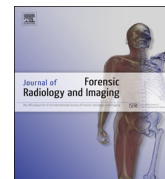




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Invited article

## The use of radiology in the Japanese tsunami DVI process

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## ABSTRACT

On the 11th of March, 2011, the world's 4th largest earthquake (magnitude of 9.0) hit Tohoku, located in the northeast coastal area of Japan. The quake generated a tsunami that crashed ashore. The first tsunami of 15 m reached the shoreline 40 min after the quake. Approximately 16,000 people were lost, and more than 2000 remain missing.

The National Police Agency took command of disaster victim identification (DVI). The Japanese Society of Legal Medicine sent member forensic pathologists and odontologists to more than 30 temporary mortuaries.

No radiological technique other than dental X-ray was used for DVI. More than 90% of the victims were estimated to have died as a result of drowning from the tsunami. Approximately 90% of the victims were visually identified. Others were identified by dental records, fingerprints, or DNA. There were cases of misidentification resulting from visual identification.

No CT scanning was undertaken throughout the DVI operation. The reasons that CT imaging was not used included the following: 1) there were too many bodies to scan, thus, it would have been too time/cost-consuming, 2) DVI was undertaken at many sites over a large area, 3) there was limited local experience with imaging techniques for DVI, and 4) most bodies were not injured or decomposed so were able to be visually identified. This was assisted by the cool winter weather at the time of the disaster.

Four years after the tsunami, 15,736/15,892 (99%) bodies have been identified, and 2573 people are still missing.

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## 1. Introduction

As computed tomography (CT) has become widely used in forensic practice, the role of CT for disaster victim identification (DVI) in mass fatality incidents has been discussed [1–4]. The current International Criminal Police Organization (Interpol) DVI guidelines mention radiology as one of the examination methods in Phase 2 (Post-mortem investigation) of the identification process, and radiologists to support the process [5,6].

During the DVI process after the Indian Ocean Tsunami on the 26th of December, 2004, dental X-ray was only the radiological technique used for victim identification [7,8].

The first incident in which CT techniques were used for DVI in a natural mass disaster was the so-called “Black Saturday” bushfires in Victoria, Australia in 2009 in which 173 people died due to the effects of fire [9]. The report of the bushfire emphasizes that CT images provide useful information in estimating age and gender or

detecting metallic medical devices for DVI [9].

Even before this event, a mobile CT scanner was used following some manmade disasters, such as a road traffic accident in England in 2006 involving six victims [1]. The Shoreham Airshow plane crash in England in 2014 was a recent accident in which CT played an important role [10].

Japan is known as a highly seismic country with considerable earthquakes and volcanic activity, as the country is located along the so-called the Pacific “Ring of Fire” [11]. In this review article, we outline our management of the deceased after the tsunami in 2011 and attempts to use radiological techniques for DVI.

## 2. The Disaster

At 2:46 pm on the 11th of March 2011, the Great East Japan Earthquake, measuring 9.0 on the Richter scale, hit the Tohoku region of Japan. This was the 4th largest recorded earthquake in history. The quake triggered a massive tsunami responsible for more than 15,000 deaths. The first tsunami, measuring as high as 15 m, reached the shore ~40–60 min after the quake. The total surface area affected by the tsunami was 561 km<sup>2</sup> [12]. Tohoku is

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**Table 1**  
Number of victims, missing persons and population.

Prefecture	Victims	Missing persons	Population (million)
Miyagi	9540	1240	2.35
Iwate	4673	1129	1.33
Fukushima	1612	200	2.03
Other	67	4	
	15,892	2573	5.71 (three prefectures)

(The table was created from the data of reference no. 16 and 20).

located in the northeast part of Japan along the Pacific coastline. The tsunami wave front extended over 400 km including Iwate, Miyagi and Fukushima Prefectures (Pref.). The population of each prefecture in 2010 was 1.33, 2.35 and 2.03 million people, respectively (Table 1).

### 3. Material and methods

The National Police Agency (NPA) in Tokyo took immediate command of DVI because in Japan, all unnatural deaths, including the tsunami victims, have to be reported and handled by police. Police, Self-Defense Forces (military forces), fire rescue units and local government personnel organized teams to recover bodies from multiple sites.

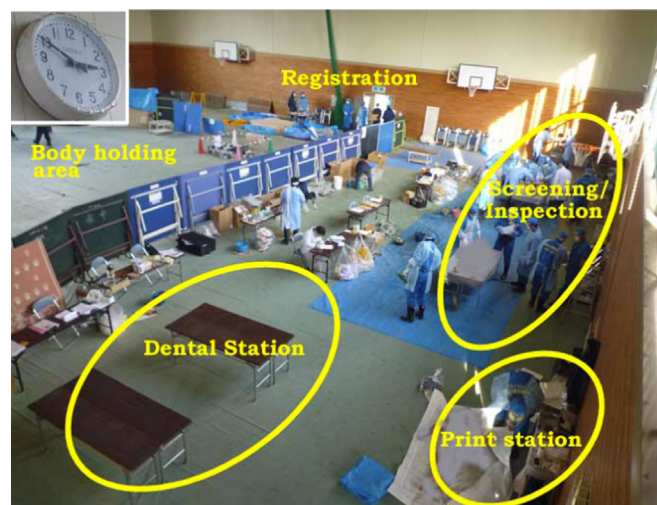
As the only domestic organization providing professional forensic medical services, the Japanese Society of Legal Medicine (JSLM) established an ad hoc Disaster Response Headquarters to dispatch member forensic pathologists and odontologists to these DVI sites. This was the first opportunity for the JSLM to establish an ad hoc Disaster Response Headquarters for DVI after it revised its regulations in 1997 [13].

An average of 60 thousands self-defense (military) officials per day were dispatched by the Ministry of Defense in the first 174 days for life-saving and body recovery. The prefectural police headquarters dispatched a maximum 497 police officers per day to the temporary mortuaries for DVI. The JSLM dispatched 9–10 member forensic pathologists per day and 2–3 member odontologists per day to the sites for 116 days. Other organizations such as the Japan Medical Association, the Japan Dental Association, other prefectural-based medical or dental associations and Tohoku University, a national university in the disaster area, dispatched many clinical physicians and dentists to the DVI mortuaries [14, 15].

More than 30 temporary mortuaries were set up by the NPA in the three prefectures for the storage of bodies and DVI. Most were located in Miyagi Pref., which had the largest number of the victims (Table 1) [16]. School gymnasiums, public halls and a police academy were used. There was no electricity or water supply for the first couple of weeks after the tsunami.

Fig. 1 shows an example of a mortuary at a junior high school gymnasium in Iwate Pref. The mortuary bays were separated by folded table tennis tables. There were five sections to examine the bodies, including a body handling area, registration, screening/inspection, dental and fingerprint stations. All official personnel working in the mortuary were police officers dispatched from all over Japan. All procedures for DVI were performed on the code of the Body Handling Regulations for the police, not the Interpol DVI guidelines.

First, the bodies were transported to the mortuary entrance, where police officers washed away any dirt from the body (Fig. 2). It was difficult to wash the bodies with a limited amount of water because the water pipeline infrastructure was damaged by the



**Fig. 1.** A temporary mortuary in Iwate Pref. A junior high school gymnasium is used as a temporary mortuary. The mortuary is separated into five sections. Folded table tennis tables are used as partitions. Notice that the clock on the wall points to the time of the earthquake (shown in the left upper corner). The original photo is courtesy of Prof. H. Iwase of Chiba University, Japan.



**Fig. 2.** Washing a body. Young police officers are washing the dirt from a body before the DVI process.

tsunami.

After placement in the body handling area, the circumstances of each body's recovery were conveyed to a police officer at the registration desk. Once registered with a unique number, police officers checked for personal belongings (Fig. 3). Subsequently, police personnel specially trained for death investigations, called "Coroners", checked for injuries or postmortem changes on the body. The officer finished the inspection by completing a document with a three-page form. This form is one that used routinely in Japan for external examinations for unnatural deaths, not the so-called "pink form" of the Interpol DVI guideline [5]. Each inspection took approximately half an hour. The form includes items for identification such as surgical scars, tattoos or major moles on the skin (Table 2).

The forensic pathologists performed the external examination to check for injuries, scars and postmortem changes from a forensic medical perspective. They added this information, if any, to the above form. The external examination took only 15 min because autopsies were not performed. They obtained blood or toenail samples from the body for DNA testing. DNA sampling was not routine until three weeks after the tsunami when the NPA

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