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Forensic Medicine Practices in Earthquake

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Abstract

Forensic Medicine practices in earthquakes will necessarily differ from the practices normally carried out. However, it should not be overlooked that this difference is valid only for earthquakes of a "catastrophic" nature that cause great destruction, injury, or death of many people. The 2 main dimensions of the event are the forensic-medical approach to people who were injured but survived and the forensic-medical procedure to be applied to those who died in the earthquake. The basic principle for people who survived the earthquake but were injured is not to evaluate the case as a forensic case unless there is any information, finding, or suspicion to the contrary. In this case, a forensic case notification is not made and a forensic report is not prepared. However, in these cases, the identity information, systemic examination findings, description of the wounds, and radiological and laboratory findings that will be needed in the future should be recorded in detail and the records should be kept. The normal forensic medical procedure is applied to the external examination of the corpse of persons who were removed from the wreckage as dead. The case is a "forensic case" and identification and external examination procedures are performed by the Public Prosecutor and the Physician. However, if there is no information, finding, or suspicion to the contrary, autopsy is not applied to the case, and burial permission is given. The important point here is to take, store/send the samples required for molecular genetic analysis, as well as forensic and medical identification.

Keywords: Forensic medicine, earthquake, disaster, mass fatalities

Forensic Medical Approach in Injury Cases

First of all, it should be emphasized that the information to be given in this section is valid for situations where an earthquake causes destruction, injuries, and deaths at a "disaster" level. Otherwise, normal forensic practice will continue for injuries sustained in a relatively mild earthquake in which several buildings collapsed. In other words, judicial notification of incoming cases will be made within the scope of Articles 279 and 280 of the Turkish Penal Code, necessary consultations will be requested according to the structure of the health institution, and forensic reports determining the severity of the injury will be prepared upon request.

Considering the conditions, it is not possible to carry out normal forensic medicine practices for injuries caused by disaster-sized earthquakes. If, as stated in the anamnesis, no wounds other than those that may have occurred due to the effect of the earthquake have been found, it is not necessary to accept the earthquake victim as a forensic case and report it. However, in case of detection of wounds that are not expected to occur in an earthquake, such as a gunshot wound or nail marks on the neck, the normal procedure will be followed, the notification will be made, the necessary forensic-medical consultations will be requested and a forensic report will be prepared regardless of the anamnesis.

There is a high probability that medical records and forensic reports of an earthquake survivor injured in the disaster will be needed. This need may also arise months or years later. If medical records are properly and adequately kept and stored, there will be no problem. Forensic reports can also be prepared later on these records upon request. However, it is very crucial that medical records and laboratory and radiological examinations are adequate and kept. While the patient is discharged, necessary steps should be taken so that he or she can access these records later electronically and even a hard copy of epicrisis should be given to him.

In such a disaster, one of the most important problems will be identification. Most of the injured patients will not have an identity card and their identity will be determined by the statements of themselves or their neighbors. In some patients, the identity will remain uncertain as they are unconscious and there is no one around. If the patient survives and regains his health, the identity information that cannot be obtained while he is unconscious can be obtained later. Identity information should not consist only of name and surname, it should also include the name of the parents, the date of birth as day, month, and year, the place of birth, and most importantly, the identity number. For foreign nationals, a passport number or temporary citizenship number should be written next to the nationality.

In the case of false and/or inaccurate statements, legal problems may arise in the future. Taking measures to eliminate these problems may not always be possible under disaster conditions. However, some simple actions can solve this issue. For instance, writing and signing one's name and surname and the date on the informed consent forms will be very useful in case of identity problems in the future. If necessary, the problem can be solved by making a text signature comparison.

Child victims will face even greater problems if their identity cannot be determined. What needs to be done in such a situation is to report the situation to the official social service institutions together with the Prosecution Office and to keep the child safe until his family is found. In these children, it may be a problem from whom to obtain informed consent for urgent medical

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interventions. For example, what will happen to a child whose leg has to be amputated? In such a case, if the required medical intervention is urgent and if the patient's life is endangered, intervention should be made. If the situation and age of the child are suitable, he/she is also informed in accordance with the relevant articles of the Convention on the Rights of the Child. In such cases, it will be very beneficial for possible responsibilities to decide on the indication of the medical intervention to be made by a committee consisting of at least 3 specialist physicians and to make an official report and add it to the medical records.

Each health institution should properly draw up and keep the records of the applicant victims regarding diagnosis and treatment and should be able to provide them at the request of the person, the one's lawyer, the Prosecution Office, or the courts at a later date.

Forensic Medical Approach in Death Cases

After mass disasters (earthquake, landslide, collapse, etc.), serious social problems arise. One of the problems in such disasters is that people reach the corpses of their relatives in a way befitting human dignity, within the rules of rights and law. Another problem is the missing persons whose bodies could not be found in legal terms. The state has obligations to bring peace to both the conscience of society and the relatives of the deceased. These obligations are of such a nature that they can be resolved professionally with the teamwork of experts and institutions.[1] Therefore, it should be clearly stated who will take responsibility for which issues with the plans and programs to be made in advance.

In mass disasters, corpses should be located and removed at the scene, identified, and handed over to their relatives after examination of the deceased.[2] If the bodies of their relatives cannot be delivered to the people in a proper manner, both the conscience of the society will be disturbed and problems in terms of justice will arise. Under the circumstances, how should the professional approach be toward corpses and/or body part(s) found in mass disasters in order to ease the conscience of the society and ensure justice?

Evaluation of the Scene in an Earthquake

When Any Corpse(s) Is Detected at the Scene

Identifying the scene should be the first thing to do. A proper and systematic study is very important for the healthy execution and resolution of the incident. Within the framework of this point of view, the data should be recorded in full, starting from the city name of the place where the incident occurred to the building name and apartment number (Table 1). Records at the scene should be supported with pictures to be taken and, if possible, video recordings.

In Corpses Whose Integrity Is Preserved

The identity of the team or person who found the body at the scene should be recorded. The date and time the body was found are essential for the beginning of the process management. Recording where the body was found in the house is significant in terms of taking precautions against future mass disasters and identification. The date and time the body was removed will contribute to the process management. As soon as the body is removed from the wreckage and carried to a safe area, the corpse should be numbered as the first thing and this number should be tied to the arm or leg of the corpse (withstanding all kinds of tearing, wiping, etc. adverse conditions). The number given to each corpse is very important to avoid confusion until identification and to resolve any confusion. By means of this number, when an issue arises, it will be possible to make a faster assessment and reach a result in a more limited area since the scene records and other records are also proper. After the corpse is numbered, photographs for identification should be properly taken and recorded together with the number. In a similar way, pictures of the clothes, shoes, and, if any, jewelry (necklace, bracelet, ring, etc.) on the corpse should be taken in order to contribute to identification. It is very precious to describe the clothes and shoes on the body in detail (especially in mass disasters that occurred at night, such as in the 1999 and Kahramanmaraş earthquakes) as the identity cards of the individuals will often not be found on them. If the relatives or acquaintances of the corpse are present at the scene, identification should be made. However, it should not be forgotten that in such cases, people who make identification may not be able to make an accurate and healthy diagnosis, as they may be under the influence of the event. In the next process, precautions should be taken against mistakes in identification (getting suitable samples will be explained in detail in the next sections of this article). Identity information of the person detecting the identity of the corpse (photocopy or picture of the witness's identity card) should be recorded. (The author of the episode was put on trial for a long time because of a wrongly retrieved corpse in the 1999 earthquake.) The corpses, both identified and unidentified, should be transferred to a suitable place to make the necessary preparations and complete the administrative and legal proceedings. It is important for the process follow-up and management to register the identity information of the people executing this transfer and to register their institutions, if any. Likewise, the date and time of the delivery of the body should be included in the records. The final procedure for transferring the corpse(s) from the scene is to note down the name and address of the place, unit, or institution to which the corpse will be carried or delivered (Table 1).

Corpses Whose Integrity Has Been Destroyed

Identity information of the team or person who found the body part(s) whose integrity has been destroyed at the scene should be recorded. It should be determined which part of the body is the body part(s) found. The date and time the body part(s) are found is very important for the beginning of the process management. Recording where the body part(s) was found in the house will contribute to the measures to be taken against future mass disasters, identification, and reassembly of the other parts of the body. The date and time of removal of the body part(s) will support the process management. As soon as the corpse piece(s) is removed from the wreckage and carried to a safe area, a number that is resistant to adverse conditions such as all kinds of tearing and erasure should be attached to a suitable part of the body as a first step. This number is very crucial to avoid confusion until identification and to resolve any confusion. With the help of this number, it will be easier to reassemble the body parts, and when there is a problem, it will be possible to reach the result with a much faster evaluation in a more limited area, since the scene and other records are also proper. After the corpse piece(s) are numbered, photographs for identification should be properly taken and recorded, along with the number. Similarly, pictures of the clothes, shoes, and, if any, jewelry (necklace, bracelet, ring, etc.) on the body part(s) should be taken in order to contribute to identification. If the relatives or acquaintances of the corpse are present at the scene, identification of the corpse part(s) should be made. However, an accurate and healthy diagnosis is not always possible. In the next process, measures should be taken against mistakes related to identification (taking appropriate samples will

Table 1. Information Required to be Recorded About the Scene and a Corpse found at the Scene (Supported with Pictures if Possible)

Information About the Scene			
City		County	
District		Neighborhood	
Main road		Street	
Name of the building		Door/Flat No	
Other			
Information About the Corpse			
Name of the person or team who found the body			
Date and time the body was found:			
Part of the house the body was found (Bedroom/Living Room/Kitchen/ Bathroom etc.)			
Date and time the body was removed			
Number given to the corpse			
Body part that the given number is attached to (arm/leg/trunk, right/left)			
Number of pictures taken for the identity of the body			
Recording the jewelry on the body and the number of pictures taken			
Recording the dresses on the body and the number of pictures taken			
Recording the shoes or slippers properties of the body and the number of pictures taken			
If there are relatives or acquaintances at the scene, the person who detects identity			
The proximity of the person who detects the identity			
The person and the institution where the body was handed over			
Date and time when the body was delivered			
Place or unit where the body will be carried or delivered			

The source of *Human Rights Foundation of Turkey, Missing Persons Research Guide for Forensic Medicine Specialists*[2] was used to create the table.

be explained in detail in the next parts of this article). Identity information of the relative or acquaintance who made the identification should be recorded and, if possible, a photocopy of the identity witness's identity card or a picture of the identity card should be taken. Thus, it will also be determined who will provide support for the corpse piece(s) to be found later. The part(s) of the corpse, both identified and unidentified, should be transferred to an appropriate place in order to reassemble, make the necessary preparations, and complete the administrative and legal proceedings. It is essential for the process follow-up and management to register the identity information of the people making this transfer and to register their institutions, if any. In a similar way, the date and time of delivery of the body part(s) should be included in the records. The final step to send the body part(s) from the scene is to register the name and address of the place, unit, or institution where the body will be carried or delivered (Table 1). In this stage, the responsibility is on the crime scene investigation experts or the people and institutions working in this sense.

Identification of Earthquake Victims

Identification is the revealing of the features enabling a living or dead person to be recognized and distinguished from other people. This process is a requirement that has religious, ethical, and spiritual aspects as well as fulfilling legal procedures. The elimination of the uncertainty about the identity of the deceased after the identification, the burial of the corpse by the relatives, and thus the feeling of fulfilling the responsibilities of the funeral owners contribute to the normalization of life. In addition, with the officialization of death, the problems related to the law of inheritance are solved.[3]

In the DVI (Disaster Victim Identification) guide prepared by Interpol (International Police Organization), disasters are classified as open and closed disasters taking into account the differences in identification processes. Open disasters are those in which the exact number of corpses that need to be identified is not known in the area where the incident took place and there is no previous record of the identity information of the people at the scene. An earthquake disaster or an explosion in an open field is an example. In closed disasters, on the other hand, the number of people who need to be identified and their probable identity information are certain. An example of this is a plane crash where the number of passengers and their identity information are known.[4] It is extremely important to act systematically and normatively in the identification of disaster victims. Identification alone is not sufficient, thus it is imperative that the records be kept properly.

The rapid and accurate identification of those who lost their lives in the earthquake is very crucial from a legal and humanitarian point of view. Common identification methods include visual identification, fingerprints, DNA analysis, radiological examinations, and comparison of personal items and dental records.

External Examination (Medical Identification)

Victims of a large-scale disaster are identified on the basis of an assessment of multiple factors. Factors such as the extent to which human body parts are damaged and the time human body is exposed will affect the nature and quality of postmortem data. Identification methods used in disaster situations should be scientifically sound, reliable, and applicable in field conditions and should be implemented within a reasonable time.[4]

In postmortem identification, the evidence and findings to be determined on the deceased and the information and findings to be obtained from the relatives of the deceased should be evaluated together. When primary and secondary identification tools of deceased persons are used together, a healthy identification will be possible. Primary identification tools are the person's medical identity, fingerprint, tooth, and DNA structure. These will be explained in detail in the sampling section.

Treatment records, reports, surgery notes, hospitalization documents, dental records, dental treatments such as prostheses, fillings, implants, x-ray images, recently obtained photographs, tattoos,

and data with characteristic features such as medical deformity or scarring should be obtained from relatives of the deceased or from various centers. Any witness statement that will help identify the person and any information about the person will help determine the identity of the victim. All these data are secondary identification tools.

The identification of the people who lost their lives in the disaster area should start with the clothes they wear. Colors, body sizes, brands, and the presence of any special name inscriptions or textures on the label parts should be recorded. The presence of money, business cards, identity cards, accessories, jewelry, and personal belongings should be searched by looking at the pockets one by one, and each material obtained should be recorded one by one. The jewelry of the person should also be recorded in detail one by one. These, too, are among the secondary identification tools and provide great support in the identification process.[4] Checking the data of corpses or body parts detected at the scene is very essential for the reliability of identification.

If the conditions are suitable before the external examination, radiological images of the body should be obtained while the corpse is in clothes and after the clothes are pulled off. The aim is to investigate the presence of metallic foreign bodies that can be detected in the body after the disaster and to determine the presence of orthopedic apparatus such as prostheses and screws that will provide clues in identification.

Photography should be taken digitally wherever possible. Photographs should be procured after each body has been given a morgue number associated with the number given at the scene, using the morgue number and, if possible, a reference scale. First, the face of the corpse must be obtained from the top as a portrait. Then, the front and back sides of the corpse as a whole with its clothes should be photographed. Dresses, underwear, items taken out from pockets, and belongings such as rings, necklaces, earrings, and watches should be photographed by placing them on a non-reflective flat surface after removing them from the body. After the body is photographed naked and whole from the front and back, all characteristics such as wounds, amputations, tattoos, and piercings on the body surface should be photographed individually. The front view with the teeth closed and the lips retracted, the inside view of the mouth can be opened, and close-up photos of certain dental treatments should be acquired. If possible, dental examination and evaluation should be performed by a forensic dentist.

Sample Collection From Unidentified Bodies

Visual methods may not be useful for identifying victims in large-scale natural disasters such as earthquakes.[4] Visual methods, which generally provide identification by relatives or close friends, are less reliable in identifying victims due to subjective factors such as the shock state and emotional states caused by the event. In addition, postmortem changes in the corpse also impose significant limitations on identification made by visual methods. Interpol rules state that victims should not be identified based solely on visual recognition.[4,5] DNA analysis is accepted as the gold standard for victim identification in mass disasters.[6] DNA profiling can be performed on a variety of body fluids and tissue types.[4,5] It has high statistical discrimination power in order to identify an individual.[5,7] DNA-based identification can be successful even in cases where the body is severely decomposed or even partially burned.[5,8] Recently, significant progress has been made in order to increase DNA extraction from heavily damaged corpses and to reduce the time required for DNA analysis, and such innovative studies are being emphasized.[9]

Nowadays, identification based on DNA analysis is recommended to be used in conjunction with other identification methods such as odontology, forensic anthropology, radiology, and fingerprints.[5,10] When combined with other diagnostic methods such as odontology and fingerprinting, DNA analysis offers high success rates in identifying victims.[5,11] Nevertheless, identification is an inconvenient and complicated process in earthquake disasters with a large number of victims. It is momentous that the identification process is concluded quickly due to reasons such as the long period of time that the corpses are under the rubble, the lack of adequate holding and storage environments for those who have been removed, and the inability of the identification teams to respond to the needs. In this section, we will focus on biological sample collection procedures for DNA analysis, which is an indispensable method for the identification of earthquake victims, for which we have expertise and field experience.

Sample Collection for DNA Analysis

DNA samples of the victims who lost their lives due to various reasons during the earthquake, mostly due to trauma, should definitely be drawn. Even if the identity of the victim has been determined by other methods, the samples to be collected for DNA analysis should be collected in accordance with certain procedures in order to confirm, to perform the matches between the body parts, and to facilitate the identification of other missing persons in the DNA database.[10]

Disaster Victim Identification teams to be involved in mass disasters should be knowledgeable and experienced in sample collection procedures. Biological samples to be collected for identification purposes should be collected by a forensic specialist or pathologist.

Clean and disposable instruments and equipment should be used for all sampling procedures[12] or re-used instruments should be sterilized to prevent contamination. The supreme mistake made here is the reuse of the instrument used to collect samples from a corpse without cleaning it. Tools such as forceps and scalpels should be cleaned by washing with 5% hydrogen peroxide after each sample collection.

Different types of tissues are collected according to the condition of the corpses for DNA profiling. Whole blood sample, deep muscle tissues, and bones/teeth are the most reliable sources of DNA. In addition to this, it is reported that swabs obtained from the urinary bladder, which is one of the tissues resistant to decay, can be used to obtain DNA in highly decomposed corpses.[13]

The collection of blood samples from fresh and not yet integrated corpses should be considered in the first place. For this reason, 2 collection methods come to the fore in terms of a practical application under challenging conditions and easy transfer.[14] Blood samples should be sampled on either clean Fast Technology for Analysis of Nucleic Acids (FTA) cards or sterile cotton swabs. As another method, buccal swabs can be collected from corpses.

In addition, approximately 1 g of deep red muscle tissue should be obtained from the undecomposed corpses. For that purpose, the psoas or femoral muscles may be preferred.

It should be noted that if dental samples are to be obtained for DNA analysis, this should only be done after consultation with the forensic odontologist and preferably only after the odontological examination has been completed.[4] If possible, non-carious molar teeth should be preferred for this application.

In the case of severely decomposed corpses, it is essential to ensure that the samples are of particularly good quality. In all these cases, bone or tooth samples should be obtained.[15] Bone material from spongios part may be rich in DNA, but reliable preservation

of this material can be challenging. Therefore, it may be a better choice to collect specimens preferably in the form of 4–6 cm sections from long leg bones and ribs. While sampling bones, it is quite important not to remove them from anthropological measuring points, articulated edges, or broken edges.[4]

Recording, Storage, and Transfer Conditions of Collected Biological Samples

The numbering system used when the body first arrived at the identification center may be applicable to the samples collected. If an internal numbering system (or any other laboratory procedure) is used for DNA, strict adherence to this numbering system matches the numbering system first identified in the body. This allows the laboratory results to be used in the overall DVI evaluation process: the date when all the samples were collected on both their containers and their envelopes, where the sample was collected, and what it was should be clearly stated.[16] Full documentation of each DNA subsample for dismembered corpses and the body parts from which they were obtained is also crucial for reassembling the body parts.[4]

Preservers can be used to protect soft tissue at room temperature. The use of maintainers is recommended, especially in temporary morgue stations with limited cooling capacities. Samples should not be preserved in formalin as formalin will degrade the DNA. Instead, soaking the soft tissue in ethanol is the most appropriate approach.[4]

The possibility of cross-contamination among the residues should be considered both at the disaster scene and at the autopsy station. Therefore, a separate number must be assigned to each body or body part. Body residues should not be paired with or placed together with other residues based on external appearance alone.

The success rate for DNA typing depends on how quickly samples are obtained and preserved. The collected biological material should be preserved and stored, and all biological samples with evidence should be kept at +4℃ and conveyed to the relevant Prosecutor's Office or forensic laboratory in a short time as possible.[17] Samples on which DNA analyses will be performed should be protected from humid and hot environments that would damage DNA and should be maintained in such a way as to prevent the formation of factors that cause bacteria and mold growth.[6,18] Plastic bags should not be preferred because they prevent moist samples from drying out and create an environment conducive to the growth of mold and bacteria and stink.[19] However, plastic materials can be used for the samples that are stored in suitable conditions and transferred to the laboratory in a short time with the cold chain for ease of use.

As a result, the delivery chain of the sample, which includes the identification, collection, packaging, preservation, and delivery of the samples, must be carried out correctly and carefully with all its steps, in accordance with the procedure, the case, the type of evidence, the place of collection, the material collected, and the container/envelope in which it is put.[20,21] The sample delivery chain and sample retention time should be as short as possible. During the sending of the collected samples for identification purposes, necessary precautions must be taken to prevent them from being affected by external conditions.[22] Transfers should be made by establishing a cold chain.[20,23,24]

External Examination, Autopsy, Setting of Death Certificate

Although the earthquake is a natural disaster, the deaths that occurred are of judicial nature with its legal dimension such as negligence. In mass events such as earthquakes, the legal and forensic-medical management and implementation of these processes require a special comprehensive organization.

The subject of identification and forensic examination is specified in Article 86 of the Criminal Procedure Code (CMK). In this article, "preventing reasons are determined by showing the identity of the deceased in every way and especially to those who know him," "in the forensic examination of the deceased, all findings are determined to determine the medical symptoms, time of death and cause of death," and "this examination is carried out in the presence of the public prosecutor and by assigning a physician."

According to Article 86 of the CMK, although any physician may be appointed as an "expert" to reveal the cause of death and other medical findings by the public prosecutor, It is extremely important to do this with forensic medicine specialists as experts due to the forensic dimension of a mass disaster such as an earthquake. In mass deaths, the examination of the deceased, the preparation of death certificates, and, if necessary, autopsy are naturally the subjects of forensic medicine.[25]

In mass deaths that occur in disasters such as earthquakes, dent, floods, avalanches, and landslides, the subject of "identification" is focused on the examination and autopsy of the corpse. However, in death cases, "identification" and "dead examination" constitute integrity. It is important to ensure that the relatives or, if there is not any, those who know the body attend the exploratory examination to testify. It is essential that unidentified corpses are kept in suitable places such as ghusl rooms and morgues (cold storage rooms in case of earthquakes) for at least 2 weeks and that they are buried with the permission of the public prosecutor if no identification witnesses are found during this period. However, the waiting period for unidentified corpses was reduced to 5 days and then to 1 day, with a ministry circular, due to the force of the conditions in February 2023—Kahramanmaraş and subsequent earthquakes.

In catastrophic events, the relatives of the deceased first want their loved ones to be identified quickly and accurately, the death certificate to be drawn up, and their dead to be handed over to them. Therefore, the organization should be planned to complete all necessary investigations as soon as possible.

The first step in identification of the dead, the main principle, is to photograph the dead from different angles in each case (also video can be recorded), fingerprinting, blood sampling with an FTA card, taking a swab from the mouth; in decayed, deteriorated, or fragmented cases, tooth (canine, molar) and, if necessary, bone and muscle tissue samples are obtained. Following this, the official identity testimony of the dead relatives should be applied.

February 2023—In the first days of Kahramanmaraş and subsequent earthquakes, crime scene investigators (police/gendarmerie) made definitive identification with fingerprints in a significant part of the cases. In these cases, samples for DNA were collected as a precaution. DNA analysis from the FTA card and identification from the tooth were effective in cases that started to decay later. In cases where blood samples could not be drawn from frozen corpses, DNA analysis was performed from the swab material taken in the mouth. Identification of unidentified bodies was carried out with teamwork by forensic experts, crime scene investigators, and forensic biologists. However, in the first days of the earthquake, in places where there was no forensic medicine organization, a death examination was carried out by a physician in many cases, and death certificates were issued with the identity testimony of the dead relatives without taking fingerprints and DNA samples. In fact, the dead who were pulled out of the rubble, especially in rural areas, were buried by their relatives without being bound by an

official procedure. In such cases, autopsy had to be performed with the conquest of the grave upon the requests of the relatives who could not find the body later and the allegations of false identification.[26]

Starting from the first examination and photographing of the corpse, there should be a standard numbering (coding) system. It is of great importance that this code is stated in all processes, including subsequent reporting, setting a death certificate, registration, placing in a body bag, transport, burial, and autopsy if necessary. It is the identification of the corpse by comparing and matching the identification data with the pre-death information, the scene information, and examination findings obtained from the relatives of the dead. Identification and examination of the dead, as in all other forensic cases, should be done both while in clothes and after the clothes are removed.[25]

Although earthquake-related deaths are of a forensic nature, no autopsy is performed due to a large number of deaths occurring, the demand for a quick conclusion and the delivery of the body to the family, the unsuitable physical conditions, and the formation of an opinion about the cause of death which is usually stated with the findings of the scene and especially the external examination. However, in some cases, autopsy may be required in order to specify the role of injuries in the person's death such as burning and gas poisoning accompanying trauma caused by the earthquake environment, to determine the injuries that may occur during the removal of the body from the wreckage, to detect and identify the person's previous operation scars, devices, and prostheses, or to illuminate the suspicions and doubts that could be clarified in the autopsy if allegations exist.

Disasters such as earthquakes, dents, and landslides are considered and coded as the cause of death according to the International Classification System for Disease and Death Causes (ICD-10, ICD-11). According to the ICD morbidity and death causes classification system, it is shown as the cause of death per "earthquake" ("X34 Earthquake victim"), especially "being trapped or injured in a building or other structure collapsed due to earthquake" (Table 2).[27]

However, for example, people who are trapped or injured in the same building due to an earthquake may have very different causes and mechanisms of death. Blunt traumatic injuries occur in the head, chest, abdomen, and extremities with direct or sometimes indirect effects as a result of being under objects such as buildings, objects or soil in earthquakes, collapses, landslides, and so on. However, when examined from a forensic-medical point of view, it can show different causes and mechanisms of death in death cases as a result of earthquakes.

Table 2. Earthquake Coding as a Cause of Death according to the ICD-10 System

Coding of ICD-10*
X 34. Victim of earthquake
X34.0 Victim of cataclysmic earth movements caused by earthquake Trapped in or injured by collapsing building or other structure due to earthquake
X34.1 Victim of tsunami
X34.8 Victim of other specified effects of earthquake
X34.9 Victim of unspecified effect of earthquake

*International Classification of Diseases 10. Revision.

- Although the type of trauma is generally and predominantly in the form of "blunt" type regional or general bodily traumas, sometimes, "cutting" and "penetrating" injuries may also accompany them.
- These injuries can be open/closed or penetrating/non-pene trating injuries.
- These injuries cause serious and lethal damage to the skin, subcutaneous soft tissues, internal organs, large vessels, and nerves.
- Heavy objects may cause direct mechanical/traumatic asphyxia with neck, chest, and abdominal compression/inc arceration or may be effective with blunt traumatic injuries.
- Mechanical-type asphyxia can also be a cause of death by suffocation of people in a closed area under building debris, soil, and similar objects, or by closing their mouths and noses. Stuffiness or closure of the mouth and nose can alone cause death.[28]
- It can be thought that mechanisms such as heart attack and shock have a role in some deaths due to the effect of fear and panic on the cardiovascular system during earthquakes and aftershocks.
- Poisoning and burning due to gas leakage as a result of an earthquake can lead to death.
- Deaths due to hypothermia and frostbite may occur in people who are trapped or injured in a building in an earthquake, depending on climatic conditions, and also hypothermia and dehydration may play a role in deaths. Freezing and hypothermia were recorded as an important cause of death in the February 2023—Kahramanmaraş earthquake.[26]
- In an earthquake, drowning and injury cases due to tsunami may also occur.
- Secondary injuries that may occur during the removal of the injured people from the wreckage in the earthquake may have an effect on the death of the person.
- Deaths due to complications may occur in the cases that were removed alive from the earthquake wrecks. Among these, especially in cases of exposure to heavy objects, when the exposure period is prolonged, damage to the subcutaneous soft tissues, muscle crushing, and Crush syndrome can lead to severe consequences. Crush syndrome in earthquakes is the most common cause of death after the direct effect of trauma. While the dead/injured ratio was generally 1 : 31 during earthquakes, this ratio was recorded as 1 : 2.52 in the 1999 earthquake (Table 3).[29]

Crush Syndrome Findings: Local findings of trauma, compartment syndrome, hypovolemic shock, acute kidney failure, hyperkalemia, heart failure, respiratory failure, infections, and so on. Although the rates of patients with Crush syndrome appear to be low, in fact, Crush syndrome is the most common cause of death after the direct effect of trauma in earthquakes.[29]

Complications such as burns, poisonings, infection due to trauma, cardiac, and other organ diseases may have an impact on the death of people in events such as earthquakes, collapses, landslides, and mining accidents.

In such events where a large number of deaths occur, death certificates can be issued in a form in accordance with ICD-10, or an A-4 paper can be prepared as a death certificate if necessary. In the next process, the cases can be recorded in the Death Notification System (ÖBS) by being revised. In a significant portion of the deaths in the Kahramanmaraş earthquake in February 2023, according to the ICD-10 classification system, "earthquake" was coded as a cause of death ("X34 Earthquake victim").[26]

Table 3. Some Information About the 1999 Marmara Earthquake

Example of Marmara Earthquake (1999)	
Number of dead	17 480
Number of injured	43 953
Dead/injured rate	1/2.52
Patients with acute renal failure (Crush syndrome)	639
Rate of Crush syndrome in the injured	3%
Those on dialysis	477

In the cases to be autopsied, the procedures begin with the body bags being carried to the autopsy room with the first number given at the scene, radiological examinations are carried out without removing the body from the bag, and then postmortem examinations are carried out according to the rules in accordance with the international protocols for mass disasters.

In conclusion, a rapid and comprehensive organization and a multidisciplinary working system (republican prosecutors, forensic medicine specialists, forensic medicine technicians, crime scene investigation specialists, forensic biologists, forensic dentist physicians, and forensic anthropologists and supported by relevant voluntary organizations) for identification and drawing up the death certificates at the scene are of great importance in order to clarify the legal problems in events that lead to mass deaths such as earthquakes. The results of postmortem examinations will have the value of definitive proof in solving legal problems that may be encountered in the future. However, what is more important is to be prepared for natural disasters in advance and in real terms.

Forensic Psychiatry in Mass Fatalities

Events occurring in a short period of time with various external, natural, and unnatural effects that cause the death of at least 12 people and the injury of many people according to some definitions as well as the destruction of the physical environment with various degrees have existed in almost every century of our civilization history. It is known that these events, which are widely called “disasters” in Turkish, are interpreted as traumatizing not only for the people who experienced them but also in a wide social environment. It is well known that as well as physical damage that can lead to death in foreground, mental traumas, and disorders developing as comorbid and all kinds of losses (such as the loss of relatives, physical environment, vital opportunities, and comfort) create an irreparable mourning. No matter how prepared, a sudden horror and freezing response when disaster strikes will lead to serious neuropsychiatric consequences in the future. After such an event, evaluation of all kinds of damage to the physical and mental integrity of the person is the main subject of expertise in reaching the conclusion of legal issues. Since the main subject of forensic medicine is to evaluate the physical and mental consequences of all kinds of trauma with the current medical criteria and present them to the court, it is imperative to detect physical as well as mental symptoms based on evidence within the framework of medical criteria. Different from physical assessment, various symptoms that are relatively abstract, sometimes impossible to detect and measure, make the assessment challenging. The effects of the event on professionals sometimes make a neutral assessment impossible. Moreover, such incidents, which shake society in general, will also harm all professionals who have to evaluate the situation closely and give support.

In the events leading to mass deaths, injuries, and losses accepted as a disaster, the main topics that are important from the neurological and psychiatric perspectives in the recording and evaluating the data as required by law are listed below:

1. Information to be recorded in Medical Assistance in the Acute Period.
2. Consequences of Problems Experienced in Reaching Victims and Identifying Disaster Victims.
3. Urgent Organization and Channelization of Neurological and Psychiatric Consultation Processes.
4. Evaluation of Advanced Neurological and/or Psychiatric Findings in the Medium and Long Term.

Since mass deaths that occur naturally (earthquake, flood, tsunami, hurricane, landslide, etc.) or unnaturally (war, acts of terrorism, etc.) are situations that require urgent intervention, primary medical intervention is vital as a part of emergency medicine to keep the patient alive and to continue the organic treatment, psychiatric evaluation, and help could stay in the background. Since easily observable psychiatric symptoms are accepted as normal, emergency psychiatric intervention is in the second place and these findings are not recorded in the medical records as detailed as other physical findings, and sometimes they are not even recorded. It is customary to have such a hierarchical structure in somatic and psychiatric assessments.

However, in the future, the mental symptoms that occur as the dimensions of the damage are confronted will cause functional problems as much as the physical damage. Professionals working for emergency medical assistance in the area should record all findings, whether physical or mental, normal or unusual, as much as possible. Even if all systems have been evaluated after the necessary emergency medical intervention, some issues should be considered. Everyone’s reaction to events that are considered a traumatic event is different from each other. Someone who seems very calm after the event may have developed a severe acute stress response of confusion and petrification. The cold-blooded and powerful image is just an image. Excessive calmness to the point of dullness may require urgent psychiatric consultation and intervention. Attention should be paid not only to noisy and easily observed acute stress reactions but also to such symptoms, and neurological evaluation and consultation should not be neglected as they will be confused with some neurological manifestations.

In long-term assessments, it is mandatory to evaluate issues such as how long the neurological and psychiatric findings last, whether they are already present or not, if they are present, how they respond to treatment, how they affect functionality, and whether the person simulates symptoms in order to reach the final result. Consultations, including past medical records, examination findings, and necessary neurological and psychometric tests should be done completely, as all details in the expertise have to be interpreted in an evidence-based manner if possible, and the final evaluation should be postponed when necessary, as such disorders and diseases may show significant improvements or worsening in the process.

For the survivors, finding the relatives of the disappeared and, if found dead, duly burial after identification is of special importance not only in terms of religion and culture but also in terms of mental health. For loved ones whose fate is not known, the disappearances become “ghosts,” a well-known phenomenon. They neither live nor die. This situation causes a healthy grieving process to not be experienced. Since the issue of survival and meeting basic needs, which is much more urgent for everyone, is at the forefront,

this issue can be skipped without paying due attention. The importance of DVI should in no way be underestimated. The existence of corpses that cannot be reached because they are under debris or rubble after major earthquakes or that are presumed missing or whose integrity has been severely damaged after knife accidents, major explosions, and conflicts requires a very meticulous and careful separate study, as it is necessary to make identification at the DNA level. All professionals working in the disaster area should know what a part of the victim's body, even a tiny piece of tissue, means to their anxious relatives. Every loss that cannot be found and buried may cause the living to be unable to complete their mourning like a ghost. This can lead to various mental symptoms that can even be passed on from generation to generation. Although the mass graves where unknown people are buried and the missing bodies may seem strange at first, they are of great importance for the mental health of the relatives.

It should be kept in mind that all kinds of professionals, including medical personnel working at the scene, can be severely affected after such an event, which is a neglected condition that only takes place in DSM 5. Although they are defined as natural disasters, even if major events such as lightning strikes, unexpected tsunamis, plane crashes, and ship accidents are considered to occur naturally, what actually kills and damages people is the fact that the settlements they have established to live together which does not compensate the necessary response against all these natural events. A settlement built on a flood bed, a hotel built without taking into account the avalanche, and buildings built without adequate consideration of the earthquake threat still cause frightening losses despite our knowledge. Leaving the unpredictable aside, victims who survive such incidents begin to question the cause of the incidents after a few months, sometimes even not that long, as an expected humanitarian response. In fact, to put it better, after the answer to the question "What happened?", the question "Why did it happen?" or "Why did it happen to me?" starts from the very first hours. However, the effort to survive and reach righteousness causes this problem to remain in the background for a certain period of time. Nevertheless, it will soon be brought to the fore and it will perhaps cause a lifetime of reckoning. At that time, a clear understanding of justice and claims for compensation begin to form the agenda of the person and the inevitable end of this is a court. The most important basis for the court to make a decision is the expert reports that have evaluated scientific data in an objective and neutral way.

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