

Radiological Services Providing in Catastrophic War Zones: Review Article

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ABSTARCT

Background: Radiological services are a very important medical branch in emergencies, especially in catastrophic or war zones. All radiology modalities depend on electricity to work; without it, no services could be provided. Teleradiology can provide radiological consultations to the zones deprived of radiologists due to any cause, but the destruction of the machine or a cut-off electric supply or internet will make teleradiology services impossible. Natural catastrophes and wars can affect any country with or without previous warning signs.

Objective: This study aimed to through the light on radiological services providing in catastrophic war zones.

Methods: We searched in PubMed, Scopus, and Web of Science for Emergency radiology, Teleradiology, War zones and Gaza genocidal war to identify relevant studies published between 2000 and 2024. Articles were selected based on their clinical focus, language (English and Arabic), and relevance to diagnostic and therapeutic challenges. Strict inclusion and exclusion criteria were applied to ensure that the analysis focused on studies pertinent to this research.

Conclusion: Destruction of infrastructures is affecting medical services, either indirectly by lack of electricity and supplies or directly by the destruction of hospitals or deprivation of medical teams by the detaining, injuring, or killing of them. The genocidal war against Gaza till now, which began 15 months ago, is an example of a bloody war and a highly destructive war zone caused by wild targeting of everything. Nothing is excluded from being targeted. This article discusses this area as a recent and current example of ways to provide medical and radiological services in a catastrophic war zone.

Keywords: Emergency radiology, Teleradiology, War zones, Gaza genocidal war.

INTRODUCTION

No place or country in the world is safe from catastrophes or wars. Natural catastrophes like earthquakes, volcanoes, tornados, and tsunamis. Some of them may give a warning before they occur (like volcanoes) and others can occur suddenly without any warning signs (like earthquakes). War is an unwanted occasion that almost all nations and countries have suffered from. The infrastructure of any country suffering from a catastrophe or a war is usually affected according to the severity of it. Hospitals and medical teams are highly forbidden areas to be targeted in any war, but this usually does not occur. Hospitals, even if they are not affected by direct destruction on these occasions, will indirectly be affected by lack of electricity, oxygen, or fuel, which may be totally out of service or seriously affected. The radiology department mainly depends on machines and radiologists cannot work without electricity, like many other specialties that can introduce some medical services in these circumstances. A radiological scan is formed mainly of two parts: Making the scan or film, which is usually made by technicians or radiographers and scan interpretation by the radiologists. Teleradiology can solve the issue of scan interpretation whenever the internet and enough qualified radiologists are available. It can be solved, but the real problem is the probability of doing the scan itself with the suitable modality, machine, and technique. Indirect stops by cut-off electricity or fuel or targeting hospitals by direct bombing or sniping medical teams are already occurring in the genocidal war in Gaza that began in Oct 2023 and

still continues till now for more than 15 months, causing more than 60,000 killed and 121,000 injured⁽¹⁻⁶⁾.

Telemedicine And Teleradiology in Gaza:

By April 2024, 30 out of the 36 hospitals in the Gaza Strip had been bombed (the number is progressively increasing), according to UNICEF, which means that the strip has been deprived of all these hospitals for one year till now (Fig. 1)^(1,3,6). Deprivation of medical services and personnel, as explained in tables (1) and (2), involves radiology as one of the emergency medical branches. No clear records are available for the radiological machines, clinics or departments that are stopped^(1, 4, 5, 6). Many groups on social applications like WhatsApp and Telegram contain doctors trying to provide telemedicine and teleradiology services to the people of Gaza, but this is not sufficient to treat the mass destruction of medical infrastructures occurring there during this continuous war⁽⁷⁻¹⁰⁾. Hospitals in Gaza, especially large ones, are targeted by direct bombing (e.g., Kamal Adwan, Naser, Alshifaa, and others). The Israeli occupation forces declared that they are targeting these hospitals because they contain weapons; they said that weapons were found beside the MRI machine, which is scientifically impossible, as the MRI machine is a large superconductive magnet working all the time with no relation to the integrity of the electric current, and this approved the lying of these occupation forces targeting hospitals against any human rights or international laws^(1, 2, 4, 6). The Internet is mandatory for any teleradiology to work, the absence of it will stop any teleradiology services⁽⁷⁻¹³⁾.



Figure (1): Different hospitals destruction in Gaza by direct targeting and bombing ⁽¹⁻⁶⁾.

Using social media applications as an alternative solution for teleradiology is not ideal, as the quality of the scans is usually not enough for proper interpretation and diagnosis. These scans are usually imaged by mobile phones with insufficient quality, which is further compressed by sending them on different social media applications (**Fig. 2**).

A much smaller number of CT and MRI scans were sent, as sending CT and MRI scans is much more difficult due to the multiple numbers and required high quality of every scan ⁽⁷⁻¹⁰⁾. The majority of medical consultations requested by these groups are usually a question about certain medical complaints, asking about certain drug doses or contraindications, or searching for blood transfusion (**Fig. 3**), which occurs frequently after bombing the different regions of displaced civilians in tents with nothing to protect them from any military targeting by any type of weapons ^(1, 2, 5, 6).

RADIOLOGICAL MODALITIES AND EMERGENCY

Radiology, as a medical branch, depends on many modalities (X-ray, US and Doppler, CT, and MRI) every

one of them has its own role in an emergency. X-ray and US small, portable and chargeable machines are available and can be used in different places, but this option has not been available for CT and MRI till now, which need to be installed in a specific well-equipped place with a sufficiently high voltage electric current.

Sending of X-ray for teleradiology is much easier than for CT and MRI, as X-ray usually involves one or a few scans, while CT and MRI need to send numerous scans for proper diagnosis, which subsequently require faster internet with large bundles.

The gross number of radiological cases sent to consultation groups is relatively very low in comparison with the total recorded cases of injuries. This is due to the fact that, even if injured people survive, they frequently don't have the chance to reach the hospital, either because ambulances are targeted and medical teams and patients are killed together inside it, or even if a radiological scan was done, the absence of the internet will give no chance for teleradiology consultation ^(7, 10-13).



Figure (2): Examples of X-ray scans sent to teleconsultation groups. Notice that the majority are imaged by mobile, and low quality interferes with accurate and proper diagnosis.



Figure (3): An example of requesting a blood transfusion in the social media telemedicine consultation group after one of the repeated daily massacres.

DISCUSSION

About 2.2 million people live in Gaza Strip, an area of 365 square km that is divided into five main governorates (North, Gaza City, Deir al-Balah, Khan Younis, and Rafah). On 7 October 2023, following a military attack by Palestinian factions in Gaza against some Israeli military bases (as Israel has been occupying the Palestinian land since 1948).

Although the Gaza Strip has been frequently attacked by Israeli Occupation Forces (e.g., 2008, 2009, 2012, 2014, 2012, and 2017) (Fig. 4), but this is the most bloody and destructive, not only in Gaza, but maybe all over the world regarding the number and percentage of killings & destruction per area and number of population and duration. The population of Gaza distribution and

forced displacement is explained in (Fig. 5) and table (1), denoting massive destruction and aggressive forces. Numerous disabilities due to the loss of one or more of the special senses or one or more limb amputations occur and increase every day.

The total amount of explosives used in Gaza is at least three to four times that of those thrown on Hiroshima. Although the Middle East has been subjected to many wars all throughout its history, none of them was destructive and bloody like this one, with mass destruction of the infrastructure and direct targeting of children. Gaza War records the highest level of child deaths in conflicts in the region, with an average of 136 children per day killed (Table 1 & 2 and fig.6), Targeting children is not the first time or unusual from Israeli force science they occupy

Palestine in 1948 or other Arabian lands (as Sinai in Egypt, Golan in Syria) in 1967. 8th April 1970 the Israeli military aircrafts were directly targeted and bombed an Egyptian primary school (Bahr Elbaqar) at Alsharqia governorate, 30 children were killed and the injuries were 50 children and 11 of school employee, and this occurring now daily in Gaza strip.

All these high percentages of injuries are directly equal to more required medical supplies and urgent medical services, which are almost prevented from the strip by the sever siege. Some studies are discussed before applying Teleradiology and Telemedicine services to a war zone in the Middle East, as *Arabi et al.* ⁽²²⁾ who discussed providing Teleradiology services through social media applications in Syria during the war ^(1-6, 7, 16-23).



Figure (4): Comparison between total injuries and deaths from 2008 to 2020 between the both sides (UN Statista.com).

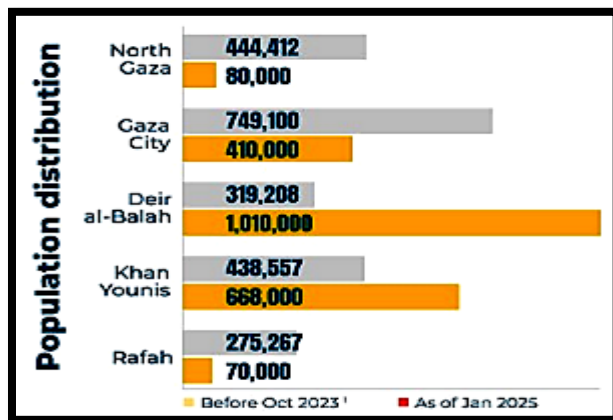


Figure (5): Population distribution in Gaza strip before and after war ⁽¹⁾.

Table (1): The details of different targets of killing of the genocidal war on Gaza after 546 days of war according to the Euro-med human rights monitor ⁽¹⁻⁶⁾.

Killed	Number
Civilians	45044
Children	18600
Women	12430
Journalist	210
Civil defenses workers	113
Healthcare Professionals	2748
Doctors	96
Total Killed	60250

Table (2): Percentages of destruction in Gaza strip after 546 days of war according to the Euro-med Human Rights Monitor ⁽¹⁻⁷⁾.

Injured / Destroyed	Percent / Number
Orphans	40000
Population Forcibly Displaced (At least Once)	97%
Targeted Civilians / Military	90%
Water Infra structure	97%
Population Facing Acute Food Insecurity	96%
Prevented Organized International Humanitarian Missions	60%
Budlings	79%
Schools	90%
Hospitals	90%

ISRAEL-GAZA WAR

Child deaths in conflict zones

The number of children killed in Gaza every day significantly exceeds every other recent conflict.

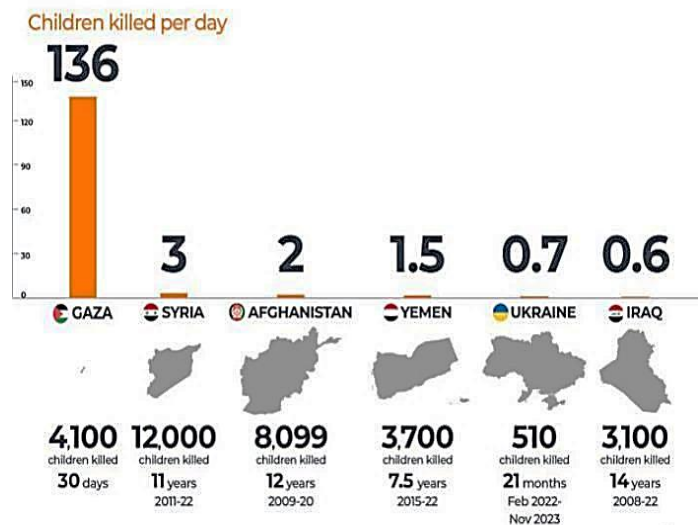


Figure (6): Child deaths in conflict zones ⁽²⁴⁾.

Table (3): Buildings destroyed in Gaza strip after 546 days of war according to the Euro-med human rights monitor ⁽¹⁾.

Buildings destroyed or damaged	
Since the onset of its war on Gaza, the Israeli military has pursued a scorched earth policy, decimating the strip's civilian infrastructure, property, and essential buildings.	
Housing units	510,000
Schools	560
Industrial facilities	3,100
Mosques	872
Churches	3
Heritage sites	205
Press headquarters	188

Billions of dollars are required to establish a complete reconstruction of medical infrastructure and provide sufficient medical services to the strip, which will also take a long time (if it occurs). Tables (1) & (2) and figure (4) explain that the number of deaths, injuries, and children killed in this war is significantly higher than in other recent wars (Syria, Afghanistan, Yemen, Iraq, or Ukraine) ⁽²⁴⁾.

This can explain how this war is destructive and how much load is needed to supply sufficient medical services for this catastrophic war zone. Even if physical reconstruction is established, the lack of qualified doctors killed, injured, or still detained in this war will need many more years to be equalized. The continuous, unbroken, strict siege even of water, food, and medications multiplies the disaster by continuing it and increases the upcoming load when medical reconstruction occurs. While, table (3) explains how much the extension of destruction is all over the strip of all types of buildings (e.g. more than 510.000 housing buildings), which means that doublings the efforts and cost is required for total reconstruction, even if occurred will never compensate for the lost souls, which are increasing day by day with the non-stopped war, which are much more than those recorded by the different organizations, as still there are many missed people under the non-removed ruins of destructed buildings ^(1-6, 14, 20-24).

RECOMMENDATIONS

The health problem in Gaza is complicated or even catastrophic and progressive with the progress of the severe siege and war. Supplying Gaza with all mandatories of water, food, and medication is the first mandatory direct step. The next steps prior to the plan of reconstruction should be widely regulated steps to overcome the medical problem there, in the form of:

- Providing teleradiology and telemedicine mobile units (cars) that can provide a wide range of services in multiple places in a short time without the need for long-time fixed constructions or mobilization of large numbers of citizens who need medical help in different places ^(7, 10, 15).
- **PACS instruction:** PACS implementation in all reconstructed hospitals is mandatory for the providing of teleradiology services, especially for cases of CT and MRI with complicated findings ⁽⁷⁻¹³⁾.
- **Robotic surgery units:** although this solution is expensive, needs heavy construction, is difficult to install, and needs highly qualified, well-trained surgeons in the source country, but it may be a solution more rapid and less costly than traveling thousands of cases to different countries ⁽²⁵⁾.

CONCLUSION

Teleradiology, either by PACS or using social media applications, can provide radiological consultation services to catastrophic or war zones like Gaza whenever the radiological scan can be done and sent on the internet, but when the radiological machine itself is stopped, broken, or destroyed, there will be no scans to be sent or evaluated. Gaza genocidal war is considered one of the bloodiest wars targeted at civilians, with the highest rates of child assassination and disabilities in a war. Most of the hospitals there were destroyed by direct targeting of it, and the few non-destroyed are now deprived of electricity or fuel needed to generate it.

The provision of medical services generally and radiological services specifically has been significantly decreased or even totally stopped in most areas of Gaza Strip. Stopping this war and breaking down the restricted siege of civilians is the responsibility of the whole world generally and all Arabian and Islamic countries specifically. If this war continues for a few more weeks or months, the whole people of Gaza Strip will face death by starvation and diseases if they are not killed by bombs and weapons. History will write that we were watching this genocidal war for several months until there were no people to provide either medical or radiological services for them. Breakdown of the siege surrounding Gaza is mandatory, and providing the strip with the basics of life (clean water, food, and medications) is the first step, with concomitant provided by a mobile telemedicine and teleradiology unit being the urgent solution, as reconstruction, whatever the financial support, will take considerable time.

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