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### Title

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### Permalink

<https://escholarship.org/uc/item/0zv6z7m3>

### Journal

Archives of Bone and Joint Surgery, 6(4)

### ISSN

2345-4644

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### Publication Date

2018-07-01

### DOI

10.22038/abjs.2018.22025.1580

Peer reviewed

**SYSTEMATIC REVIEW**

# Ethical Issues in Technological Disaster: A Systematic Review of Literature

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*Received: 07 March 2017*

*Accepted: 08 November 2017*

**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**

**T**echnological 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

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various roots have impact (directly and indirectly) on the health condition of community. It has been found that Mortality resulting from disaster include TD have 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 evacuated 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 of disasters in affected area. On the other hand, it is nessaccary 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**

#### Inclusion Criteria

Years limited to 2000-2013  
English Language  
Technological Disaster  
Article published Pubmed, Embase, Scopus and ISI

#### Exclusion Criteria

Duplication  
War related  
research  
epidemic illness  
language other than English  
Book review  
Conference Articles (Abstract)

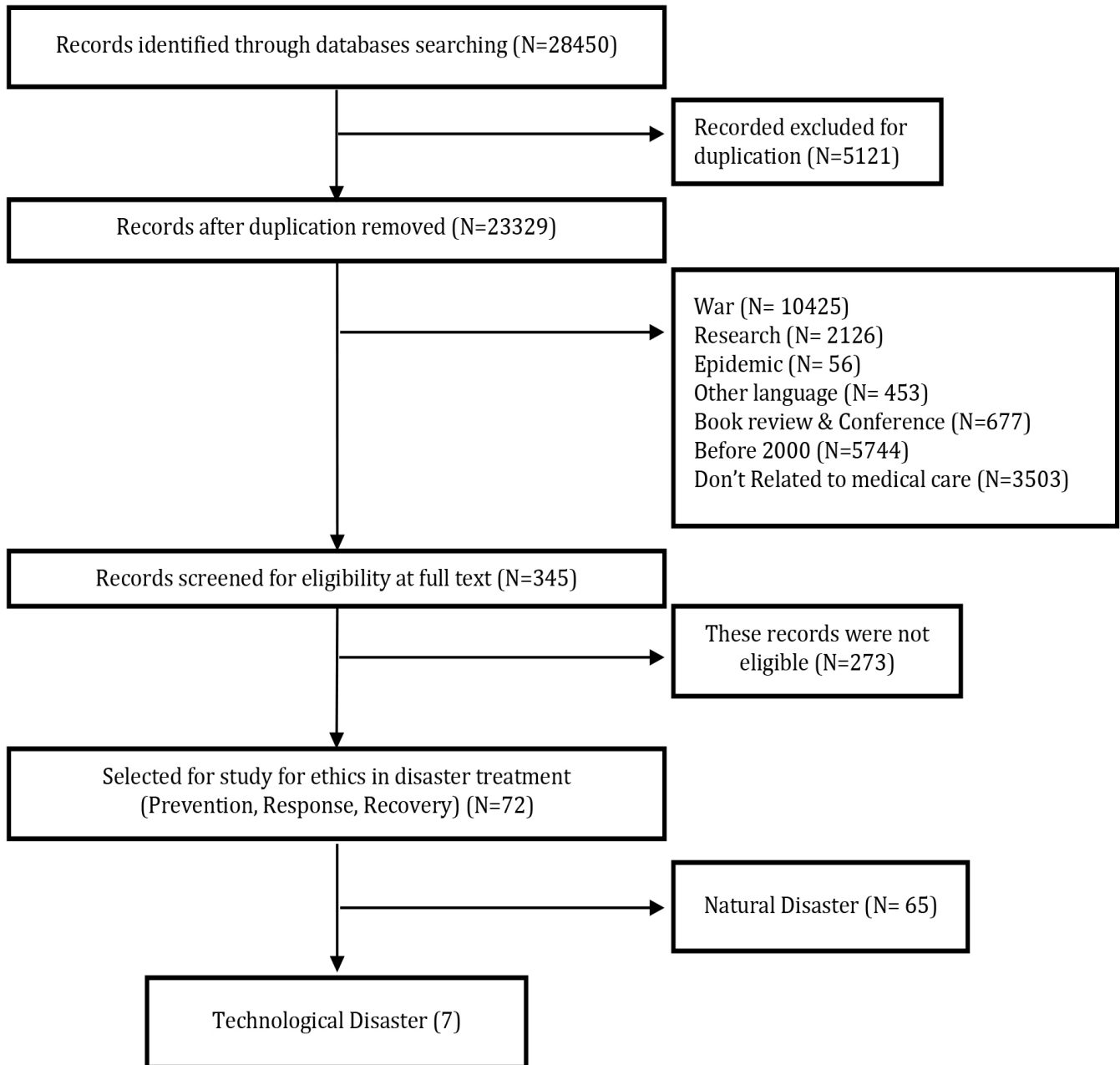


Figure 1. Flowchart of the review process.

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

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, randomly 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 justify ethically 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 beneficence 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 to 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 T.D is similar to that accepted in other natural disaster but it seems that determination of severity and extent of injuries following a T.D make decision making very difficult. Due to the unknown extent of the affected area in some of TD such as an atomic explosion, make assessment of the amount and type of injuries very difficult and somewhat unpredictable. Need and efficiency of intervention are the basic elements for Decision but when the compliance and extent of injuries is unknown, efficiency of treatment is not in certain non-predictable. In an 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 is 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 are obligated to change previous decisions such as that need to do in repeat triage. The repeat triage usually brings a hard situation for decision making while we have less discussion about it among professionals (18).

Someone has been tried 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 beneficence 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 a 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 Establishment of

public order could not be acceptable one. For establishment of 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 related to Fukushima or one of TD. The previous technological disasters have not been investigated ethically. It is possible that related articles has been published in national language that is out of our study. The English language is our exclusion criteria. The likelihood 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 be reported since political or financial problems.

### Acknowledgements

This study was approved by the Research Vice-Chancellor (Proposal No. 8921435002) and the ethics committee (IR.TUMS.VCR.REC.1396.3224) of Tehran University of Medical Sciences. This research was the subject of a Ph.D. thesis of Ali Khaji as a PhD Candidate in Medical Ethics, Medical Ethics and History of Medicine Research Center, Tehran University of Medical Sciences, Tehran, Iran.

**Funding/Support:** This research has been performed with a grant from Trauma and Surgery Research Center, Sina General Hospital, Tehran University of Medical Sciences (Grant Number: No.29/01/38/1392).

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