LETTER to the EDITOR

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The Importance of Scaling Earthquake Magnitude and Intensity for Medical Management of Disasters: An Emergency Physician's Perspective

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Dear Editor,

Geologists characterize earthquakes by their magnitude and intensity. Magnitude refers to the total energy produced by the Earth's crust. This energy is measured using a seismograph and converted using the Richter scale. While it is well known that the Richter magnitude scale is a logarithmic scale for estimating the total energy released by an earthquake, it is less commonly known that a one-unit increase on the Richter scale corresponds to a tenfold increase in ground motion and a thirty-twofold increase in energy release (1).

The most used scales for measuring earthquakes are the modified mercalli (MM) intensity scale and the Richter magnitude scale. A comparison of the MM Intensity scale with the Richter scale is provided in Table 1 (2). The main point to consider when interpreting the values in Table 1 is that although the Richter scale values represent magnitude, the roman numerals on the MM intensity scale denote intensity. While measurements above 5.0 on the Richter scale can cause environmental and human damage, those below 2.0 are generally not felt. Foreshocks, smaller tremors preceding major earthquakes, may also occur. Additionally, aftershocks, smaller events following the main earthquake, can also happen and may lead to significant additional damage, as seen in the February 6 Kahramanmaraş earthquake in Turkey, necessitating further local or regional evacuations (3-5).

The level set for disasters also determines the response scale. For example, Turkey called for level 4 aid after the February 6 Kahramanmaraş earthquake (6). These levels of aid calls are developed within the framework of the Turkey Disaster Response Plan (TAMP), and as the level increases, the scope of the call extends from local resources to international aid requests. TAMP classifies disasters into four levels: S1 indicates that local resources are sufficient; S2 is when the scale of the disaster or emergency in a province exceeds the capabilities of that province, necessitating support from neighboring provinces; S3 indicates a need for national-level support; and S4 is when international assistance is required (7).

The primary factors determining the earthquake intensity in these scaling systems are multifaceted. Socioeconomic factors, which reflect the impact on people and property, include the number of deaths, injuries, missing persons, homeless individuals, evacuated people, the total number of affected individuals, and damage cost, encompassing property damage, crop losses, and economic impact. Additionally, power measurement factors, which reflect the strength and intensity

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of the event, encompass parameters such as the magnitude, duration, speed, location, and distance of affected populated areas from the disaster zone. Finally, preparedness factors, which reflect a region's readiness, involve available technology, resources, ability to evacuate areas before they are impacted, mitigation strategies, and response rate.

Throughout history, it has been observed that the naming of destructive events has often taken precedence over their scaling. For instance, in the Oxford dictionary, the term "catastrophe" is used to define "disaster", while "disaster" is used to define both "catastrophe" and "calamity." This cyclical nature of definition has resulted in these terms being used interchangeably to describe the severity and intensity of natural events (8).

In the categorization of natural disasters, it is common to see events with vastly different levels of severity placed in the same category. For example, both the 1998 Mitch hurricane and the 2004 Indian Ocean tsunami were categorized as catastrophes (9). However, when compared with the tsunami, the impact of hurricane Mitch was much smaller: It struck the Caribbean and Central America, resulting in 11,000 deaths, whereas the Indian Ocean Tsunami affected 12 countries across Asia and Africa and caused approximately 230,000 deaths. The root of this problem lies in the lack of a sufficient number of categories to represent the severity of a natural disaster adequately. Consequently, using terms such as emergency, disaster, and catastrophe does not provide enough detail to clearly understand the impact of an event.

To accurately represent the magnitude of a disaster and avoid subjective and inaccurate classifications, the universal disaster severity classification scheme (UDSCS) was developed (9). Table 2 shows the classification of disaster magnitude and color on an international scale. Using the UDSCS, it may be easier to evaluate a city's population and damage, and infrastructure losses caused by a disaster than assessments based solely on property losses, such as homes and other assets. Using the UDSCS, planning decisions can include determining the storage and distribution of essential resources such as food, water, medicine, sanitation supplies, and clothing to the affected area; identifying hospitals to be mobilized and their capacity; and determining where and

Table 1. Comparison of the modified mercalli intensity scale with the richter scale

Richter magnitude	Mercalli intensity	Shaking	Occurrence frequency
0 to 1.9	I	No felt	8000 times per day
2 to 2.9	II	Weak	1000 times per day
3 to 3.9	III	Weak	49000 times per year
4 to 4.9	IV and V	Light-moderate	6200 times per year
5 to 5.9	VI	Strong	800 times per year
6 to 6.9	VII and IX	Very strong-severe-violent	120 times per year
7 to 7.9	X and XI	Extreme	18 times per year
8 to 8.9	XII	Extreme	1 time per year
9.0 and above	-	Extreme	1 time per 20 years

Table 2. Universal disaster severity classification scheme and disasters

UDSCS	Color coding	Descriptive term	Description	Fatality range
0	White	Emergency	Suddenly occurring, causing injuries and fatalities	F<1
1	Blue	Emergency	Suddenly occurring, causing injuries and fatalities	1≤ F<10
2	Dark green	Disaster type 1	Many people severely injured or killed	10≤F<100
3	Light green	Disaster type 2	Many people severely injured or killed	100≤F<1,000
4	Yellow	Calamity type 1	Widespread area damage, severe injuries and fatalities	1,000≤F<10,000
5	Dark yellow	Calamity type 2	Widespread area damage, severe injuries and fatalities	10,000≤F<100,000
6	Red	Catastrophic type 1	Very widespread area damage, affecting a continent	100,000≤F<1m
7	Dark red	Catastrophic type 2	Extremely widespread area damage, affecting multiple continents	1m≤ F<10m
8	Light purple	Cataclysm type 1	Global damage, countless fatalities	10m≤F<100m
9	Dark purple	Cataclysm type 2	Global damage, extreme fatalities	100m≤F<100b
10	Black	Partial or total annihilation	Intercontinental, partial, or total annihilation	100b≤F

UDSCS: Universal disaster severity classification scheme, F: Number of fatalities, m: Million, b: Billion for how long temporary shelters will be established. By having a comprehensive understanding of disaster severity, emergency response management organizations, disaster managers, first responders, government stakeholders, aid organizations, and nongovernmental organizations can quickly estimate the potential impact of a natural disaster. This allows for the efficient allocation of resources, accelerated mitigation efforts, and expedited recovery processes (10).

When asked why the intensity scale of an earthquake is valuable to an emergency physician, the answer is multifaceted. Foremost among these is that clearly understanding the magnitude of a disaster is crucial for planning every step, from providing aid to managing the response to the disaster (11). These classifications and scales are not only developed for healthcare workers and disaster managers but also for emergency response teams, national/regional/local governments, aid organizations and civil society organizations, reporters and media, the public, insurance managers and assessors, database/information managers, and research communities. For disaster managers and emergency response personnel, these classifications provide a clear understanding of the severity scale of each disaster type by considering expected probabilities based on historical events. The UDSCS facilitates relative comparisons among different disaster levels and ranks natural disasters using a set of criteria, providing a comprehensive disaster picture. This information can be used for proper resource allocation during disasters and for advanced planning.

The initial assessment of a disaster is based on estimates made shortly after the event occurs, and this decision is part of a dynamic process that is frequently updated. For example, in the aftermath of an earthquake, initial assessments are used to determine whether to declare a state of emergency, initiate evacuations, request international aid, or involve military forces in response efforts. In devastating earthquakes, many buildings, including government institutions and even hospitals, sustain damage, often leaving only the ground floors and emergency departments operational. Efforts to mitigate the impacts of earthquakes depend on accurately estimating the disaster's impact on the city and its residents. Timely and accurate assessment of disaster impacts is crucial because lives depend on these decisions. Consequently, emergency departments, as the first point of contact after earthquakes, play a vital role, and the proficiency of physicians in these concepts is of paramount importance. The inconsistent identification of disaster impacts can lead to either excessive or insufficient allocation of resources by disaster managers. Over-allocation of resources can result in significant and critical wastage, while insufficient resources can exacerbate the disaster's impact on public health and its overall severity.

For both preparedness and post-disaster mitigation efforts, disaster managers and health administrators should adopt a standardized disaster scale that reflects the human impact of earthquakes. This strategy offers several advantages. Firstly, activities such as issuing warnings, organizing evacuations, providing public education, and conducting earthquake training and drills can shift public perceptions of earthquake risks. Secondly, these initiatives can engage public interest and foster greater trust in the methods employed by emergency management systems and response teams. Lastly, utilizing uniform terminology can shorten response times to warnings and improve the effectiveness of public responses.

In summary, as Durage stated, "the frequent occurrence and intensity of natural disasters can leave irreversible negative impacts on people. To mitigate the adverse effects of disasters, it is crucial to take preventive measures well in advance, which can either prevent or significantly reduce the impact of such events." By nature, disasters occur suddenly and require rapid decisions and activation. Therefore, in an established emergency management system, the use of appropriate classifications and terminology can facilitate timely warnings and accurate situation reporting to the necessary institutions and organizations in the hierarchy. This approach can minimize deaths and injuries by ensuring prompt and effective response efforts.

In conclusion, clearly defining the link between a disaster and its potential human impact through the use of the UDSCS can significantly improve public awareness, education, and responsiveness to warnings. Communicating the severity of natural disasters using precise terms from the UDSCS can increase the chances of appropriate public reactions and raise awareness of life-threatening situations. Furthermore, this method can minimize confusion, strengthen understanding between the community and response teams, and enhance decision-making processes. It is recommended that these communication strategies be tested before being fully implemented.

Footnote

Informed Consent: Informed consent is not necessary.

Authorship Contributions

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