

1 **Ethical issues in Technological disaster: A systematic review of literature**

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

6 Material and Methods: A systematic search was conducted on the main international
7 literature databases including Pubmed, Embase, Scopus and ISI (Jan 1, 2000 to March 30,
8 2014). From 64articles were eligible for investigation of ethical issues in Natural disaster, 6
9 was related to Technological Disaster. The articles were in English language.

10 Result: Our result show that there are six articles discussing ethical issues during
11 Technological disaster. All of them are related to nuclear crisis in Fukushima resulting from
12 Japan tsunami 2011. These articles discussed mainly three ethical issues in providing medical
13 care to victims of Technological Disasters as follow: 1- Duty of care 2- Mandatory
14 evacuationand3- Resource Allocation.

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

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26 Introduction:

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

34 The most dangerous one that have been recorded are Chernobyl, Bhopal and Japan crisis (5,
35 6). During Bhopal crisis more than half a million exposed to methyl isocyanide (MIC) gas
36 and other chemicals. About 30,000 of them lost their lives (10,000 in the first days and
37 15,000 to 20,000 in next two decades) (7). Explosion of Chernobyl reactor happened on April
38 26, 1986. In two stages more than 380,000 evacuated the area around the reactor (135,000 in
39 the first phase and about 250,000 others in the spring of 1989). There is controversy about
40 deaths from this crisis meanwhile according to the Ukrainian government statistics, about
41 12,000 clean workers that participated in operation of decontamination lost their lives (8).
42 According to a report, it is estimated that about five million people radionuclides resulting
43 from crisis in three countries of Belarus, Russia and Ukraine. It has been reported 4000 cases
44 of thyroid cancer due to explosion that mainly were children and young people. Only nine
45 deaths reported for them (9).

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

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

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56 Material and methods:

57 We performed a systematic review of literature by searching four main international literature
58 databases including: Pubmed, Embase, Scopus and ISI. The search achieved in March 30,
59 2014 and consist articles published in the period of Jan 1, 2000 to March 30, 2014. The
60 search strategy that used for selection of relevant articles is shown in the first Appendix. The
61 study performed in Medical Ethics and History of Medicine Research Center (MEHMRC).

62 There were 26000 articles in our search. About 4000 excluded due to duplication (Figure 1).

63 The evaluation achieved based on inclusion and exclusion criteria as defined in Table 1, the
64 judgment about the articles was based on title and abstracts. Finally, 400 articles selected for
65 eligible process which was done by their full text. From them, 64 articles were suitable for
66 our study and were related to ethical issues in medical treatment of victims of disasters.

67 Among these articles, six was related to technological disaster totally Japan Tsunami and
68 Fukushima nuclear power accident. The review was achieved two times and the extracted
69 texts were coded for ethical issues using inductive qualitative content analysis. More than 80
70 codes were created and reviewed frequently until categorized in 7 groups as subtheme and
71 finally 3 them.

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

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79 Results:

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

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

88 **1- Duty of Care:** related issues have been categorized in three parts as follow:

89 1- Ethical principle for duty to Care: Wicclair et al (11) mentioned a question about the duty
90 of care and say whether physicians have duty to provide care to the victims of disaster in
91 every circumstance and argues that this question is an ancient one. Akabayashi (12) argues
92 that doctors should go in critical situations to help victims and has been stated reasons for
93 responsibility of physician for work in affected area as follow: 1- The main reason for ethical

94 responsibility is “Beneficence principle”. 2- The society has spent for her/his. This spending
95 is directly and indirectly by family and government and so... 3- the physician has special
96 privilege in the society and the last reason is solidarity. 4- Solidarity: A society is survived
97 only by help and assist of his people. 5- People expectation: People expect doctors and
98 medical personnel use their knowledge and expertise to help them at the time of disaster or
99 another emergency situation.

100 2- Limitation for beneficence: As mentioned above, the main reason for duty of care is
101 Beneficence principle meanwhile there is a question about the extent and level of
102 beneficence. Is it any limitation for it or it is absolute?

103 Akabayashi et al (13) believed that there is limitation for general beneficence and state that it
104 is based on three factors: 1- necessity and urgency of situation. 2- The severity of compliance
105 if the physician does not help and 3- the moral agent's ability for prevention from
106 compliances must considered and the rate of moral agent sacrifice should be to account.

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108 About the extent of dangers that medical personnel could sustain for helping to survival of
109 disasters, Akabayashi (13) have been pointed to Beauchamp and Childress argument.

110 Beauchamp and Childress (14) expressed that ‘a person (1) has a determinate obligation of
111 beneficence towards another person (2) if and only if each of the following conditions is
112 satisfied:

113 1- Y is at risk of significant loss of or damage to life or health or some other major interest.

114 2- X’s action is necessary (singly or in concert with others) to prevent this loss or damage.

115 3- X’s action (singly or in concert with others) has a very high probability of preventing it.

116 4- X’s action would not present significant risks, costs, or burdens to X.

117 5- The benefit that Y can be expected to gain outweighs any harms, costs, or burdens that X
118 is likely to incur.’

119 In the following, they affirm that it is very difficult to decline “significant Risk”. Definition
120 of risk and its severity and rate is different towards people and nations (14).

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122 3- Barriers to duty of care: The barriers are divided in two groups: the first one is related to
123 health of themselves and their relatives. For health factors, the safety of person is important.
124 Radiation could bring acute and chronic injuries and illness meanwhile all complications due
125 to exposure to radioactive are not clear and could appear many years later. Injuries resulting
126 from radioactive could debar them for taking care from their relatives that is their ethical
127 responsibility. So, they are worry about their families: children, parents or all people who
128 they taking care of them. Akabayashi (12), mention the reasons of one physician who after
129 passing many days in providing care in Fukushima decided to leave the area. The physician
130 says:

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

134 The second group includes the following factors: 1 - responsibility to patients that before
135 disaster he/she was treated. Normally they are working in health centers and have
136 responsibility of many patients. If they left their patients who will take care of them? 2-The
137 type of treat is important. In an earthquake the severity and consequence of situation to a
138 great extent is obvious but in a nuclear accident it is very hard and sometimes impossible to
139 determine of contamination and the risk of radiation. Mental history and past experiences can
140 also have an effect. The physician has born in Hiroshima where has been experience an
141 Atomic Attack in the end of World War II (12).

142 **2- Resource allocation:**

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

145 1- Medical factors: In usual situation, the need of patients is the main factor for priority and
146 person who need more take care soon than others. It seems this manner is based on
147 proportionality principle. In situation that there is a lack of resource, efficacy will be added.
148 In addition, for justifying ethically, the resource allocation must be fairness. So due to scare
149 of resource in disaster, two other factors must be considering: Efficiency and fairness. Caro
150 et al (15) divided patients into three categories based on their need:

151 1- Urgency: patients that need to intervention in quickly as possible to live. The more risk of
152 death is enough important that considered first priority meanwhile the considered
153 intervention must have potential to prevent the death. 2- Victims that if untreated there is very
154 little chance to die but will give severe compliance. 3- Patients who his/her injury is not
155 severe and it is possible to delay the treatment.

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

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

163 2- Non-medical factors: It should be noted that some factors such as race, gender, socio-
164 economic and previous health conditions that have no effect on therapeutic efficacy must not

165 consider for rationing health care. Potential conditions or performance (benefit) of future
166 should not have place in the decision to treat or not to treat victims.

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

171 Knebel et al (16) stated that flexibility is an important factor in R.A. so they argue the six
172 strategies for manages resource in crisis situation including:

173 1- Preparedness: Warehousing and storage of necessary equipment and materials according to
174 the potential threat.

175 2- Substitute: The use of equipment or personnel to replace the original ones whenever
176 needed and can do the same job.

177 3- Adapt: Use of equipment and personals based on the needs and constraints, adapting to
178 existing conditions and try to maximum utilization of facilities.

179 4- Conserve: Less use of resources by reducing the dose or changing the application way.

180 5- Reuse: Re-use of facilities after separation and proper sterilization.

181 6- Reallocation: such as Assign a ventilator from a patient to another that was more profit or
182 more is needed, or cut down a treat (17).

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184 **3- Mandatory Evacuation:**

185 1- Negative consequences of Mandatory evacuation: Living in camp or new accommodation
186 pursuant mandatory evacuation will have serious problems. Debate usually is on the
187 measures such as: Violation of privacy, individual freedoms and rights of citizens are
188 important. On the other hand, health problems are being raised. There was Lack of food,
189 water and poor sanitary conditions in Fukushima. Basic necessities such as water and food

190 supply and medical supplies were resolved gradually but bad state of health and the problem
191 of privacy remained. It is believed that Paternalisms acceptable and necessary in this situation
192 since it could prevent the further damage meanwhile the mentioned problems must solve
193 meanwhile attention to people Consent and cooperation for providing appropriate services is
194 necessary.

195 2- The cause of Mandatory evacuation: Two mandatory evacuation orders was announced
196 following Tsunami in Japan (2011). Certainly in the first, the aim was protection of people
197 towards possible side effects of radiation but there is a doubt about the second time whether it
198 is ordered for protection individuals from health consequences or maintaining public order
199 since there are reports from Insecurity in the affected area. The author stated that the only
200 reason that makes mandatory evacuation justify ethically is protection resident's health and
201 safety that live in the affected area. The author opinion is that other methods to maintain
202 public order for example; usage of army and military forces for maintenance of public order.

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204 Discussion:

205 Our study shows that there are a few articles discussing ethical issues in the field of providing
206 care to victims of technological disaster. Comparing natural disaster, TD such as happened in
207 Fukushima are rare and we have been witness for only two samples from this type of disaster;
208 Chernobyl and Fukushima.

209 Review of articles show that they have been focused mainly on three ethical issues: 1- Duty
210 of care 2- Mandatory evacuation and 3- Resource Allocation.

211 The main issue about "Duty of care" was a question and it is "to what extent professionals
212 have duty to participate in relief operation and provide care to victims".

213 For ethical responsibility of physician, the American Medical Association (AMA) stated that
214 physician must provide care to injured and ill person at the time of emergencies and during
215 disaster even if the likely risk is more than what is normally found [18, 19]. Iserson et al (20)
216 stated that professional has duty to accept fairly a part of the risks in the workplace. Morin et
217 al (21) believed that doctors should not put themselves in danger if its benefit is less than the
218 danger. On the other hand, professionals have duty to save their safety and health (18, 22).

219 So, care workers must protect from their health and life meanwhile they must accept the risk
220 for help to injured people. In fact, they must balance between the risk and benefice of their
221 provided care. It seems that manner is based on proportionality principle. Now, there is a
222 question: what extent is the risk that they could accept? Unfortunately, there is not an exact
223 response to this question. The fact is that it is impossible to determine a sharp and exact line
224 between duty and un-duty for care in disaster.

225 Beneficence principle is the main cornerstone for duty of care in disaster. As said, there are
226 limitations for it. Beauchamp and Childress describe the border of risk acceptance and no as
227 “Significant Risks” but they themselves mentioned that there is an important problem and it
228 is very difficult to determine an exact definition for “significant risks”. We must pay attention
229 to existence of this differences definition for risk and its acceptable border nationally and
230 internationally (14).

231 It seems that is why somebody despite prevail of utilitarian ethics in disaster believe that
232 virtue ethics and self-sacrifice could help us in very difficult circumstance such as that the
233 manager of Fukushima Daiichi Nuclear power plant did (23).

234 2- Prevention of negative health and social consequences is a main factor for justifying
235 mandatory evacuation ethically. Some reports suggest that the number of people who lost
236 their lives resulting from mandatory evacuation in Fukushima was more than tsunami itself.

237 Further studies have shown that this increase is related to older individuals who lived in a
238 nursing home. Changes in living, the creation of new conditions and especial needs in camps
239 or new location resulted to increasing of mortality. This reports show that the initial stages of
240 individual's evacuation that are alone have the greater risk and can increase the mortality of
241 the elderly (24, 25).

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243 To deal with this problem and prevent mortality of elderly people in similar circumstances, a
244 model of forced evacuation suggested. The Results of studies in Chernobyl show that the
245 thyroid cancer is the most common one among victims of a nuclear explosion. The time
246 necessary for complications in the elderly is very more than their life expectancy. Due to the
247 long-term effects of radiation on children and youth people, the evacuation is essential for
248 their health and safety. Due to this issue it is offered that we allow to elderly to remain in
249 affected area meanwhile force young and children to abandon there.

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

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259 The second issue is whether public order could be morally acceptable a reason for the
260 mandatory evacuation of people following occurrence of disaster? In answer they stated that

261 only protection of individual health and safety is acceptable ethically and we can take another
262 way to establish public order expect evacuation.

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264 3- What has been mentioned for Resource allocation in a T.D is similar to that is accepted in
265 other natural disaster but it seems that determination of severity and extent of injuries
266 following a T.D make decision making very difficult. Due to the unknown extent of the
267 affected area in some of TD such as an atomic explosion, make assessment of the amount and
268 type of injuries very difficult and somewhat unpredictable. Need and efficiency of
269 intervention are the basic elements for Decision but when the compliance and extent of
270 injuries is unknown, efficiency of treatment is not in certain non-predictable. In a earthquake,
271 flood and so, the type of injuries and related illness or their severity is predictable in a great
272 extent but our knowledge about consequences of TD such as a atomic accident is very little
273 and inadequate.

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275 Another issue is repeated assessment of field situation and evaluation of victim, health
276 condition. It is an important factor to make correct and ethical decision for resource allocation.
277 We need accurate and timely information for decision. It is very likely that we are obligated to
278 change previous decisions such as that need to do in repeat triage. The repeat triage usually
279 bring hard situation for decision making while we have less discussion about it among
280 professionals (17).

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282 Limitation: Total articles is related to Fukushima or one of TD. The previous technological
283 disasters have not been investigated ethically. It is possible that related articles has been
284 published in national language that is out of our study. The English language is our
285 exclusion criteria. The likely of outbreak of Technological disasters increase follow

286 industrialization of more countries in the world. Our knowledge is low and will be so since
287 some of them will not reported since political or financial problems.

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290 Conclusion:

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

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

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306 Resourec allocation is fair only when is based on medical need. In addition,selected
307 intervention must be effective. Non-medical fctorsalone and as an independent factor could
308 not be ethichally acceptable. There is not a prominent differnce between triag in Natural and
309 Technologivcal disaster except that the determination of extent and severity of injuries is very
310 difficult.

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