ORIGINAL RESEARCH

Estimating Blood Transfusion Requirements in Preparation for a Major Earthquake: The Tehran, Iran Study

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Keywords: blood transfusion; earthquake; estimate; Iran; needs; Tehran

Abbreviations:
AABB = American Association of Blood Banks
BTP = blood transfusion post
BTR = blood transfusion rate
CEST = Centre for Earthquake and Environmental Studies of Tehran
HAR = hospital admission rate
IBTO = Iranian Blood Transfusion Organization
IDR = injury-to-death ratio
JICA = Japan International Cooperation Agency
NT = North Tehran
RBC = red blood cell
TBTP = Tehran Blood Transfusion Post

Received: 05 June 2009
Accepted: 22 June 2009
Revised: 29 July 2009

Web publication: 03 June 2010

Abstract

Introduction: Tehran, Iran, with a population of approximately seven million people, is at a very high risk for a devastating earthquake. This study aims to estimate the number of units of blood required at the time of such an earthquake.

Methods: To assume the damage of an earthquake in Tehran, the researchers applied the Centre for Earthquake and Environmental Studies of Tehran/Japan International Cooperation Agency (CEST/JICA) fault-activation scenarios, and accordingly estimated the injury-to-death ratio (IDR), hospital admission rate (HAR), and blood transfusion rate (BTR). The data were based on Iran's major earthquakes during last two decades. The following values were considered for the analysis: (1) IDR = 1, 2, and 3; (2) HAR = 0.25 and 0.35; and (3) BTR = 0.05, 0.07, and 0.10. The American Association of Blood Banks' formula was adapted to calculate total required numbers of Type-O red blood cell (RBC) units. Calculations relied on the following assumptions: (1) no change in Tehran's vulnerability from CEST/JICA study time; (2) no functional damage to Tehran Blood Transfusion Post; and (3) standards of blood safety are secure during the disaster responses. Surge capacity was estimated based on the Bam earthquake experience. The maximum, optimum, and minimum blood deficits were calculated accordingly.

Results: No deficit was estimated in case of the Mosha fault activation and the optimum scenario of North Tehran fault. The maximum blood deficit was estimated from the activation of the Ray fault, requiring up to 107,293 and 95,127 units for the 0–24 hour and the 24–72 hour periods after the earthquake, respectively. The optimum deficit was estimated up to 46,824 and 16,528 units for 0–24 hour and 24–72 hour period after the earthquake, respectively.

Conclusions: In most Tehran earthquake scenarios, a shortage of blood was estimated to surge the capacity of all blood transfusion posts around the country within first three days, as it might ask for a 2–8 times more than what the system had produced following the Bam earthquake.

Tabatabaie M, Ardalan A, Abolghasemi H, Holakouie Naieni K, Pourmalek F, Ahmadi B, Shokouhi M: Estimating blood transfusion requirements in preparation for a major earthquake: The Tehran, Iran study. ***Prehosp Disaster Med*** **2010;25(3):246–252.**

Introduction

Tehran, the capital city of Iran has a population of more than seven million, and is located at the foot of the Alborz Mountains, which form part of the Alpine-Himalayan Orogenic Belt. Tehran has high seismic potential with many active faults, the most significant are the Ray, Mosha, and Tehran North faults. Although Tehran has not experienced severe damage due to earthquakes during the last 150 years, it has recorded several major earthquakes in its history. The latest earthquake with a magnitude of >7.0 on the Richter scale, occurred in 1830.[1]

As the most important city in the country in terms of politics and economy,[2] Tehran has experienced rapid urban development and increasing popu-

Year	Location	Magnitude*	Injury	Death	IDR
1990	Rudbar-Manji	7.3	105,090	40,000	2.63
2003	Bam	6.3	22,739	26,271	0.87
1997	Ghaenat	7.3	2,600	1,700	1.6
1997	Ardebil	6.1	2,600	965	2.70
2005	Zarand	6.4	1,621	612	2.65

Table 1—Earthquakes with more than 500 deaths, Iran, 1986–2007 (IDR = injury-to-death ratio)
*Richter scale

lation density during recent decades; however, appropriate earthquake mitigation measures have not been given a high priority.[3] The Centre for Earthquake and Environmental Studies of Tehran (CEST), in collaboration with the Japan International Cooperation Agency (JICA), has estimated a death toll ranging from 20,000–340,000 for an earthquake affecting Tehran, based on four fault-activation scenarios, with eight death-estimation scenarios for each (including two earthquake occurrence times and four rescue types).

The Iranian Blood Transfusion Organization (IBTO), the main agency responsible for providing safe blood during both non-emergency and emergency situations, expects that a Tehran earthquake would cause a disaster requiring the availability of a large blood supply, while the process of blood collection, safety testing, and distribution would be adversely affected. Quantitative assessment for blood requirements in the event of an earthquake would assist the organization to enhance its comprehensive response planning. This study aims to estimate the needs for blood following an earthquake in Tehran, and considers the surge capacity of IBTO around the country.

Methods

To predict the damage from a Tehran earthquake and estimate the related number of blood units that would be needed, the CEST/JICA fault-activation and death estimation scenarios were applied for a Tehran earthquake. The CEST/JICA assumed that an earthquake affecting Tehran would occur on an active fault near the city. Accordingly, four earthquake model scenarios were developed based on active faults: (1) the Ray Fault; (2) the Mosha Fault; (3) the North Tehran (NT) Fault; and (4) a floating earthquake not identifiably linked to a particular fault. The CEST/JICA assumed that an earthquake with an intensity of 7–9 on the Modified Mercalli Intensity (MMI) scale would occur on an active fault near Tehran. Accordingly, four earthquake model scenarios were developed based on active faults: (1) the Ray Fault; (2) the Mosha Fault; (3) the North Tehran Fault; and (4) a floating earthquake not identifiably linked to a particular fault. The estimated death tool in each fault activation scenario varied according to the time of occurrence (day or night), and four types of rescue operations, including no rescue (NR), rescue by the community only (CR), community rescue plus emergency squads (ES), such as the Red Crescent Society and firefighting teams, and joint-rescue operations by community, emergency squads, and expert teams (Ex) from other countries. The CEST/JICA study provided the estimated number of deaths at the time of the earthquake. To estimate the number of people in need of blood transfusion, these steps were followed: (1) calculate *injury-to-death ratio* (IDR) to estimate the number of persons injured during the earthquake; (2) estimate the *hospital admission rate* (HAR), defined as the proportion of earthquake-related injured who are hospitalized; (3) estimate the *blood transfusion rate* (BTR), defined as the proportion of hospitalized injured who are in need of blood transfusion.

In order to estimate the IDR, the earthquakes with the highest mortality that occurred over the last 20 years in Iran were selected so that the sample would resemble present building types and resistance patterns. The overall IDR during the last 20 years has been 1.99, and ranged from 0.88 to 2.70 (Table 1). Three options of IDR values equal to 1, 2, and 3 were considered for the analysis. Based on the range of estimation available from recent earthquakes, mostly the Bam (2003) and Zarand (2005) earthquakes, the study group took into account two options of HAR equal to 0.25 and 0.35 and three options of BTR equal to 0.05, 0.07, and 0.10.

The formula suggested by American Association of Blood Banks (AABB) was adapted to calculate the total number of units of Type-O red blood cell (RBC) that should be obtained as given three units of Type-O RBC that should be provided for each injured person needing transfusion:

Total blood transfusion expected X 3 units = Total Type-O RBC needed – Total Type-O RBC available

The blood requirement estimations relied on the following assumptions:

1. The expected death ratio has not changed since the time of the CEST/JICA study in 2000. The Tehran vulnerability situation has not changed significantly;
2. The Tehran Blood Transfusion Post (TBTP) will remain functional after the earthquake;
3. Standards of blood safety will not be cut short during the emergency operation; and
4. During the first 24 hours following the earthquake, Tehran will have received blood from the inventories of the TBTP, five neighboring provinces (Ghazvin, Mazandaran, Semnan, Ghom, and Markazi), and the nine provinces with maximum blood reserves (Fars, Khorasan-Razavi, Khuzestan, Isfahan, East Azerbaijan, Sistan-va-Balouchestan, Kerman, Kermanshah, and Golestan); after the second and third days following the earthquake, all 30 Blood Transfusion Posts (BTPs) will provide Tehran with the required blood.

To estimate the total Type-O RBC units available during the second and third days following the earthquake, this formula was used to calculate the surge capacity of 30 BTPs of the IBTO around the country for responding to a Tehran earthquake:

			Ray Fault Scenario							
			Nighttime				*Daytime*			
			Rescue Type				*Rescue Type*			
			NR	CR	CR+ES	CR+ES+Ex	NR	CR	CR+ES	CR+ES+Ex
IDR	HAR	BTR	**0.06**	**0.05**	**0.047**	**0.044**	**0.031**	**0.026**	**0.024**	**0.023**
1	0.25	0.05	17,544	14,620	13,743	12,866	9,065	7,603	7,018	6,725
		0.07	24,562	20,468	19,240	18,012	12,690	10,644	9,825	9,416
		0.10	35,089	29,241	27,486	25,732	18,129	15,205	14,036	13,451
	0.35	0.05	24,562	20,468	19,240	18,012	12,690	10,644	9,825	9,416
		0.07	34,387	28,656	26,937	25,217	17,767	14,901	13,755	13,182
		0.10	49,124	40,937	38,481	36,025	25,381	21,287	19,650	18,831
2	0.25	0.05	35,089	29,241	27,486	25,732	18,129	15,205	14,036	13,451
		0.07	49,124	40,937	38,481	36,025	25,381	21,287	19,650	18,831
		0.10	70,178	58,481	54,973	51,464	36,258	30,410	28,071	26,901
	0.35	0.05	49,124	40,937	38,481	36,025	25,381	21,287	19,650	18,831
		0.07	68,774	57,312	53,873	50,434	35,533	29,802	27,510	26,363
		0.10	98,249	81,874	76,962	72,049	50,762	42,574	39,300	37,662
3	0.25	0.05	52,633	43,861	41,229	38,598	27,194	22,808	21,053	20,176
		0.07	73,687	61,405	57,721	54,037	38,071	31,931	29,475	28,247
		0.10	105,267	87,722	82,459	77,195	54,388	45,615	42,107	40,352
	0.35	0.05	73,687	61,405	57,721	54,037	38,071	31,931	29,475	28,247
		0.07	103,161	85,968	80,810	75,652	53,300	44,703	41,264	39,545
		0.10	147,373	122,811	115,442	108,074	76,143	63,862	58,949	56,493

Table 2a—Blood unit needs in Tehran earthquake: Ray Fault scenario (BTR = blood transfusion rate; CR = community rescue; ES = emergency squads; Ex = experts; HAR = hospital admission rate; IDR = injury-to-death ratio; NR = no rescue)

IBTO surge capacity = Total units of Type-O RBC produced by BTPs in 2007 x7

Where: seven is the observed surge capacity of IBTO during the Bam earthquake.

To calculate the deficit of blood requirement, two possible blood requirement scenarios for each model of fault-activation were considered: (1) the maximum blood requirement scenario (MBRS), defined as the earthquake occurring at night, IDR = 3, HAR = 0.35, BTR = 0.1, and (2) the optimum blood requirement scenario (OBRS), defined as the earthquake occurring at night, IDR = 2, HAR = 0.25, BTR = 0.1. It was assumed in both scenarios that rescue will be provided by both community and emergency squads (CR + ES)

Results

The number of units of Type-O RBC that would be needed for the different damage scenarios of a Tehran earthquake according to the values of the key variables is listed in Tables 2a–2d.

In the absolutely worst situation, activation of the Ray fault at night, with no rescue operation (NR), IDR = 3, HAR = 0.35, and BTR = 0.1, the requirement for blood would be 147,373 units of Type-O RBC. An occurrence of the earthquake during the day would decrease this estimate by half. Given the activation of the Mosha fault during the daytime, with a full-scale rescue operation when community rescue, emergency squads and experts are present (IDR = 1, HAR = 0.25, and BTR = 0.05), a minimum of 585 units of Type-O RBC would be needed. In the relatively favorable circumstances defined by IDR = 2, HAR = 0.25, and BTR = 0.1, the

			North Tehran Fault Scenario							
			Nighttime				*Daytime*			
			Rescue Type				*Rescue Type*			
			NR	CR	CR+ES	CR+ES+Ex	NR	CR	CR+ES	CR+ES+Ex
IDR	HAR	BTR	**0.06**	**0.05**	**0.047**	**0.044**	**0.031**	**0.026**	**0.024**	**0.023**
1	0.25	0.05	5,848	4,679	4,386	4,094	3,801	3,216	2,924	2,632
		0.07	8,187	6,550	6,141	5,731	5,322	4,503	4,094	3,684
		0.10	11,696	9,357	8,772	8,187	7,603	6,433	5,848	5,263
	0.35	0.05	8,187	6,550	6,141	5,731	5,322	4,503	4,094	3,684
		0.07	11,462	9,170	8,597	8,024	7,451	6,304	5,731	5,158
		0.10	16,375	13,100	12,281	11,462	10,644	9,006	8,187	7,369
2	0.25	0.05	11,696	9,357	8,772	8,187	7,603	6,433	5,848	5,263
		0.07	16,375	13,100	12,281	11,462	10,644	9,006	8,187	7,369
		0.10	23,393	18,714	17,544	16,375	15,205	12,866	11,696	10,527
	0.35	0.05	16,375	13,100	12,281	11,462	10,644	9,006	8,187	7,369
		0.07	22,925	18,340	17,194	16,047	14,901	12,609	11,462	10,316
		0.10	32,750	26,200	24,561	22,925	21,287	18,012	16,375	14,737
3	0.25	0.05	17,554	14,036	13,158	12,281	11,404	9,649	8,772	7,895
		0.07	24,562	19,650	18,422	17,194	15,965	13,509	12,281	11,053
		0.10	35,089	28,071	26,317	24,562	22,808	19,299	17,544	15,790
	0.35	0.05	24,562	19,650	18,422	17,194	15,965	13,509	12,281	11,053
		0.07	34,387	27,510	25,790	24,071	22,352	18,913	17,194	15,474
		0.10	49,124	39,300	36,843	34,387	31,931	27,018	24,562	22,106

Table 2b—Blood unit needs in Tehran earthquake: North Tehran Fault scenario (BTR = blood transfusion rate; CR = community rescue; ES = emergency squads; Ex = experts; HAR = hospital admission rate; IDR = injury-to-death ratio; NR = no rescue)

average number of blood units needed for the Ray, NT, Mosha, and floating faults would be 58,774, 19,007, 2,924, and 45,908 in the night-time, and 30,410, 12,574, 2,632, and 26,902 in the day-time, respectively.

During the first 24 hours, it is estimated that the neighboring provinces and the provinces with maximum blood reserves plus TBTP would provide 8,149 units of Type-O RBC, given road and airport access. From 48–72 hours after the earthquake, it was estimated that 12,166 units of Type-O RBC would be available, considering the total blood produced by 30 BTPs in 2007 equal to 1,738 units of Type-O RBC and assuming a surge capacity of seven times the existing reserves for the IBTO.

The blood deficit in case of the activation of the Ray, NT, Mosha, and floating models, based on the maximum and optimum blood requirement scenarios is summarized in Table 3. The maximum blood deficit will be 107,293 and 95,127 at the 0–24 hour and 24–72 hour time periods, respectively. No deficit is estimated in the case of Mosha fault activation and the optimum scenario of the NT fault. In the case of activation of the Ray fault, the maximum blood deficit will be 107,293 and 95,127 units for 0–24 hour and 24–72 hour time periods after the earthquake, respectively. While considering the optimum scenario, it would be up to 46,824 and 16,528 units for 0–24 and 24–72 hours after earthquake, respectively.

Discussion

This study has estimated the required number of units of Type-O RBC that might be required following the probable event of a Tehran earthquake. Taking into account the limitations that arise from the uncertainty of the assumptions, this is the first

			Mosha Fault Scenario							
			Nighttime				*Daytime*			
			Rescue Type				*Rescue Type*			
			NR	CR	CR+ES	CR+ES+Ex	NR	CR	CR+ES	CR+ES+Ex
IDR	HAR	BTR	**0.06**	**0.05**	**0.047**	**0.044**	**0.031**	**0.026**	**0.024**	**0.023**
1	0.25	0.05	877	877	585	585	877	585	585	585
		0.07	1,228	1,228	819	819	1,228	819	819	819
		0.10	1,754	1,754	1,170	1,754	1,170	1,170	1,170	1,170
	0.35	0.05	1,228	1,228	819	819	1,228	819	819	819
		0.07	1,719	1,719	1,146	1,146	1,719	1,146	1,146	1,146
		0.10	2,456	2,456	1,637	1,637	2,456	1,637	1,637	1,637
2	0.25	0.05	1,754	1,754	1,170	1,170	1,754	1,170	1,170	1,170
		0.07	2,456	2,456	1,637	1,637	2,456	1,637	1,637	1,637
		0.10	3,509	3,509	2,339	2,339	3,509	2,339	2,339	2,339
	0.35	0.05	2,456	2,456	1,637	1,637	2,456	1,637	1,637	1,637
		0.07	3,438	3,439	2,292	2,292	3,439	2,292	2,292	2,292
		0.10	4,912	4,912	3,275	3,275	4,912	3,275	3,275	3,275
3	0.25	0.05	2,632	2,632	1,754	1,754	2,632	1,754	1,754	1,754
		0.07	3,684	3,684	2,456	2,456	3,684	2,456	2,456	2,456
		0.10	5,263	5,263	3,509	3,509	5,263	3,509	3,509	3,509
	0.35	0.05	3,684	3,684	2,456	2,456	3,684	2,456	2,456	2,456
		0.07	5,158	5,158	3,439	3,439	5,158	3,439	3,439	3,439
		0.10	7,369	7,369	4,912	4,912	7,369	4,912	4,912	4,912

Table 2c—Blood unit needs in Tehran earthquake: Mosha Fault scenario (BTR = blood transfusion rate; CR = community rescue; ES = emergency squads; Ex = experts; HAR = hospital admission rate; IDR = injury-to-death ratio; NR = no rescue)

exercise that addresses the quantitative assessment of the needs for blood during disasters in the country. It was determined that in most Tehran earthquake scenarios, the IBTO will face a shortage of blood within the first three days even considering the surge capacity of all BTPs around the country.

Figure 1 illustrates a model for estimating the required blood following an earthquake. According to the model, the following factors must be addressed:

1. *Blood Requirement*—determined by: (1) number of injuries; (2) admission rate; and (3) blood transfusion rate;
2. *Blood Production*—defined by: (1) function of BTPs; (2) donation rate; and (3) safety testing;
3. *Transportation*—characterized by ground or air access to transfer blood packs and the injured to the hospitals serving the affected population; and
4. *Transfusion*—depending on whether the hospitals have remained functional, and how many beds of field hospitals are available.

The number of deaths and injuries varies among earthquakes even with the same magnitude based on the time of the event, location, population density, community readiness, seismic intensity, etc.[4] The multi-factorial nature of the causality inference of earthquake-related injuries and the interaction of the factors make the estimation of the number of casualties difficult; however, it is a crucial step for predicting the blood requirement.

In the current study, the best available information derived from the Iranian earthquakes during last two decades was used, although more research is needed to estimate the number of injuries in the case of a Tehran earth-

			Floating Scenario							
			Nighttime				*Daytime*			
			Rescue Type				*Rescue Type*			
			NR	CR	CR+ES	CR+ES+Ex	NR	CR	CR+ES	CR+ES+Ex
IDR	HAR	BTR	**0.06**	**0.05**	**0.047**	**0.044**	**0.031**	**0.026**	**0.024**	**0.023**
1	0.25	0.05	13,743	11,696	10,527	9,942	8,187	6,725	6,141	5,848
		0.07	19,240	16,375	14,737	13,919	11,462	9,416	8,597	8,187
		0.10	27,486	23,393	21,053	19,884	16,375	13,451	12,281	11,696
	0.35	0.05	19,240	16,375	14,737	13,919	11,462	9,416	8,597	8,187
		0.07	26,937	22,925	20,632	19,486	16,047	13,182	12,035	11,462
		0.10	38,481	32,750	29,475	27,837	22,925	18,831	17,194	16,375
2	0.25	0.05	27,486	23,393	21,053	19,884	16,375	13,451	12,281	11,696
		0.07	38,481	32,750	29,475	27,837	22,925	18,831	17,194	16,375
		0.10	54,973	46,785	42,107	39,767	32,750	26,901	24,562	23,393
	0.35	0.05	38,481	32,750	29,475	27,837	22,925	18,831	17,194	16,375
		0.07	53,873	45,849	41,264	38,972	32,095	26,363	24,071	22,925
		0.10	76,962	65,499	58,949	55,974	45,849	37,661	34,387	32,750
3	0.25	0.05	41,229	35,089	31,580	29,826	24,562	20,176	18,422	17,544
		0.07	57,721	49,124	44,212	41,756	34,387	28,247	25,790	24,562
		0.10	82,459	70,178	63,160	59,651	49,124	40,352	36,843	35,089
	0.35	0.05	57,721	49,124	44,212	41,756	34,387	28,247	25,790	24,562
		0.07	80,810	68,774	61,897	58,458	48,142	39,545	36,106	34,387
		0.10	115,442	98,249	88,424	83,511	68,774	56,493	51,581	49,124

Table 2d—Blood unit needs in Tehran earthquake: Floating scenario (BTR = blood transfusion rate; CR = community rescue; ES = emergency squads; Ex = experts; HAR = hospital admission rate; IDR = injury-to-death ratio; NR = no rescue)

		Ray		NT		Mosha		Floating	
		MBRS*	OBRS†	MBRS	OBRS	MBRS	OBRS	MBRS	OBRS
Required unit of Type-O RBC		115,442	54,973	36,843	17,544	4,912	2,339	88,424	42,107
Deficit unit of Type-O RBC	0–24 hours	107,293	46,824	28,694	9,395	-3,237	-5,810	80,275	33,958
	24–72 hours	95,127	34,658	16,528	-2,771	-15,403	-17,976	68,109	21,792

Table 3—Required and deficit of Type-O red blood cell (RBC), 0–24 and 24–72 hours after a Tehran earthquake
*MBRS = Earthquake at night-time, IDR = 3, HAR = 0.35, BTR = 0.1, and rescue type = CR + ES
†OBRS = Earthquake at night-time, IDR = 2, HAR = 0.25, BTR = 0.1, and rescue type = CR + ES
BTR = blood transfusion rate; CR = community rescue; ES = emergency squads; Ex = experts; HAR = hospital admission rate; IDR = injury-to-death ratio; MBRS = maximum blood requirement scenario; NR = no rescue; NT = North Tehran; OBRS = optimum blood requirement scenario; RBC = red blood cell)

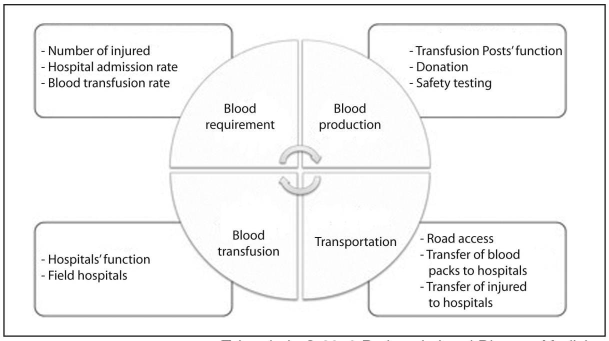

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Figure 1—Determinants of blood transfusion requirements in preparation for disasters

quake. Since the number of injuries was not provided by CEST/JICA analysis, the IDR to provide a figure for injury estimation was accounted.

Following an earthquake, not all of the injured need to be hospitalized, and not all of the hospitalized patients are in need of transfusion. Hospital admission and blood transfusion rates are factors that could be determined mostly by the severity of the injuries. Beside the variability of these rates in different earthquakes, it was not possible to find registration-based data for past earthquakes. The anecdotal evidence suggests that 25–35% of the injured people are in need of hospitalization. As for the rate of transfusion, despite not being recorded information, the IBTO experts and hospital managers who were involved in serving the injured during Bam (2003) and Zarand (2005) earthquakes estimated that 5–10% of injured were transfused. This study group decided on three options for BTR equal to 5, 7, and 10%. For the future disasters, the surveys must estimate the HAR and the hospital-based registration system must be strengthened to provide more accurate estimates about BTR.

Admitting the injured requires functional hospitals in the field or neighboring facilities and accessibility. For the purposes of this study, it was assumed that all of the health facilities would be functional following the earthquake and that the roads were accessible. However, this assumption contradicts the CEST/JICA scenarios, as they estimated destruction of hospitals as 50, 29, 9, and 44% in the Ray, NT, Mosha, and floating models, respectively.

The literature has elaborated the effects of donor influx and the consequent burden on local blood transfusion systems in terms of performance overload, safety concerns, and need to discard the extra blood.[5–9] The Bam earthquake showed that IBTO has the capacity to stretch its resources up to seven times in order to receive the blood from donors and test the safety. As a matter of fact, given the defined scenarios, a Tehran earthquake might require 2–8 times more than what the system produced in response to the Bam earthquake. This means that IBTO needs a rigorous response plan to mobilize all internal and external resources. The external resources can include the Red Crescent Society (RCS) and the Basij of the Medical Community, which can serve only for receiving donations, while IBTO will retain sole responsibility for ensuring the safety of the blood. The IBTO also must develop plans for field assessments and identification of needs and communication with BTPs and the media. It seems that planning for a Tehran earthquake must rely on "community altruism" to donate blood.[9]

An important approach to resolve the shortage problem is to reduce the demand. Not all of those receiving blood have a lifesaving need for it and there is the possibility of an overuse of blood when easily available. Further studies are needed to elaborate the strategies of demand reduction.

Conclusions

In most Tehran earthquake scenarios, within first three days, a shortage of blood was estimated to surge the capacity of all BTPs around the country, as it might require 2–8 times more than what the system produced following the Bam earthquake. It is expected that the community response in such a devastating event would be enormous, but the IBTO needs a rigorous plan to be prepared. For the purpose of accurate estimation of required blood at the time of any disaster, research-driven evidence is needed. The estimation model introduced in this study would provide the decision-makers with a list of variables they need to consider before planning for an accurate and realistic estimation of blood requirements during a disaster.

Acknowledgements

The authors appreciate the comments of Dr. Claude de Ville de Goyet.

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