during the war, the impact of the war on operating room services, operational challenges, resource shortages, priority setting and decision-making, coordination between departments, coping strategies, the impact of the war on staff and patients, and lessons learned. The guide was used flexibly, allowing participants to describe their professional experiences freely.

Data Analysis

The interview data were transcribed using Whisper AI (WhisperAI, 2026) and analysed using thematic analysis in NVivo 15 (Lumivero, 2025) to identify recurring patterns and meanings in participants' experiences regarding the continuity of operating room services. The analysis began with repeated reading of the interview texts to develop a general understanding of the data and its context. Relevant statements were then extracted in relation to the study questions, such as fuel and electricity shortages, pressure from injuries, staff shortages, priority setting, sterilisation difficulties, weak referral and communication systems, and coping strategies.

The themes were reviewed to ensure their consistency with the interview data, the study objectives, and the research questions. Selected quotations from participants were used to support the findings, while any names or information that could reveal the identity of participants, patients, or workers were removed.

Ethical Considerations And Trustworthiness

Given the sensitivity of the study topic and its connection to war and health care work under complex security and humanitarian conditions, ethical considerations were handled before conducting the interviews. The purpose of the study was explained to participants, along with the nature of participation and the right to refuse to answer

any question or withdraw at any time. Confidentiality was also emphasised, and no names or identifying details of participants, patients, or workers were used.

Participants were coded using identifiers such as P1, P2, and P3 instead of real names. The study also avoided presenting any sensitive security information that could place participants, the hospital, or medical teams at risk. Trustworthiness was strengthened through the selection of participants with direct experience, comparison of participants' perspectives within the same themes, documentation of the analytical steps, and linking the findings to the data and selected quotations. Although the sample size was limited, the interviews provided rich and focused data because they came from within the surgical service chain itself.

RESULTS

The thematic analysis showed that the continuity of operating room services at Al-Ahli Arab Hospital during the war was neither stable nor normal. Rather, it was linked to the ability of health teams to adapt to resource shortages, pressure from injuries, security risks, weak referral and communication systems, and expanded staff roles. The findings were organised around four main themes that bring together the detailed themes emerging from the interviews.

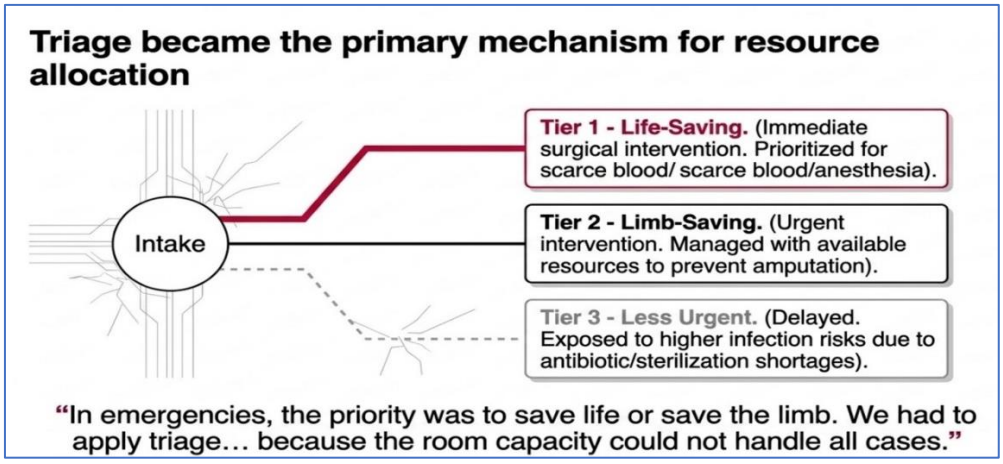
Theme One: The Transformation of the Operating Room's Function During The War

The interviews showed that the war caused a fundamental transformation in the function of the operating room. Before the war, the service was closer to an organised or scheduled pattern, where surgeries were arranged according to a relatively defined schedule. During the war, however, the operating room turned into an emergency response centre for war-related injuries, especially bleeding cases, complex orthopaedic injuries, open wounds, and cases in which delay could threaten life or limb.

"Before the war, most operations were scheduled, but during the war the operating room became a main emergency centre, and emergency cases and complex injuries requiring urgent intervention increased." P5. This transformation shows that the continuity of service was no longer measured by the regularity of surgical schedules. Rather, it was measured by the department's ability to receive emergency injuries, triage cases, and provide the minimum life-saving surgical intervention.

Figure (2) since Oct 2023 triage in Gaza's hospitals became the primary mechanism for resource allocation, with surgical cases stratified into three tiers—life-saving (prioritized for scarce blood and anesthesia), limb-saving (urgent interventions to prevent amputation), and less urgent cases (delayed and exposed to higher infection risks). This structured prioritization system was essential because operating room capacity could not handle all cases simultaneously, forcing teams to make ethically difficult decisions about who would receive limited surgical resources first.

Figure (2)



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ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue XV July 2026 | Issue on Public Health

The fragile nature of the operating room's continuity, where each day brought new threats of collapse, reflects a system operating under conditions of creative destruction. Buheji (2025) proposes an anti-fragility framework that suggests disruptions, while destructive, can be harnessed to build systems that not only withstand shocks but improve through them. However, the Gaza operating room experience shows that without adequate systemic support, fragility overwhelms adaptive capacity, preventing the transition to anti-fragility.

The reduction or loss of operational capacity in other health facilities also increased the burden on Al-Ahli Arab Hospital, causing the operating room to function under pressure that exceeded its normal capacity.

Figure (3) illustrate how before the war, Al-Ahli Arab Hospital's operating rooms functioned as a scheduled surgical service with three standard rooms and organized daily schedules for elective and standard care. During the war, they transformed into an emergency war-response center, expanding to five rooms by repurposing non-clinical spaces and operating 24/7 across three shifts to handle mass casualties, strictly focusing on life and limb-saving cases.

Figure (3)

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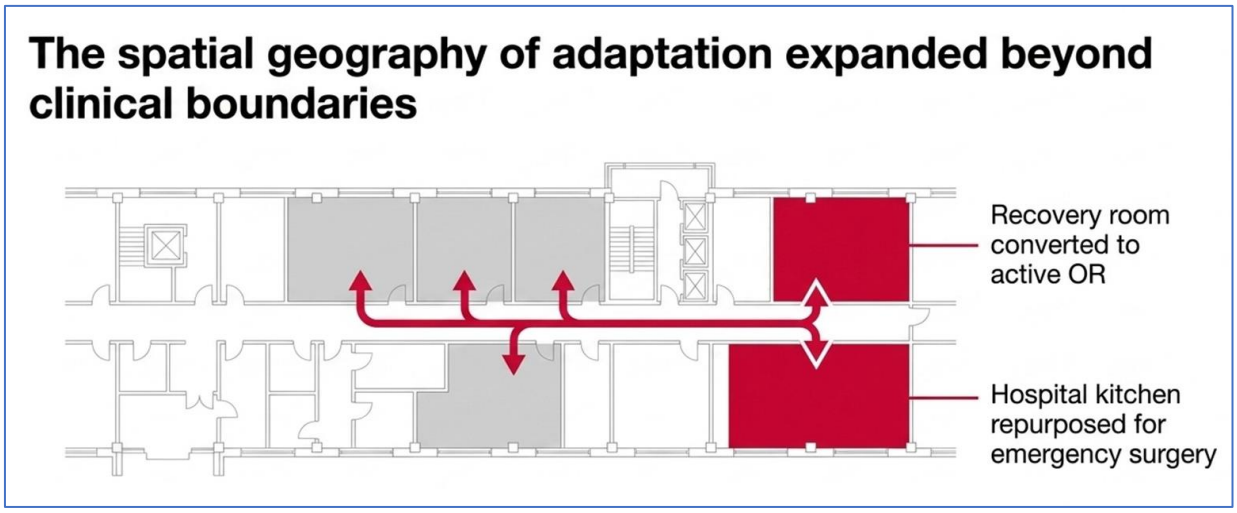
“At one point, we were working in five rooms: three original operating rooms, the recovery room was converted into an operating room, and the nearby kitchen was also converted into an operating room. We also had to work in three shifts to cover all emergency cases.” P1. This quotation demonstrates that the continuity of service depended on repurposing available spaces and temporarily expanding operational capacity. It also shows that the operating room did not function during the war according to its normal pattern but was reshaped to fit the reality of mass casualties and the increased demand for surgical intervention.

Figure (4) how the adaptation spatial geography extended far beyond traditional clinical boundaries, as non-clinical spaces like the recovery room and hospital kitchen were repurposed into active operating rooms to expand surgical capacity. This creative reconfiguration, combined with round-the-clock shift work, enabled the team to maintain life-saving services despite the destruction of infrastructure and the overwhelming influx of mass casualty cases.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue XV July 2026 | Issue on Public Health



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Theme Two: Resource Constraints and Allocation from a Health Economics Perspective

Resource shortages emerged as the most influential factor affecting the continuity of operating room services. Participants repeatedly referred to shortages of fuel, electricity, anaesthesia medications, blood, oxygen, antibiotics, surgical supplies, sterilisation materials, and staff. These constraints did not appear as separate problems, but as an interconnected chain in which the shortage of one component could affect the capacity of the entire operating room.

“Shortages of electricity and fuel were among the most dangerous factors threatening the continuity of operating room work, because operating the rooms depended on the availability of power and functioning devices.” P6. From a health economics perspective, this finding represents a clear case of severe scarcity in critical health resources. Operating rooms require high-value and limited resources, and when demand exceeds available capacity, health teams are forced to allocate these resources according to clinical priority and operational feasibility. Therefore, the surgical decision was not related only to the patient’s need but also to the availability of anaesthesia, blood, oxygen, electricity, sterilisation, and staff.

“The shortage of anaesthesia medications negatively affected patients, and the use of some medications was reduced. Anaesthesia machines were also used for long periods without sufficient oxygen, and the shortage of antibiotics led to increased wound infections.” P3. This quotation shows that resource shortages affected not only the number of operations performed but also the quality of care and patient safety. Continuing to provide services under shortages of anaesthesia, oxygen, or antibiotics may preserve a minimum level of surgical intervention, but it also increases the risk of complications and makes patient safety more fragile. The destruction of supporting infrastructure, including medical laboratories, further compounds these challenges by increasing the 'cost of illness' through delayed diagnoses, inability to monitor patients, and reduced capacity to manage complications (Ahmed et al., 2026).

Theme Three: Priority Setting And Coping Strategies

The findings showed that priority setting was a central mechanism for maintaining the minimum level of surgical service, especially when the number of cases exceeded the operating room’s capacity. The teams relied on surgical triage, giving priority to lifesaving and limb-saving cases, while delaying less urgent cases or those that could wait without immediate risk.

“In emergencies, the priority was to save life or save the limb. We had to apply triage and choose the patient most in need of entering the operating room, because the room capacity could not handle all cases.” P1. This quotation shows that triage was not merely an administrative procedure. It was both a clinical and ethical decision. Under limited resources, teams faced a difficult balance between injury severity, the likelihood of benefiting

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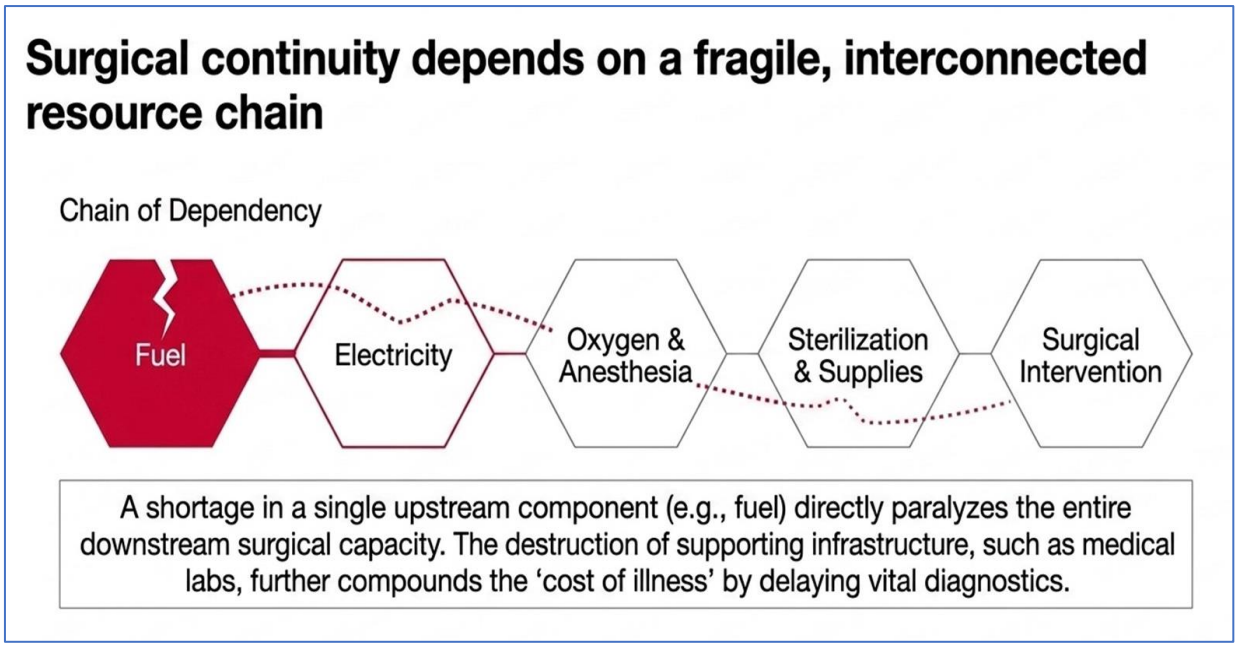
from surgery, resource availability, and urgency of intervention. This reflects how operating room continuity during war depended on the ability of teams to make difficult decisions under pressure.

“We tried to arrange patients according to priority, organise staff according to their ability to work, and find alternatives for instruments when the original tools were not available.” P5. In addition to priority setting, teams used several coping strategies, including resource rationing, temporary alternatives, redistribution of roles, adjustment of work schedules, and cooperation between surgeons, anaesthesia staff, and technicians. Although these strategies helped maintain services, they also revealed the fragility of the situation and the dependence of service continuity on daily and uncertain solutions.

“During the war, our role changed. Sometimes we covered the doctor’s role, sometimes the technician’s role, helped open instruments in a sterile way, and participated in transferring the patient and preparing the bed.” P4. This quotation shows that maintaining the service required staff to perform multiple roles beyond their usual job descriptions. This helped keep the work going but also increased the professional and physical burden on teams and highlighted the need for prior training in flexible emergency work.

Figure (5) show how the surgical continuity at Al-Ahli Arab Hospital depended on a fragile, interconnected resource chain where a shortage in any single upstream component—such as fuel, electricity, oxygen, anesthesia, sterilization, or supplies—could directly paralyze the entire downstream surgical capacity. The destruction of supporting infrastructure, including medical laboratories, further compounded the 'cost of illness' by delaying vital diagnostics and increasing the risk of complications, making the operating room's functionality highly vulnerable to systemic disruptions.

Figure (5)



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Theme Four: The Impact of War on Staff, Patients, And Lessons Learned

The result showed that operating room staff and supporting teams were among the most important elements of service continuity, but they were also among the most exposed to pressure. They faced physical exhaustion, psychological stress, fear, difficulty reaching the hospital, staff shortages, and expanded professional roles. This means that health workers were not simply providers of care; they were a critical resource on which surgical service continuity depended.

“We used to walk long distances to reach the hospital, sometimes around fifteen kilometres going and returning, and then we would start work while exhausted and under great pressure.” P2.

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The psychological toll on healthcare workers extends beyond exhaustion to include moral injury, as staff are forced to make impossible decisions about resource allocation and patient prioritisation (Buheji, 2025a). The broader economic context—transitioning from an occupation economy to what has been described as a genocide economy—has fundamentally altered the conditions under which healthcare is delivered (Buheji, 2025b). Understanding the tension between economies of resilience and resistance helps explain how health workers continue to function despite overwhelming odds (Buheji, 2025c).

Patients were also directly affected by resource shortages, weak referral systems, and overcrowding. Shortages of blood, anaesthesia, and oxygen delayed some operations, while overcrowding and shortages of sterilisation materials and antibiotics increased the risk of infection and complications. Therefore, operating room continuity cannot be evaluated only by whether surgeries continued to be performed. It must also be evaluated through the quality of care and patient safety. The war's impact on vulnerable populations, particularly children, extends beyond surgical care to include widespread malnutrition, which further complicates surgical outcomes and recovery (Ashour et al., 2025a; Fetaiha et al., 2026).

“Shortages of blood and anaesthesia tools affected the patient’s entry into the operating room. Sometimes the patient was bleeding, and there was not enough blood, so we had to wait until blood became available.” P4 and “The continuity of the operating room was linked to the availability of basic capacities, such as fuel, staff, fixation tools, and medical consumables. When any of these resources was lacking, the service was directly affected.” P5. The lessons learned indicate that operating room preparedness in conflicts and disasters must be more robust than regular hospital emergency plans. Surgical services require a dedicated stock of critical resources, clear surgical triage protocols, alternative communication and referral systems, and mechanisms to support staff and protect them from exhaustion and burnout.

DISCUSSION

The distinction between formal and functional continuity in conflict- and resource-limited settings is a critical condition that describes the effect of healthcare infrastructure destruction on institutional performance, patient survival, and health service quality. A department may remain open, but its actual ability to provide safe and effective surgical interventions depends on the availability of an interconnected chain of resources and supporting functions. Furthermore, resilience does not only depend on physical infrastructure but also on leadership and adaptation (Truppa et al, 2026). Consequently, the conflict reduces workforce capacity and limits healthcare delivery (Martineau et al., 2017).

Our results are consistent with the literature on health service continuity in crises, which emphasises that keeping a health facility open does not necessarily mean that it can provide safe and effective services. Moreover, Pavignani et al. 2014 demonstrate that facilities often continue operating during conflict; they experience a shortage of medicines, medical staff, information systems, and financing that severely affect performance. From the perspective of health emergency and disaster risk management, service continuity depends on resource availability, staff readiness, internal coordination, referral systems, and the ability to adapt to sudden shocks (WHO, 2019). This aligns with the findings of the current study, where operating room continuity was not linked solely to the existence of the department but also to the availability of critical resources such as fuel, electricity, anaesthesia, blood, oxygen, sterilisation, and staff.

Our findings align with humanitarian response principles that emphasise the importance of maintaining essential and lifesaving services in conflict and disaster settings, while respecting human dignity and equity in access to care (Sphere Association, 2018). This was clearly reflected in the prioritisation of surgical cases, where teams focused on lifesaving and limb-saving cases. This shows that surgical decision-making during war was not only a medical decision but also an ethical and economic one, because it involved distributing limited resources among many patients in need. The unprecedented humanitarian impact of the war on Gaza's public health system, as documented in recent analyses, underscores the urgency of strengthening surgical service continuity as part of broader health system resilience (Ashour et al., 2025b).

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The findings support the concept of health system resilience. The team demonstrated the limited ability to reorganise work, using temporary alternatives, redistributing roles, and rationing resources. However, this resilience does not mean that the system was stable or sufficient. Rather, it also reveals the fragility of the work environment and its dependence on emergency solutions. Therefore, resilience in this study should be understood as the ability of workers to endure and adapt under severe shortages, not as evidence of a health system capable of an ideal response. This reflects the broader analysis of health risks during the war, which emphasises that healthcare workers operate 'in the crossfire' of multiple intersecting threats—physical, operational, psychological, and systemic (Shorrab et al., 2024).

The fragile situation in the operating rooms—where continuity depended on daily improvisation, temporary alternatives, and the constant threat of service collapse—exemplifies a context that requires not just resilience but an 'anti-fragility' framework. Buheji (2025d) argues that creative destruction, while disruptive, can create opportunities for building systems that absorb disruption and chaos, transforming vulnerability into adaptive capacity. In the Gaza operating room context, this suggests that the extreme pressure forced teams to develop innovative solutions that could inform future surgical preparedness, yet this potential was constrained by the severity and duration of resource shortages. Without systemic support, the fragility of the operating room environment risks overwhelming the adaptive capacity of health workers, preventing the transition from mere survival to genuine anti-fragility. Jaser et al. (2026)

This aligns with the concept of 'agile resilience' in the Gaza context, where healthcare workers demonstrate adaptive capacity despite systemic fragility (Buheji & Mushimiyimana, 2023). Addressing human factors, including psychological support and workforce wellbeing, remains critical for sustaining resilience without leading to burnout or resilience fatigue (Buheji, 2024a; Buheji, 2024c).

From a health economics perspective, the study provides an important insight by showing that the operating room during war becomes a practical site for applying the concepts of scarcity, resource allocation, opportunity cost, and efficiency. When fuel, blood, or anaesthesia medications are used for one case, their availability for another case may be reduced. Therefore, priority setting was not simply an organisational procedure. It was a mechanism for allocating scarce resources in a way that aimed to achieve the greatest possible health benefit while preserving equity and patient safety. This aligns with recent work examining how the war on Gaza has created new necessities for healthcare insurance development, particularly in how risk pooling and resource mobilisation mechanisms must adapt to conflict-induced healthcare needs (Abu Nada et al., 2026).

Emphasising that health services in crises cannot be maintained through physical infrastructure alone. They require a preparedness system that includes resources, staff, communication, referral, leadership, and infection control. Surgical priority setting and triage should not be left only to individual judgment under pressure. Instead, they require clear protocols that support health teams and reduce their ethical and professional burden. This is consistent with the WHO technical package on quality of care in fragile, conflict-affected and vulnerable settings, which highlights the need for systematic approaches to maintaining care standards even under extreme conditions (WHO, 2021).

Thus, systemic protocols, such as shown in Figure (6), like standardized surgical triage based on injury severity, resource availability, and likelihood of benefit, are essential to remove the ethical burden from individual surgeons and shift the weight of difficult decisions to a systemic standard. Establishing alternative, offline communication and referral networks further strengthens surgical continuity by ensuring patient transfers can be coordinated even when telecommunications and roads are destroyed.

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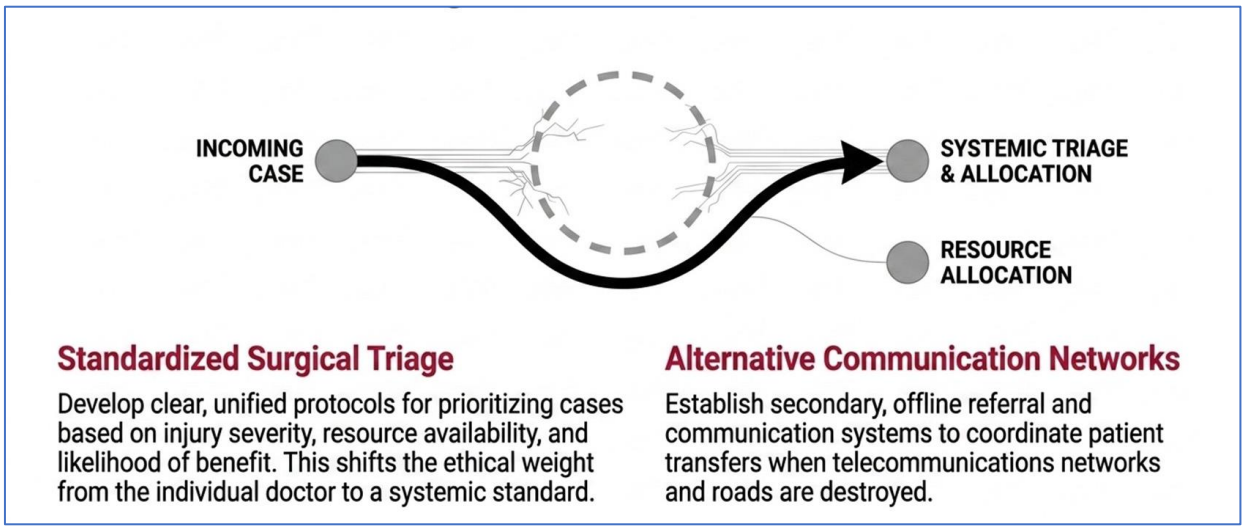
Figure (6)



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One strength of this study is that it relied on direct experiences from workers within the surgical service chain. This provided a practical understanding of how the operating room continued to function under war conditions. However, the study also has limitations. It is a single case study in one hospital; the sample size is limited, and the sample was concentrated in orthopaedic surgery, anaesthesia, and anaesthesia technicians. In addition, the data depended on participants' accounts in a context of war and psychological and security pressure. Therefore, the findings should be understood as an in-depth qualitative interpretation rather than a statistical generalisation.

Despite these limitations, the study provides clear practical value. It shows that operating room continuity in conflict settings is not only a medical issue but also an administrative, economic, and ethical issue. It requires continuous balancing between clinical need, resource availability, the chance of saving life or limb, patient safety, and the ability of health workers to continue. These findings provide a basis for developing more realistic plans for the continuity of surgical services in conflicts and disasters.

CONCLUSION

The continuity of operating room services at Al-Ahli Arab Hospital during the ongoing war in Gaza in 2023 was not stable but fragile and conditional on health teams adapting to severe resource shortages, high trauma burden, security concerns, and weak referral and communication systems. The operating room shifted from a scheduled elective service to an emergency war response unit focused on lifesaving procedures. So many challenges, including shortage of fuel, electricity, anaesthesia drugs, oxygen, blood, surgical supplies, sterilisation materials, and staff, were central determinants of clinical, administrative, and ethical decision-making. From a health economics perspective, the operating room is where decisions are shaped by efficiency, equity, and the need to maximise health benefits under extreme demand and limited capacity.

The study demonstrates that the operating room became a site where clinical decisions were forcibly merged with economic realities, as extreme scarcity turned every surgical intervention into a high-stakes resource allocation problem. The triage system—stratifying cases into life-saving, limb-saving, and less urgent categories—emerged as the primary mechanism for allocating scarce resources, reflecting a practical application of health economics principles under the most extreme conditions.

The continuity of services depended on staff resilience, work reorganisation, priority setting, task shifting, intradepartmental cooperation and temporary solutions. However, this resilience highlighted the fragility of the system, as continuity remained dependent on the minimum available resources. Accordingly, the study emphasises that strengthening operating room continuity in conflict settings requires an integrated preparedness approach, including securing essential supplies, developing surgical triage protocols, improving referral and communication systems, supporting health workers, activating infection control and prevention protocols and

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue XV July 2026 | Issue on Public Health

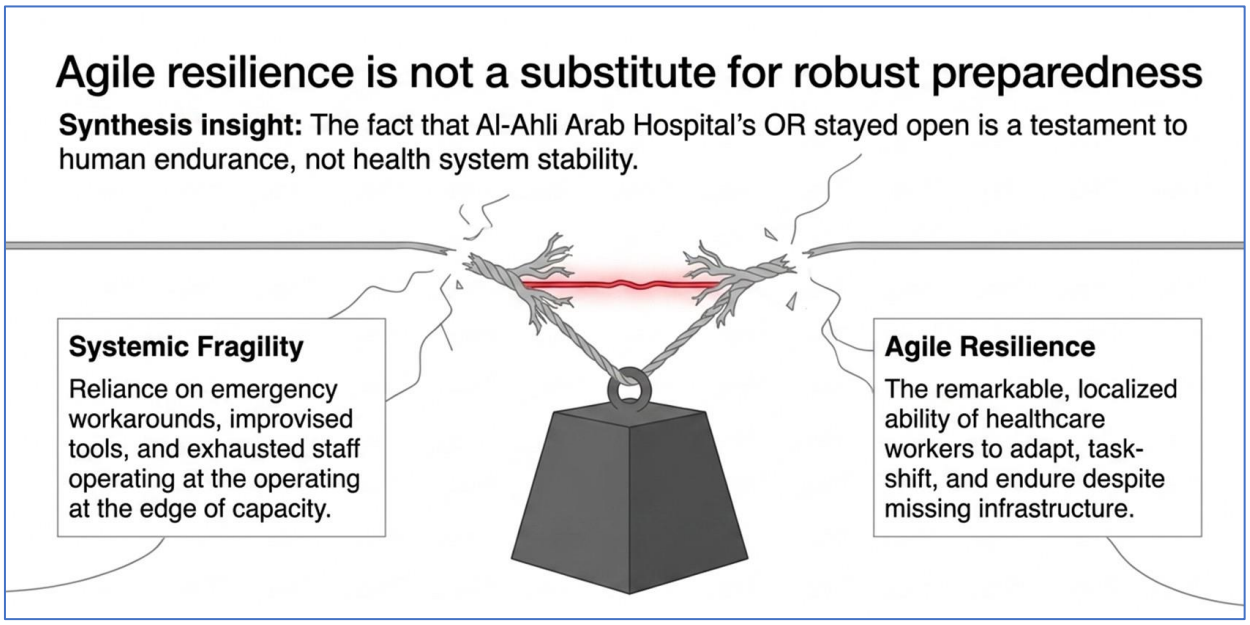
strengthening patient safety. This study provides a suggestion and a realistic plan for sustaining surgical services in war-affected settings.

A key insight from this study is the distinction between agile resilience—the remarkable, localized ability of healthcare workers to adapt, task-shift, and endure despite missing infrastructure—and systemic preparedness, which requires institutional protocols, resource stockpiles, and support systems that function independently of individual heroism. The fact that Al-Ahli Arab Hospital's operating room remained open is a testament to human endurance, not health system stability. Without addressing the underlying systemic fragility, future conflicts will continue to place unacceptable burdens on health workers operating at the edge of capacity.

The fact that Al-Ahli Arab Hospital's operating room remained open during the war is a testament to human endurance and agile resilience, but as Figure (7) illustrates the remarkable ability of healthcare workers to adapt, task-shift, and improvise despite missing infrastructure—rather than evidence of health system stability. However, this agile resilience is not a substitute for robust preparedness, as true service continuity cannot rely indefinitely on the heroic suffering of exhausted medical staff operating at the edge of capacity with systemic fragility.

This study provides a realistic plan for sustaining surgical services in war-affected settings—one that moves beyond reliance on individual sacrifice toward building anti-fragile systems that absorb disruption and chaos, transforming vulnerability into adaptive capacity through structured preparedness rather than daily improvisation.

Figure (7)



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RECOMMENDATIONS

Based on the findings of the study, the following recommendations are proposed to improve the continuity and resilience of operating room services in conflict settings.

At the Hospital Level

Develop a specific emergency plan for operating rooms as part of the general hospital emergency plan, but with more specific attention to the needs of surgical services. In addition, the emergency plan should include mechanisms for operating the operating room during fuel shortages, electricity cuts, shortages of anaesthesia medications, blood shortages, or disruption of communication and referral systems. The study also recommends organising staff shifts, if possible, in a way that reduces exhaustion and strengthens infection prevention

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procedures inside operating rooms and related areas, especially under conditions of overcrowding and shortage of sterilisation materials.

Hospitals should develop minimum essential resource packages for operating rooms during emergencies, specifying baseline quantities of fuel, electricity backup, anaesthesia medications, blood products, oxygen, sterilisation materials, and surgical supplies needed to sustain life-saving surgical capacity for a defined period. Regular simulation exercises should test the operating room's ability to function under extreme scarcity conditions, including fuel shortages, power cuts, and supply chain disruptions, to identify vulnerabilities before they become critical.

At the Level of the Ministry of Health and Official Health Authorities

Develop clear protocols for surgical triage and case prioritisation during mass casualties and conflicts. These protocols should be based on professional and ethical criteria, including injury severity, the possibility of saving a limb, resource availability, and the likelihood of benefit from surgical intervention. Moreover, strengthening referral systems between hospitals and providing alternative communication methods that can be used when networks are interrupted or roads are blocked.

Establish a national surgical preparedness framework that includes standardized surgical triage protocols applicable across all hospitals, ensuring consistency in priority setting and resource allocation during mass casualty events. This framework should also include mechanisms for **real-time resource tracking and redistribution** across hospitals to optimize the use of limited surgical supplies, blood products, and medications during emergencies.

At the Level of Health and Humanitarian Organisations

Prioritise the support for the critical resources needed to maintain operating room services, such as fuel, electricity, anaesthesia medications, oxygen, blood, sterilisation materials, antibiotics, and essential surgical supplies. This support should be based on real operational needs, not only on general supply lists, because operating rooms depend on an interconnected resource chain, and the shortage of one resource may weaken the entire service.

Humanitarian organizations should support the development of alternative communication and referral networks that function independently of telecommunications infrastructure, such as satellite phones, radio systems, or offline digital platforms, to ensure coordination of surgical transfers when roads and networks are destroyed. Additionally, organizations should invest in pre-positioning surgical supplies in strategically located warehouses to enable rapid distribution during escalations of conflict, rather than relying on reactive supply chains that are vulnerable to disruption.

At the Level of Health Workers

Focus on work under emergency and scarcity conditions. This includes training in surgical triage, resource rationing, use of temporary alternatives, and rapid coordination between departments. Also, emphasises the importance of providing psychological and professional support for workers, because the continuity of surgical services depends greatly on the ability of health workers to function under pressure without physical or psychological exhaustion.

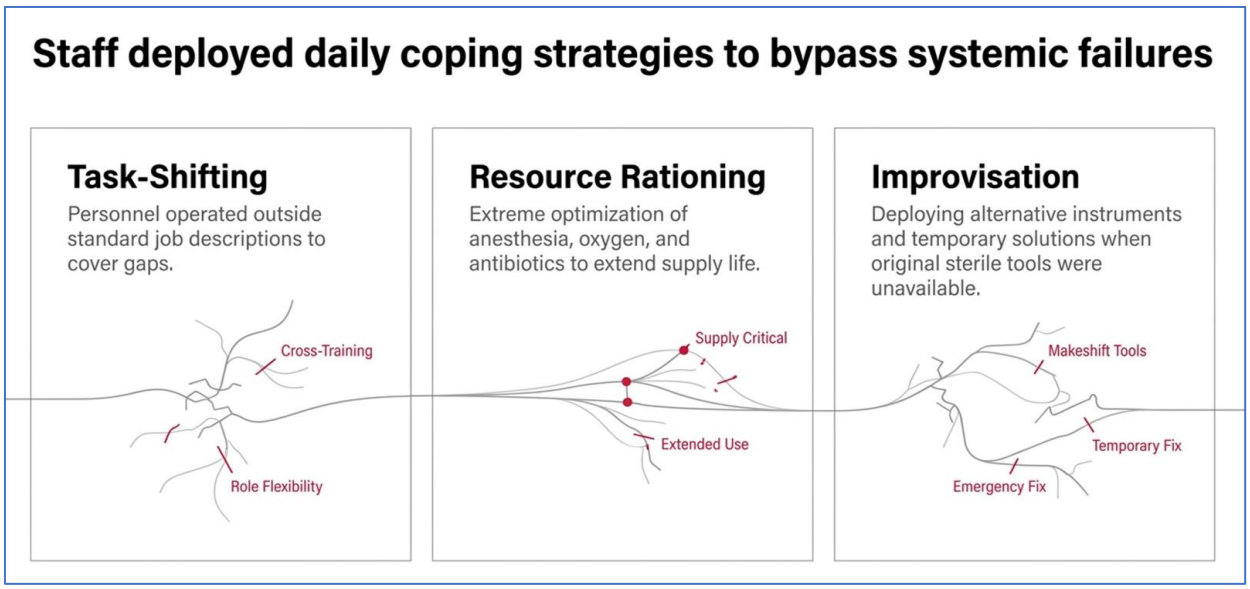
More formal task-shifting and cross-training programs can be developed that would further prepare operating room staff to perform multiple roles during emergencies, including anaesthesia support, instrument sterilization, patient transport, and basic surgical assistance. This training should be accompanied by psychological first aid and moral injury support programs to help health workers process the ethical burden of triage decisions and resource rationing under extreme conditions, reducing the risk of burnout and compassion fatigue.

Figure (8) illustrates that the operating rooms service continuity is due to the sacrifice of the staff who deployed daily coping strategies to bypass systemic failures, including task-shifting outside standard job descriptions,

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue XV July 2026 | Issue on Public Health

extreme rationing of anesthesia, oxygen, and antibiotics to extend supply life, and improvisation with makeshift tools when sterile instruments were unavailable. These localized adaptations—enabled by cross-training, role flexibility, and emergency fixes—allowed surgical services to continue, but they also revealed the fragility of a system dependent on the relentless creativity and endurance of its workers.

Figure (8)



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At the Level of Scientific Research

The authors recommend here that future research should include more functional hospitals in the Gaza Strip and a wider range of professional groups, such as operating room nurses, ward staff, sterilisation staff, emergency department staff, pharmacy, medical supply units, and blood bank workers. Future studies could also use a mixed-methods approach that combines interviews with quantitative indicators, such as the number of delayed operations, patient waiting times, blood availability, operating room working hours, and infection rates. This would help develop a broader and more applicable understanding of surgical service continuity in conflicts and resource-limited settings.

Future research should explore the long-term psychological and professional impacts on health workers who operated under extreme scarcity and moral distress, including the prevalence of burnout, moral injury, and post-traumatic stress disorder. Studies should also investigate the cost-effectiveness of different preparedness strategies, comparing the costs of pre-positioning supplies, training staff, and establishing alternative systems against the costs of service disruption and adverse patient outcomes during conflicts. Finally, research should examine the transferability of the agile resilience strategies documented in this study to other conflict-affected settings, identifying which adaptations are context-specific and which can be generalized across different humanitarian emergencies.

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Appendix A: Semi-Structured Interview Guide

This guide was used flexibly during the interviews. Its purpose was not to force participants into specific answers, but to allow them to describe their professional experiences in operating rooms and related support services during the war.

1. What was the nature of your role in the hospital during the 2023 to 2025 war on Gaza?
2. How did the nature of work in the operating room change during the war compared with the period before it?
3. What were the main operational challenges that affected the continuity of the operating room?
4. How did shortages of electricity and fuel affect the operation of the operating room and related devices?
5. How did shortages of anaesthesia medications, blood, oxygen, and surgical supplies affect daily decisions?
6. How were surgical cases prioritised when the number of injuries increased?

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7. What temporary solutions or alternatives did the team use to maintain the service?
8. How was coordination maintained between the operating room, emergency department, anaesthesia, and administration during the war?
9. What was the impact of the war and resource shortages on operating room staff and support services?
10. What was the impact of resource shortages, overcrowding, and referral difficulties on patients?
11. What are the most important lessons learned for improving operating room preparedness in conflicts and disasters?
12. What recommendations would you suggest strengthening the continuity of surgical services in the future?