SYSTEMATIC REVIEW

Ethical Issues in Technological Disaster: A Systematic Review of Literature

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Abstract

Background: Industrialization could bring risk of Technological Disaster (TD) such as happened in Chernobyl, Bhopal and Fukushima crisis. Little has been discussed about its related ethical issues. In this study, we aimed to investigate ethical issues have been stated for technological disasters.

Methods: A systematic search was conducted on the main international literature databases including Pubmed, Embase, Scopus and ISI (Jan 1, 2000 to Jan 1, 2018). From 64 articles were eligible for investigation of ethical issues in Natural disaster, 6 was related to Technological Disaster. The articles were in English language.

Results: Our result show that there are seven articles discussing ethical issues during Technological disaster. All of them are related to nuclear crisis in Fukushima resulting from Japan tsunami 2011. These articles discussed mainly three ethical issues in providing medical care to victims of Technological Disasters as follow: 1- Duty of care 2- Mandatory evacuation and 3- Resource Allocation.

Conclusion: Victim health is the main factor for making decision and implementation of any programs during response to disasters. Mandatory Evacuation for reasons other than providing health to people (such as: maintain public order) and if bring health risk to people will be unjustified. Duty of health workers for providing care is based on General beneficence meanwhile it is necessary to provide facilities to protect them from dangers that treat them in the field. For act ethically, Health workers must have adequate preparedness for response to T-D meanwhile it is necessary to provide guidelines for individuals that participation in relief operation. It is necessary to discuss more about Technological Disaster Ethics especially in industrial countries and where there is especial industrial with potential of huge crises.

Level of evidence: I

Keywords: Mandatory evacuation, Medical Ethics, Duty of care, Resource Allocation, Systematic review, Technological-disaster

Introduction

Technological Disasters (TD) is a Non-Intentional Man-Made disaster in contrast to war and can be caused by crisis happen in transport system (air, road traffic crashes and so), human-made structures and industrials that contain chemical, biological, radiological, or nuclear materials (1-3). Disasters in
vast range have impact (directly and indirectly) on
the health condition of community. It has been found
that Mortality resulting from disaster include TD has
significant negative effect on Gross Domestic Product
(GDP) of inflicted countries which indirectly influence
health condition of them (4).

The most dangerous one that have been recorded
are Chernobyl, Bhopal and Japan crisis (5, 6). During
Bhopal crisis more than half a million exposed to
methyl isocyanide (MIC) gas and other chemicals.
About 30,000 of them lost their lives (10,000 in the
first days and 15,000 to 20,000 in next two decades)
(7). Explosion of Chernobyl reactor happened on
April 26, 1986. In two stages more than 380,000
vacuated the area around the reactor (135,000
in the first phase and about 250,000 others in the
spring of 1989). There is controversy about deaths
from this crisis meanwhile according to the Ukrainian
government statistics, about 12,000 clean workers
that participated in operation of decontamination lost
their lives (8). According to a report, it is estimated
that about five million people radionuclides resulting
from crisis in three countries of Belarus, Russia and
Ukraine. It has been reported 4000 cases of thyroid
cancer due to explosion that mainly were children and
young people. Only nine deaths reported for them (9).

As mentioned, this type of disaster could result to
huge and very destructive crisis with long effects on
the health and environment condition (10).

Despite all consequences of TD, less has been
discussed about ethical issues that encounter during
providing care to its victims in response phases. In
this study, we aimed to investigate the ethical issues
has been reported by health workers during providing
care to victims of technological disasters through a
systematic review study.

Materials and Methods
We performed a systematic review of literature by
searching four main international literature databases
including: Pubmed, Embase, Scopus and ISI. The
search achieved in March 30, 2014 and consist articles
published in the period of Jan 1, 2000 to Jan 1, 2018.
The search strategy that used for selection of relevant
articles is shown in the first Appendix. The study
performed in Medical Ethics and History of Medicine
Research Center (MEHMRC).

There were more than 28000 articles in our search.
About 5000 excluded due to duplication [Figure 1]. The
evaluation achieved based on inclusion and exclusion
criteria as defined in Table 1, the judgment about the
articles was based on title and abstracts. Finally, 345
articles selected selected for eligible process which
was done by their full text. From them, 72 articles were
suitable for our study and were related to ethical issues
in medical treatment of victims of disasters. Among
these articles, seven was related to technological
disaster totally Japan Tsunami and Fukushima nuclear
power accident. The review was achieved two times
and the extracted texts were coded for ethical issues
using inductive qualitative content analysis. More
than 80 codes were created and reviewed frequently
until categorized in 7 groups as subtheme and finally
3 them.

We used the ATLAS.ti 5.2 software for analysis.
Inclusion and exclusion criteria are mentioned in
Table 1.

Results
Our study showed that there are seven articles from
64 discussing ethical issues in natural disaster were
about providing health care to victims of TD. Three
articles were review, and others were case report (1),
Commentary (2) and the last was analytic discussion.
Two articles have been published in 2011, four others
in 2012 and the last in 2016.

The debate of these articles is mainly about three
issues that discussing ethical factors in providing
medical care to victims of Natural-Technological
disasters including: 1- Duty of care 2- Resource
Allocation and 3-Mandatory evacuation. The analysis
showed seven themes discussing as follow:

1- Duty of Care
Related issues have been categorized in three parts
as follow:
1- Ethical principle for duty to Care: Wicclair et al
mentioned a question about the duty of care and say
whether physicians have duty to provide care to the
victims of disaster in every circumstance and argues
that this question is an ancient one (11).

Narita et al, encounter an ethical dilemma following
fukushima nuclear disaster (12). They believe
that professionalism principles as excellence,
Humanitarian, accountability and altruism are the
source of physician duty for providing care to victims
disasters in affected area. On the other hand, it is
nessacary to make attention to safety of physician
who work in area where there is a risk of radiation.
Now, if these physician want to leave the area to protect
their health, What should we do? A high standard of
professionalism prevents them from leaving, but we

Table 1. Inclusion and Exclusion criteria

<table>
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<tr>
<th>Inclusion Criteria</th>
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<tbody>
<tr>
<td>Years limited to 2000-2013</td>
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<tr>
<td>English Language</td>
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<tr>
<td>Technological Disaster</td>
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<td>Article published Pubmed, Embase, Scopus and ISI</td>
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<table>
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<th>Exclusion Criteria</th>
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<tr>
<td>Duplication</td>
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<tr>
<td>War related</td>
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<tr>
<td>research</td>
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<tr>
<td>epidemic Illness</td>
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<tr>
<td>language other than English</td>
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<tr>
<td>Book review</td>
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<td>Conference Articles (Abstract)</td>
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can not ignore the possible damage to them. Akabayashi argues that doctors should go in critical situations to help victims and has been stated reasons for responsibility of physician for work in affected area as follow: 1- The main reason for ethical responsibility is “Beneficence principle” (13). 2- The society has spent for her/his. This spending is directly and indirectly by family and government and so... 3- the physician has special privilege in the society and the last reason is solidarity. 4- Solidarity: A society is survived only by help and assist of his people. 5- People expectation: People expect doctors and medical personnel use their knowledge and expertise to help them at the time of disaster or another emergency.

Figure 1. Flowchart of the review process.
situation.

2- Limitation for beneficence: As mentioned above, the main reason for duty of care is Beneficence principle meanwhile there is a question about the extent and level of beneficence. Is it any limitation for it or it is absolute? Akabayashi et al believed that there is limitation for general beneficence and state that it is based on three factors: 1- necessity and urgency of situation (14). 2- The severity of compliance if the physician does not help and 3- the moral agent's ability for prevention from compliances must considered and the rate of moral agent sacrifice should be to account.

About the extent of dangers that medical personnel could sustain for helping to survival of disasters, Akabayashi have been pointed to Beauchamp and Childress argument. Beauchamp and Childress expressed that 'a person (1) has a determinate obligation of beneficence towards another person (2) if and only if each of the following conditions is satisfied (14, 15):
1- Y is at risk of significant loss of or damage to life or health or some other major interest.
2- X’s action is necessary (singly or in concert with others) to prevent this loss or damage.
3- X’s action (singly or in concert with others) has a very high probability of preventing it.
4- X’s action would not present significant risks, costs, or burdens to X.
5- The benefit that Y can be expected to gain outweighs any harms, costs, or burdens that X is likely to incur.'

In the following, they affirm that it is very difficult to decline "significant Risk". Definition of risk and its severity and rate is different towards people and nations (15). 3- Barriers to duty of care: The barriers are divided in two groups: the first one is related to health of themselves and their relatives. For health factors, the safety of person is important. Radiation could bring acute and chronic injuries and illness meanwhile all complications due to exposure to radioactive are not clear and could appear many years later. Injuries resulting from radioactive could debar them for taking care from their relatives that is their ethical responsibility. So, they are worry about their families: children, parents or all people who they taking care of them. Akabayashi, mention the reasons of one physician who after passing many days in providing care in Fukushima decided to leave the area (13). The physician says:

"My parents are pleading with me to come back home to them in Hiroshima. I have a family that needs me ...... What are you going to do for me if I can't have any more children because of this?"

The second group includes the following factors: 1- responsibility to patients that before disaster he/ she was treated. Normally they are working in health centers and have responsibility of many patients. If they left their patients who will take care of them? 2- The type of treat is important. In an earthquake the severity and consequence of situation to a great extent is obvious but in a nuclear accident it is very hard and sometimes impossible to determine of contamination and the risk of radiation. Mental history and past experiences can also have an effect. The physician has born in Hiroshima where has been experience an Atomic Attack in the end of World War II (13).

2- Resource allocation
Two groups of factors have been mentioned for distribution of scarce resource in disasters such as nuclear explosion: 1- Medical and 2-Non-medical factors.

1- Medical factors: In usual situation, the need of patients is the main factor for priority and person who need more take care soon than others. It seems this manner is based on proportionality principle. In situation that there is a lack of resource, efficacy will be added. In addition, for justifying ethically, the resource allocation must be fairness. So due to scare of resource in disaster, two other factors must be considering: Efficiency and fairness. Caro et al (16) divided patients into three categories based on their need:

1- Urgency: patients that need to intervention in quickly as possible to live. The more risk of death is enough important that considered first priority meanwhile the considered intervention must have potential to prevent the death. 2- Victims that if untreated there is very little chance to die but will give severe compliance. 3- Patients who his/her injury is not severe and it is possible to delay the treatment.

The less risk of severity compliance considered as second priority and as mentioned above the intervention has potential to prevent from the severe compliance. In addition, the access to need facilities is marked factor so what we could deduction is that the heist need (death) plus ability to response it with suitable intervention and present of related facilities take the highest priority.

If many patients entered the emergency rooms while have equal need, randomy selection could be fairness. If could allocate resource equally this is fairness

2- Non-medical factors: It should be noted that some factors such as race, gender, socio-economic and previous health conditions that have no effect on therapeutic efficacy must not consider for rationing health care. Potential conditions or performance (benefit) of future should not have place in the decision to treat or not to treat victims.

For fairness or ethical justifying the allocation in a crisis situation it must consider two aspects: the patient's medical needs and the ability to meet this need so decision must be taken on the basis of the two. Non-medical factors when effect usually is justifying such as age and sex but as independent factor are not acceptable ethically.

Knebel et al stated that flexibility is an important factor in R.A. so they argue the six strategies for manages resource in crisis situation including (17):

1- Preparedness: Warehousing and storage of
necessary equipment and materials according to the potential threat.
2- Substitute: The use of equipment or personnel to replace the original ones whenever needed and can do the same job.
3- Adapt: Use of equipment and personals based on the needs and constraints, adapting to existing conditions and try to maximum utilization of facilities.
4- Conserve: Less use of resources by reducing the dose or changing the application way.
5- Reuse: Re-use of facilities after separation and proper sterilization.
6- Reallocation: such as Assign a ventilator from a patient to another that was more profit or more is needed, or cut down a treat (18).

Mandatory Evacuation
1- Negative consequences of Mandatory evacuation: Living in camp or new accommodation pursuant mandatory evacuation will have serious problems. Debate usually is on the measures such as: Violation of privacy, individual freedoms and rights of citizens are important. On the other hand, health problems are being raised. There was Lack of food, water and poor sanitary conditions in Fukushima. Basic necessities such as water and food supply and medical supplies were resolved gradually but bad state of health and the problem of privacy remained. It is believed that Paternalisms acceptable and necessary in this situation since it could prevent the further damage meanwhile the mentioned problems must solve meanwhile attention to people Consent and cooperation for providing appropriate services is necessary (6).
2- The cause of Mandatory evacuation: Two mandatory evacuation orders was announced following Tsunami in Japan (2011). Certainly in the first, the aim was protection of people towards possible side effects of radiation but there is a doubt about the second time whether it is ordered for protection individuals from health consequences or maintaining public order since there are reports from Insecurity in the affected area. The author stated that the only reason that makes mandatory evacuation justifiethethically is protection resident’s health and safety that live in the affected area. The author opinion is that other methods to maintain public order for example; usage of army and military forces for maintenance of public order (6).

Discussion
Our study shows that there are a few articles discussing ethical issues in the field of providing care to victims of technological disaster. Comparing natural disaster, TD such as happened in Fukushima are rare and we have been witness for only two samples from this type of disaster; Chernobyl and Fukushima.
Review of articles show that they have been focused mainly on three ethical issues: 1- Duty of care 2- Mandatory evacuation and 3- Resource Allocation.
The main issue about “Duty of care” was a question and it is “to what extent professionals have duty to participate in relief operation and provide care to victims”.
For ethical responsibility of physician, the American Medical Association (AMA) stated that physician must provide care to injured and ill person at the time of emergencies and during disaster even if the likely risk is more than what is normally found (19, 20). Iserson et al stated that professional has duty to accept fairly a part of the risks in the workplace (21). Morin et al believed that doctors should not put themselves in danger if its benefit is less than the danger (22). On the other hand, professionals have duty to save their safety and health (19, 23).
So, care workers must protect from their health and life meanwhile they must accept the risk for help to injured people. In fact, they must balance between the risk and benefit of their provided care. It seems that manner is based on proportionality principle. Now, there is a question: what extent is the risk that they could accept? Unfortunately, there is not an exact response to this question. The fact is that it is impossible to determine a sharp and exact line between duty and un-duty for care in disaster.
Beneficence principle is the main cornerstone for duty of care in disaster. As said, there are limitations for it. Beauchamp and Childress describe the border of risk acceptance and no as “Significant Risks” but they themselves mentioned that there is an important problem and it is very difficult to determine an exact definition for “significant risks”. We must pay attention to existence of this differences definition for risk and its acceptable border nationally and internationally (15).
It seems that is why somebody despite prevail of utilitarian ethics in disaster believe that virtue ethics and self-sacrifice could help us in very difficult circumstance such as that the manager of Fukushima Daiichi Nuclear power plant did (24).
2- Prevention of negative health and social consequences is a main factor for justifying mandatory evacuation ethically. Some reports suggest that the number of people who lost their lives resulting from mandatory evacuation in Fukushima was more than tsunami itself. Further studies have shown that this increase is related to older individuals who lived in a nursing home. Changes in living, the creation of new conditions and especial needs in camps or new location resulted to increasing of mortality. This reports show that the initial stages of individual’s evacuation that are alone have the greater risk and can increase the mortality of the elderly (25, 26).
To deal with this problem and prevent mortality of elderly people in similar circumstances, a model of forced evacuation suggested. The Results of studies in Chernobyl show that the thyroid cancer is the most common one among victims of a nuclear explosion. The time necessary for complications in the elderly is very more than their life expectancy. Due to the long-term effects of radiation on children and youth people, the evacuation is essential for their health and safety. Due to this issue it is offered that we allow elderly to remain in affected area meanwhile force young and
children to abandon there.

Taking into account life expectancy considering the results of health evaluation of Chernobyl victims, we may be able to allow to elderly who are not willing to leave the area, remain in their homes in affected area meanwhile children and young people leave the area even by force if necessary. In contrast, the opponents believe that this policy will divide family and could be harmful. This manner of evacuation can cause a rupture in the family structure. In addition, it is necessary to note that some of these people were living in nursing homes and others lived alone in a house.

The second issue is whether public order could be morally acceptable a reason for the mandatory evacuation of people following occurrence of disaster? In answer they stated that only protection of individual health and safety is acceptable ethically and we can take another way to establish public order expect evacuation.

3- What has been mentioned for Resource allocation in a TD is similar to that is accepted in other natural disaster but it seems that determination of severity and extent of injuries following a TD make decision making very difficult. Due to the unknown extent of the affected area in some of TD such as a atomic explosion, make assessment of the amount and type of injuries very difficult and somewhat unpredictable. Need and efficacy of intervention are the basic elements for Decision but when the compliance and extent of injuries is unknown, efficiency of treatment is not certain non-predictable. In a earthquake, flood and so, the type of injuries and related illnesses or their severity is predictable in a great extent but our knowledge about consequences of TD such as a atomic accident is very little and inadequate.

Another issue is repeated assessment of field situation and evaluation of victim's health condition. It's an important factor to make correct and ethical decision for resource allocation. We need accurate and timely information for decision. It is very likely that we obligated to change previous decisions such as that need to do in repeat triage. The repeat triage usually bring hard situation for decision making while we have less discussion about it among professionals (18).

Someone has been trying to answer to this question: what extent is the risk that care providers could accept during disaster? According to the utilitarian ethics we must balance between the risk and benefit of care that will be provided. It is based on proportionality principle. Unfortunately, it isn’t possible to determine a sharp and exact border between ethically acceptable and non-acceptable duty in disaster.

Mandatory evacuation has negative effect on health and social condition of victims. We must try reducing these negative effects. One way is that the reason of evacuation limited to control of a health reason. In the other hand, mandatory evacuation is acceptable ethically only when is based on protection from health condition of affected individuals and Establish of public order could not be acceptable one. For establish public order in affected area it is possible to use from police or army forces. The proposed method to prevent mortality of elderly in mandatory evacuation was allowing to elderly to stay in the affected area and transfer young and children. It is not acceptable since it will result to disintegration of the family structure.

Resource allocation is fair only when is based on medical need. In addition, selected intervention must be effective. Non-medical factors alone and as an independent factor could not be ethically acceptable. There is not a prominent difference between triage in Natural and Technological disaster except that the determination of extent and severity of injuries is very difficult.

**Limitation:** Total articles is related to Fukushima or one of TD. The previous technological disasters have not been investigated ethically. It is possible that rerlated articles has been published in nationality language that is outed from our study. The English language is one of exclusion criteria. The likely of outbreak of Technological disasters increase follow industrialization of more countries in the world. Our knowledge is low and will be so since some of them will not reported since political or financial problems.

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