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## A research on the three-year performance of the regional emergency operation centers in Taiwan

Chia-Chou Tsai · Jet-Chau Wen · Cheng-Mau Wu · Mei-Hsuan Chen

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**Abstract** For a smooth lateral integration between Taiwan's regional emergency operation centers (EOCs) and with local health, fire, and medical units, the operating performance of the emergency medical care law (EMCL) needs to be enhanced throughout the emergency medical service system. In this article, a 3-year comprehensive evaluation was adopted to analyze the performance evaluation of six regional EOCs and to initiate a proposed framework with an appropriate coordinated operation and notification mode for the regional EOCs with above three units. The study discovered that establishing a closer coordinated operation and notification model relationship for the EOCs with above three units was a key factor to provide real-time information delivery and query services. A common disaster information and medical resource exchange platform should be established in the future, and the EMCL that allows EOCs to be the official dedicated units should be amended. In addition, EOCs must be given a regulatory power and responsibility to execute their services, which allows them to play an active role rather than a passive role. This would effectively help to integrate the fire, health, and medical units uniformly in the rescue response operation of disaster incidents.

**Keywords** Emergency medical care law (EMCL) · Emergency medical service system (EMSS) · Disaster response · Emergency operation centers (EOCs)

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## 1 Introduction

In the past decade, Taiwan has been subject to earthquakes and typhoons that resulted in mass casualty incidents, which includes health emergency status such as severe weather, terrorist acts, hazardous material incidents, nuclear incidents, aircraft incidents, and earthquakes. These have overwhelmed the medical resources of local government and thus hindered full-scale and precise medical attention on large number of victims with severe and diverse injuries (Hoffner et al. 2009; Frykberg 2003). In order to enhance the efficiency for responding to emergency medical care during a severe disaster incident, the Department of Health (DOH), Executive Yuan of Taiwan, set up six regional emergency operation centers (EOCs) over the country in 2005–2007 by research projects. Meanwhile, the DOH amended the emergency medical care law (EMCL) in 2007 to stipulate several operational projects. An operational project relies on a protocol among the regional EOCs, the health, fire, and medical units within their jurisdiction. The components of the protocol include information exchange, communication, and coordination. However, the mass casualty incidents caused by recent disasters have exposed the incapability of three substantive relief response units of the health, fire, and medical units in securing information and response efforts at the first moment of incident. These drawbacks have highlighted a need to improve the capability of trans-city/county medical resource coordination efforts and have prompted research to analyze the performance evaluation of Taiwan's EOCs from 2005 to 2007.

An impact incident that has caused a number of injuries and off-balanced conditions regarding the treatment of medical resources was referred to as a disaster (Rutherford and Boer 1983). Apart from having dealt with large numbers of injuries, disaster also includes other fields and other disaster response efforts such as emergency evaluation of medical needs, rescue coordination and command, handling of public health, and so on (Bechtal et al. 2000). From experiences of other countries, the operation of the emergency medical service system (EMSS) was closely coordinated with the medical centers, public health, and public safety agencies (Arthur et al. 2008). Therefore, the health, fire, and medical units in Taiwan must be coordinated and interact closely during the period of a disaster response operation to improve the effectiveness of Taiwan's EMSS. The purposes of establishing EOCs are to deal with following factors: (1) access trans-city/county applicable information correctly and swiftly; (2) integrate regional relevant medical resources; (3) shorten reaction time; (4) simplify the contact channels to assist all medical units; (5) facilitate the collection of the medical events, notifications, and medical resource statistics; and (6) other information-related functions; these factors will help to heighten immediate decision making when a disaster happens. Use of a more flexible response application and most appropriate application of the emergency medical resources (Noji 1996; Batho et al. 1999) would also enhance the integration and coordination function of Taiwan's EMSS.

Other features of EOCs include conducting emergency medical-related trainings and drills; contacting regional city/county health, fire, and medical units; cultivating harmonious relationships; developing information delivery; and upgrading the capabilities of the emergency medical service.

Taiwan's EMSS has the advantages of being still in the developmental stage and has gained considerable attention from the government and the public (Chiang et al. 2009). The only drawback is that the current critical care medical resources are distributed unevenly with the highest concentrations in large metropolitan areas and low availability in remote regions. This drawback has resulted in an imbalance usage of medical resources, congestion at medical centers and emergency rooms of large hospitals, a high bed occupancy

rate of patients with minor illnesses while lacking bed space for the severely ill, an inability of small hospitals to join the hospital EMSS because of lacking 24-h emergency treatment, a lack of capability to treat patients with specific illnesses, an inability to handle the patient load for large-scale disasters, and an inability to transfer critical patients in a timely manner to another hospital for emergency treatment. Other countries' EMSS faced many challenges in receiving adequate resources and personnel trainings (Lockey 2009). In past, a large-scale disaster strikes, EMSS took over the local and national response capabilities, including health and medical resources (Bettina 2005), and EMSS often needed mutual cooperation and assistance from the neighboring cities/counties. This article focuses on how EOCs laterally integrated the EMSS of the neighboring cities/counties into fire prevention and relief, health administration, and medical services, enhanced vertical command and emergency medical response capabilities in conjunction with the central authority and local governments, so that the services of EOCs include offering the correct resources of emergency medical services to the right person at the appropriate time and use the right methods to provide correct instructions to treat patients (The National Heart Attack Alert Program Coordinating Committee 1995).

This study assessed and analyzed the service performance of six regional EOCs in Taiwan from 2005 to 2007 by conducting an interview survey to collect the personnel's opinions from the regional EOCs, fire, health, and medical units. The aims are to analyze the encountered problems in order to propose a possible coordination mode of the operation and notification model for the regional EOCs, fire, health, and medical units while manipulating the EMSS; strengthen the handling of injured patients in regional disaster and emergency events; and upgrade the efficiency of the EMSS to be used as a reference by other countries in coping with future disasters.

## 2 Methods

This study has assessed the performance of six regional EOCs from 2005 to 2007 and the current coordinated operation and notification mode of regional EOCs with local health, fire, and medical units by comprehensive evaluating and exploring. Both aspects of quantitative services and non-quantitative services were assessed among six regional EOCs. The aims are to analyze the encountered problems and initiate a proposed framework with an appropriate coordinated operation and notification mode for the regional EOCs with above three units in order to upgrade the efficiency of the emergency medical service.

### 2.1 Performance evaluation of EOCs from 2005 to 2007

Based on visits and meeting reports of six regional EOCs and the project outcome reports collected from the six regional EOCs from 2005 to 2007, this paper analyzed their operational records over those years since their establishment. The annual operation records were then listed, which include the emergency medical disaster monitoring mode, interactions profile with the other emergency operation units including local health, fire, and medical units, emergency medical resource database, emergency medical incident review, and drill and training numbers per year. For the drill and training numbers per year, both operations could be quantitatively evaluated to show the performance achievement. On the other hand, for the operation records that could not be expressed quantitatively, setup goals of the regional EOC and objectives were expressed through descriptions or by a method

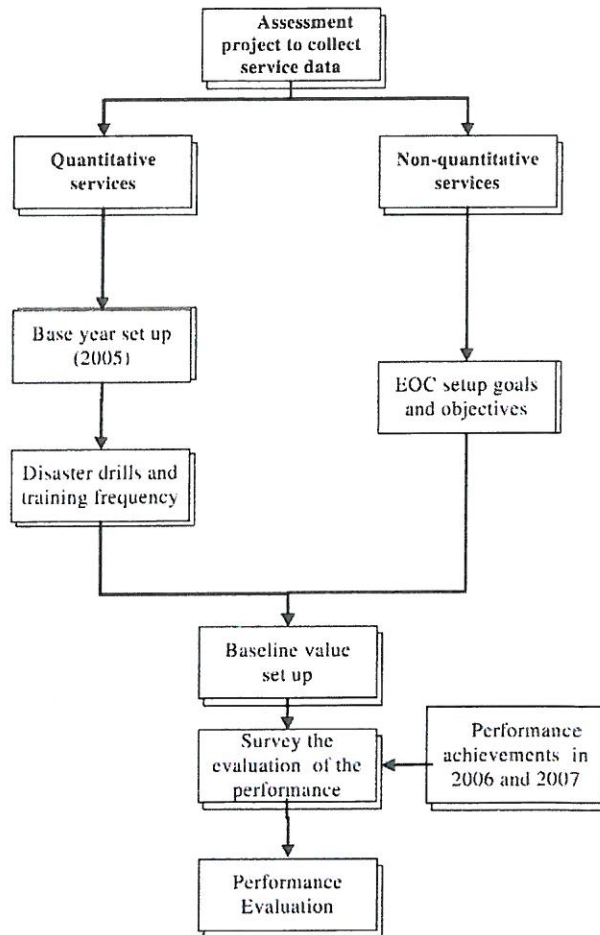


Fig. 1 The procedure of the EOCs performance evaluation

that could achieve the targets. The service performances of the regional EOCs were inspected and discussed with the non-quantitative data, and a reasonable baseline control for the first base year (2005) was set up for evaluating and reviewing the outcomes achieved by the EOCs for 2006 and 2007. The procedure of the performance evaluation of the EOCs during these 3 years is shown in Fig. 1.

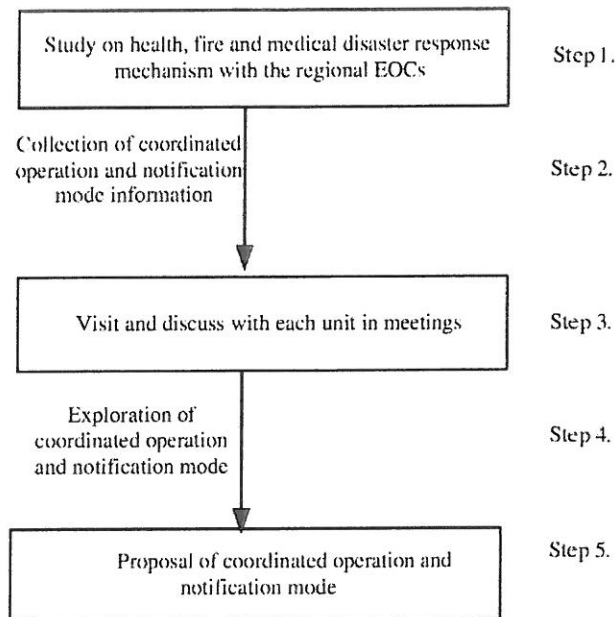
According to the amended EMCL Article 9 promulgated in 2007, the DOH should follow the regional emergency medical service to schedule the command system stated in the second paragraph of Article 5 to entrust the medical units to establish regional EOCs in six different regions that offer eight kinds of services. These six different regional EOCs include Taipei Region (TR), Northern Region (NR), Central Region (CR), Southern Region (SR), Kaohsiung/Pingtung Region (KPR), and Eastern Region (ER). The eight kinds of standard services prescribed in the EMCL Article 9 were consistent with the goal of the EOC's 3-year subsidiary program (2005–2007). Therefore, these eight subsections were decided on as services that the EOCs should achieve, and the operational outcomes of

each regional EOC during these 3 years. listed as 10 performance items of EOCs, were used to compare with the requirements of the EMCL 9 as shown in Table 1.

Among ten performance items shown above, items 1–4, namely the emergency medical disaster monitoring mode, the interaction profile with regional emergency operation units, the emergency medical resource database, and the emergency medical incident review are the four items, which depend on local characteristics and cultural needs of each regional EOC. These four items are later amended or deleted according to needs of each regional EOC. The items 1–4 are listed as non-quantitative performance items. The performance of relevant EOCs services is inspected through a descriptive approach. The two performance items that could be quantitatively shown were the number of emergency disaster drills and training frequencies. The baseline control for the handling conditions was set at the first base year (2005) for evaluating the performance achieved by the EOCs during 2006 and 2007. However, the increasing yearly frequencies of the handling conditions does not mean they have become better, but only serve to be compared with the activity-handling conditions of 2006 and 2007. As the development focus in each region varied according to the regional emergency disaster-prone incident characteristics and directives stipulated by the DOH, they resulted in training preferences and differences in the number of emergency disaster drills regionally. In addition, the EMCL Paragraph 2 of Article 9 has specified that “the scheduling prescribed in the preceding Subsection 6 and Subsection 7, namely startup elements of scheduling and commanding, command system structure, response procedures, and other coordination matters should be set up by the DOH.” Thus, the four operational response mechanisms such as schedule and command startup conditions of EOCs, command system structure, response procedures, and other coordination matters should be handled according to a relevant integration method set up by the DOH. Based on the above

**Table 1** Correlation table of the performance items of the EOCs compared with the requirements of the EMCL, Paragraph 1 of Article 9

EMCL, Article 9	Performance Items of EOCs
Subsection 1 Monitor in real-time regional disaster-related emergency medical incidents	1. Emergency medical disaster monitoring mode
Subsection 2 Secure in real-time regional emergency medical information and resource status	2. Interactions profile with the regional emergency operation units
Subsection 3 Establish a database of regional disaster medical resources	3. Emergency medical resource database
Subsection 4 Assist in planning disaster-related rehabilitation work of emergency medical incidents	4. Emergency medical incident review
Subsection 5 Regularly organize the annual major disaster-related emergency medical drills	5. Drill frequency per year
Subsection 6 In the event of a trans-municipality/city/county disaster, assist the Department of Health (DOH) to schedule the regional emergency medical resources to conduct the contingency plan	6. Startup elements of scheduling and commanding 7. Command system structure 8. Response procedures
Subsection 7 Assist the Department of Health (DOH) to command the regional emergency responsibilities, and the hospitals to dispatch relevant personnel to assist in handling mass emergency injured patients	9. Other coordinating matters
Subsection 8 Other matters related to regional emergency medical disaster response	10. Training frequency



**Fig. 2** The procedure of establishing the coordinated operation and notification mode

facts, two quantitative evaluation indicators and four non-quantitative evaluation indicators were adopted by this study to evaluate the performances of the EOCs.

## 2.2 Review of the coordinated operation and notification mode of regional EOCs with the health, fire, and medical units

In order to strengthen the service capability of regional EOCs with the fire, health, and medical units for emergency rescues of incidents and to prevent the problems of on-site response personnel being unable to link with mutual support in disasters, the study thus drafted an essential coordination operation and notification mode. Prior to proposing, each disaster response mechanism unit was thoroughly studied. The existing emergency incident notification conditions, standard operation procedures, and other information of each unit were collected. Each unit was visited to understand the processing procedures in actual event occurrences. After mutual discussions with each unit, the suggestions of discussions through meetings that were made for knowing the situations of existing disaster responses were reported. Consequently, a coordinated operation and notification mode was proposed. The procedure of establishing the coordinated operation and notification mode is shown in Fig. 2.

## 3 Outcomes

### 3.1 Performance outcomes of EOCs from 2005 to 2007

The overall analysis of the six EOCs' functional establishment was conducted by this article based on its operational evaluation from 2005 to 2007. There are two aspects: one



based on the year-by-year non-quantitative service performance outcomes, and the other based on quantitative service performance outcomes. The explanations are as follows:

### 3.1.1 Non-quantitative service performance outcomes

Non-quantitative services are the tasks of regional EOC such as operational system construction or mechanism development, which cannot be quantified. The six different regional EOCs were listed in order. Table 2 shows the non-quantitative service performance outcomes of each regional EOC. The non-quantitative services performance indicators that include four categories such as the emergency medical disaster monitoring mode, the interaction with regional emergency operation units, the emergency medical resource database, and the emergency medical incident review are established by each regional EOC individually.

In Table 2, the circular symbol “○” represents that the service was begun by the regional EOC in 2005 and the dash symbol “-” shows that such service was not shown in the outcome reports from 2005 to 2007.

The descriptive approach of the non-quantitative performances of the relevant services of the regional EOCs during year 2005–2007 is made as follows:

1. *Emergency medical disaster monitoring mode* For real-time response of regional disaster-related emergency medical incident, the instant and simultaneous information of the emergency medical incident is important. In this category, each regional EOC's operations are generally the same. The category involves personnel on duty 24 h who monitors on media, side listening to the radio system of the fire unit, answering relevant phone calls with double checks, recording and analyzing each incident, and collecting relevant data from the emergency medical management system. For the working shifts, the TR EOC and NR EOC worked in two shifts (morning/evening) while the other EOCs worked in three shifts (morning/afternoon/evening).

2. *Interactions with regional emergency operation units* The three emergency operating units of the city/county health unit, the city/county fire unit, and the designated emergency medical units are practical response units for emergency medical incidents.

The regional EOCs are in charge of exchanging information of incident and medical resource among the three emergency operating units. Therefore, it is relatively important for the regional EOCs to establish connections with the emergency operating units. The ways of establishing connection in each regional EOC are varied. They depend on the administrative cultures and regional characteristics of the three emergency operating units. The details will be stated in the section of discussions.

3. *Emergency medical resource database* The emergency medical management system is the channel for the regional EOCs to obtain medical resource information. The medical resource database for each regional EOC is generally the same, which includes the emergency incident record e-form, the disaster response database (medical resources, medical institutions, the number of medical staff, and number of beds for various illnesses within the regional city/county), the disaster response system, the medical rescue human contact method and the support mode (including personal data, service unit, emergency contact method, willingness participation mode), and the emergency medical resource database (the affected public and injury conditions, handling trend, and epidemiological data).

4. *Emergency medical incident review* After the recovery of the emergency medical incident, the regional EOCs write a detailed report of the whole event, review the

**Table 2** Non-quantitative performance outcomes of regional EOCs

Regional classification	Taipei Region (TR)	Northern Region (NR)	Central Region (CR)	Southern Region (SR)	Kaohsiung/Pingtung Region (KPR)	Eastern Region (ER)
Emergency medical disaster monitoring mode	-	-	○	○	○	○
24-h shift system	○	○	-	-	-	-
2-shift system	○	○	○	○	○	○
3-shift system	○	○	○	○	○	○
News media monitoring	○	○	○	○	○	○
Attentive listening to the fire radio system	○	○	○	○	○	○
Emergency medical management system	○	○	○	○	○	○
Conduct incident recording and analysis	○	○	○	○	○	○
Actual visitation of the regional health unit	○	○	○	○	○	○
Telephone interviews of the regional health unit	○	○	○	○	○	○
Establish regional health unit contact window	○	○	○	○	○	○
Actual visitation of the regional fire unit	○	○	○	○	○	○
Telephone interview of the regional fire unit	○	○	○	○	○	○
Establish regional fire unit contact window	○	○	○	○	○	○
Actual visitation of the designated regional emergency medical unit	○	○	○	○	○	○
Telephone interview of the designated regional emergency medical unit	○	○	○	○	○	○
Establish designated regional emergency medical unit contact window	○	○	○	○	○	○
Emergency medical management query system	○	○	○	○	○	○
Emergency disaster event e-fog	○	○	○	○	○	○
Disaster response resource database	○	○	○	○	○	○
Disaster response system	○	○	○	○	○	○
Contact method and support mode of medical rescue manpower	○	○	○	○	○	○

Table 2 continued

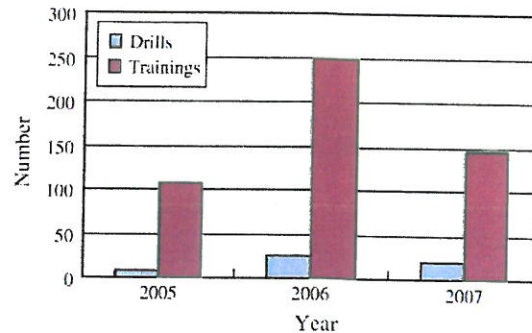
Regional classification	Taipei Region (TR)	Northern Region (NR)	Central Region (CR)	Southern Region (SR)	Kaohsiung/Pingtung Region (KPR)	Eastern Region (ER)
Service project						
Emergency medical incident review						
Notification time	○	○	○	○	○	○
Notification frequency	○	○	○	○	○	○
Disaster classification	○	○	○	○	○	○
Incident name	○	○	○	○	○	○
Source of information	○	○	○	○	○	○
Casualty number count (death, injury, hospitalization, discharge)	○	○	○	○	○	○
Incident content description	○	○	○	○	○	○
Tracking profile of injured patients	○	○	○	○	○	○
Center response summary	○	○	○	○	○	○
Incident handling status of health unit	-	-	-	-	-	-
Incident handling status of medical units	-	-	-	-	-	-
Incident handling status of fire unit	-	-	-	-	-	-
Damage estimates	○	○	○	○	○	○
Medical resource demand	○	○	○	○	○	○
Case closing time	○	○	○	○	○	○
Incident handling status of media	-	-	-	-	-	-
Suggestions for future disaster prevention measures	-	-	-	-	-	-

**Table 3** Comparison of quantitative service performance outcomes of regional EOCs in 2005, 2006, and 2007

Regional classification	Taipei Region (TR)	Northern Region (NR)	Central Region (CR)	Southern Region (SR)	Kaohsiung/Pingtung Region (KPR)	Eastern Region (ER)
Service project/year	2005 <sup>a</sup>	2005 <sup>a</sup>	2005 <sup>a</sup>	2005 <sup>a</sup>	2005 <sup>a</sup>	2005 <sup>a</sup>
Emergency disaster drill	–	–	–	4 classes	4 classes	–
Training	24 h	13 classes	183 h	7 classes	31 classes	–
Internal staff	–	3 classes	2 classes	7 classes <sup>b</sup>	–	60 h
External staff	–	–	–	–	–	–
Service project/year	2006	2006	2006	2006	2006	2006
Emergency disaster drill	3 classes	8 classes	6 classes	5 classes	1 class	3 classes
Training	15 classes	60 classes	120 h	5 classes	115 classes	–
Internal staff	–	6 classes	12 classes	1 class	5 classes	8 classes
External staff	–	–	–	–	–	–
Service project/year	2007	2007	2007	2007	2007	2007
Emergency disaster drill	–	5 classes	4 classes	4 classes	6 classes	1 class
Training	13 classes	–	152 h	6 classes	79 classes	–
Internal staff	–	3 classes	3 classes	6 classes	6 classes	–
External staff	–	–	–	–	–	–

<sup>a</sup> The base year<sup>b</sup> One class contains 6 h

**Fig. 3** The quantitative service performance outcomes from 2005 to 2007



appropriateness of the event response, and send feedback to emergency medical response units to provide necessary revisions of their standard operating procedure.

### 3.1.2 Quantitative service performance outcomes

An analysis was conducted based on the regional EOCs outcome reports from 2005 to 2007 regarding trainings and emergency disaster drills. The emergency disaster drills include mass injuries, poisonings, and so on. The trainings were divided into two sections: expertize competency upgrade of internal staff and relevant courses regarding emergency medical services for external staff participation. There were different quantitative units regarding educational training in handling situations, and there were even time variances in conducting the same educational training course as well as preferences based on local regional characteristics or directives stipulated by the DOH. Table 3 shows quantitative service performance outcomes of regional EOCs from year 2005 to 2007. Both services of educational trainings and emergency disaster drills are quantitatively presented. The training services are recorded in two types of units, namely classes and hours. Each class contains 6 h. The dash symbol in Table 3 shows that no relevant data were obtained from the specific regional EOCs.

According to Table 3, a histogram of quantitative service for both trainings and emergency disaster drills from 2005 to 2007 is made as shown in Fig. 3. In comparison with year 2005, the service performance of EOCs in 2006 and 2007 clearly shows that the emergency disaster drills and trainings of the EOCs have generally increased.

## 3.2 Coordinated operation and notification mode of the current EOCs with the health, fire, and medical units

### 3.2.1 Exploration of the current coordinated operation mode

Under the general emergency case, the emergency treatments on injured patients are offered by the fire unit before arrival of medical unit. However, the practical situation is the fire unit in charge of both incident rescues and injury treatments on site. The fire unit often encounters the problem of insufficient manpower until the medical unit takes over after the injured patients are transferred.

A mass casualty incident was defined as more than 15 injuries in the incident. Under this situation, both fire unit and health unit are involved on site of incident. At the earliest time, the rescue team of the fire unit is in charge of setting up an on-site rescue command center. The command will then be transferred to the official of health unit when he (she) arrives at the

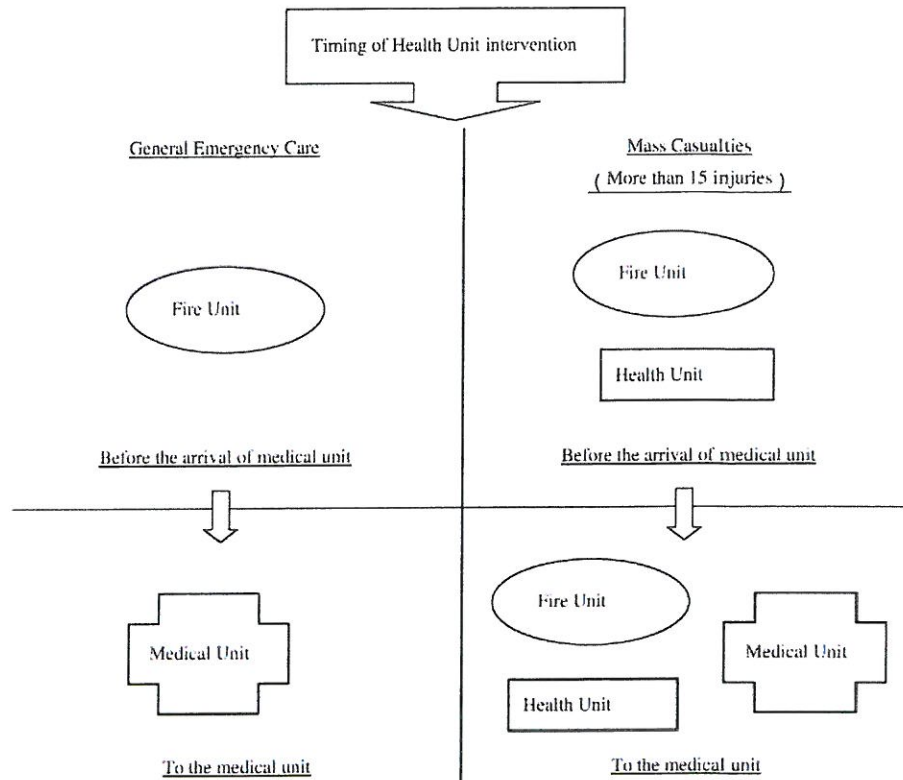


Fig. 4 The current coordinated operation works (Yang 2005)

site. The official of health unit proceeds the consequence of injury treatments until patients are delivered to the medical unit such as the medical center or the regional hospital.

The current coordinated operation scheme for both general case and mass casualties is shown as in Fig. 4 (Yang 2005). As can be seen from the coordinated operation scheme, the regional EOC did not appear in the scheme. It cannot tell when or how the EOC intervenes with coordinated operation. On the other hand, the regional EOCs are not in charge, and a proper position is not given for assistance and coordination during the event of medical incident.

### 3.2.2 Exploration of the current notification mode

The current status of the notification mode between regional EOCs, health, fire, and medical units, such as TR EOC regarding its national disaster level of the notification mode, is shown in Fig. 5. When an incident rescue happens, the fire unit starts receiving reports through 119 (emergency call number), and the standard operation procedures then start as follows: (1) the fire unit initially judges the response level, initiates the response plan, notifying the health unit, and designated emergency medical units, respectively, and (2) the EOCs monitoring the radio or TV news to track the messages and to notify the DOH, Executive Yuan. The overall incident rescue status is tracked by regional EOC. The regional city/county health unit, fire unit, and designated emergency medical units are kept informed by regional EOC as well. In case of a

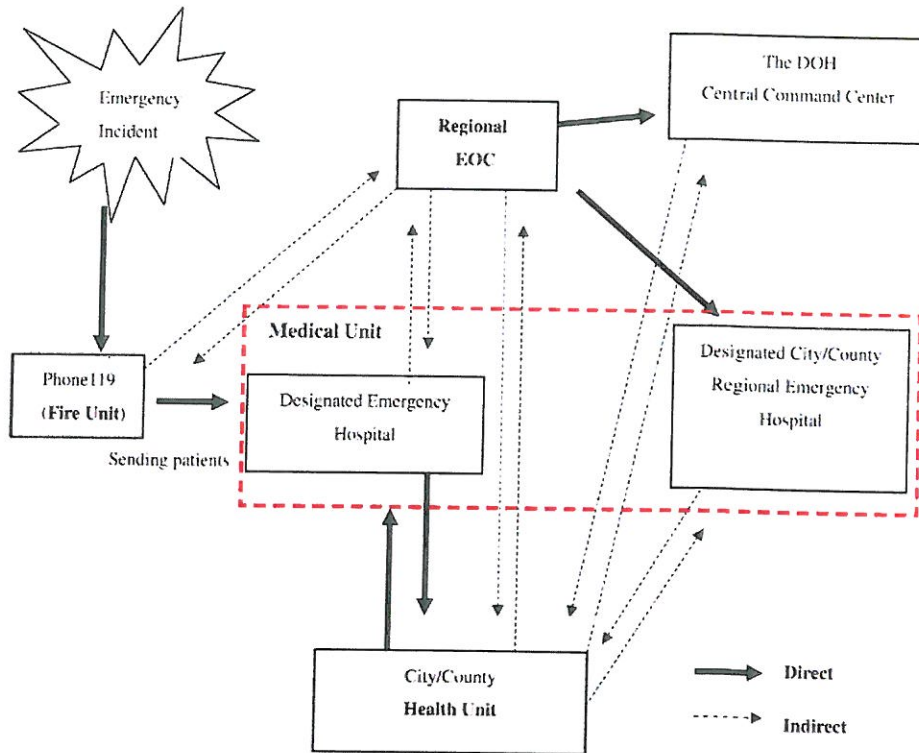


Fig. 5 National disaster level of the notification mode of Taipei's regional EOC

mass casualty incident that reaches to the level of the national disaster, the central command center of the DOH, Executive Yuan, initiates the response operation. It provides an integrated command to pass onto the Minister of the DOH (or a person appointed by the Minister) who will then take charge as a commanding officer to give orders to the national disaster rescue team, supervisor, and coordinate operations. The regional EOCs will then coordinate with the commanding officer to secure the regional personnel, equipment, supplies, and facility information; collect the regional emergency medical incident and medical resource information; take charge of the regional response and resource scheduling to perform medical and rescue resource coordination as instructed by the central command center (Shih 2005).

In Fig. 5, a discrepancy with the startup mechanism of EOCs has been discovered. There are two independent direct notification paths shown in the diagram; the first one is as follows: while an emergency incident happened, the 119 of fire unit was informed. And then, injured patients were transferred to designated emergency medical unit, which could be university hospital, medical center, regional emergency hospital, or local emergency hospital. Meanwhile, the medical unit reported to the authorities whom it belonged to. The second notification path is as follows: while an emergency incident happened, the regional EOCs notified both the central command center of DOH and regional emergency hospital.

The information that the regional EOC obtained related to emergency incident is not guaranteed. Normally, the regional EOCs obtain information of incident rescue by indirect ways (i.e., monitoring the radio or TV news). The staffs of EOCs have to gather their information by attentively monitoring the media; therefore, sometimes the notification mode will fail for missing information or receiving incorrect news (Shih 2005).

## 4 Discussion

### 4.1 Performance evaluation of EOCs from 2005 to 2007

#### 4.1.1 *Non-quantitative service performance*

From Table 2, it was found that in addition to incident handling status of health unit, fire unit, medical units, and media, the emergency medical incident review was also not shown in the outcome reports from 2005 to 2007 for all regional EOCs besides SR EOC. The reason is that when emergency medical incidents such as floods, earthquakes, or landslides occur, the tasks of rescue and recovery belong to the fire unit, while the health unit is in charge of the medical unit supervision and management. The regional EOCs only play a minor role regarding this situation and does not have authority from the government to invite health, fire, and medical units to convene for a review meeting, and through the feedback, review, incident handling action, and improved measurements for future disaster prevention.

As mentioned in Sect. 3.1.1, the methods of connection establishment vary depending on the administrative cultures and regional characteristics of the three emergency operating units. For the NR EOC, it mainly interviews the designated emergency medical units and relevant units by phone. In order to receive the simultaneous notification, the NR EOC inquires the emergency response requirements and establishes interactive relationship with the three emergency operating units. The CR EOC visits the three emergency operating units regularly: once per month to health unit and fire unit; 2 h per month to medical centers; once per 3 months to the designated regional hospitals to collect related data. The SR EOC dispatches the personnel on duty to visit the three emergency operating units every 6 months and to collect related reports. The KPR EOC establishes a special disaster incident notification and a contact operation with the three emergency operating units to ensure the related messages not being loss.

For the emergency medical resource database, the CR EOC is different from the other EOCs and has gradually established a database for an inter-hospital resource scheduling mode during 2006 and 2007. It also completed the filing of the personal data of the disaster medical rescue team.

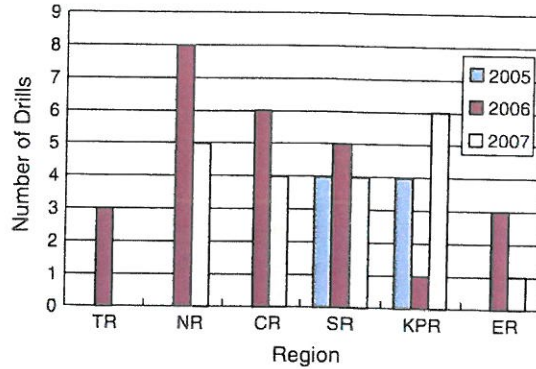
#### 4.1.2 *Quantitative service performance of regional EOCs*

As mentioned in Sect. 3.1.2, quantitative service outcomes include both the emergency disaster drills and trainings. Owing to the regional EOCs that were initially founded in 2005, the services have focused on establishing EOCs hardware, facilities, and operating mechanisms such as startup conditions and response planning, personnel recruitment, professional trainings, establishment of cooperative relationships among the regional health, fire, and medical units, and collection of regional emergency medical resource information. The services on conducting emergency disaster drills and trainings for external staff participation were mainly in their planning stage in year 2005.

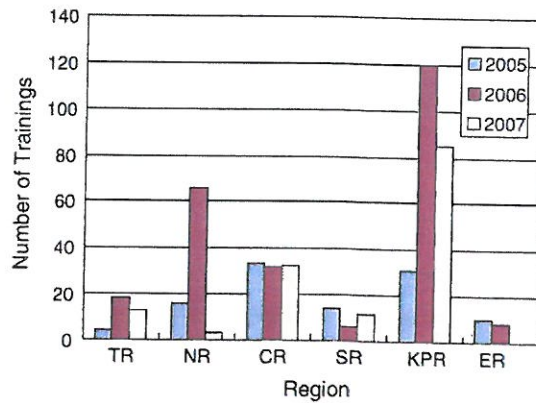
For changes of the performance of individual regional EOCs over time, Fig. 6 shows number of drills of individual EOCs from 2005 to 2007 in different regions. Since 2005 was the first year which the regional EOCs were founded, most of them did not record the number of drills. Only the regional EOCs of SR and KPR presented sufficient data for 3 years. Most of the regional EOCs including NR, CR, SR, and ER show higher performance in year 2006. The reason was that DOH ordered each EOC to facilitate sharing of



**Fig. 6** Service performance (drills) of individual EOCs from 2005 to 2007



**Fig. 7** Service performance (trainings) of individual EOCs from 2005 to 2007



medical information and supporting to their jurisdiction in 2006. Figure 7 shows number of trainings of individual EOCs from 2005 to 2007. Most of the EOCs show an increasing trend for the service of trainings except NR and ER. By comparing to year 2005, the regional EOC of TR and KPR present growing performance in spite of their trainings dropping down a little in 2007.

As shown in Fig. 6, the classes conducted in emergency disaster drills handled by the TR, NR, CR, SR, and ER have become more frequent than those in 2005. In contrast, for service performance of trainings, the numbers of class conducted in the TR and KPR have become more frequent than those in 2005 (Fig. 7). Looking at the numbers of external training class, the NR, CR, and KPR have also increased than those in 2005 (Table 3).

#### 4.2 A proposed coordinative operation and notification mode of regional EOCs with health, fire, and medical units

##### 4.2.1 Proposed coordinated operation mode for emergency medical incidents

The current mission of regional EOCs was limited to information transferring rather than medical incidents response. The interactions between regional EOCs and health, fire, and medical units did not work properly. For example, the regional EOCs can only monitor the status of incidents through the radio or TV news and report to the DOH. The main reason is because the position and authority of EOCs as the current six regional EOCs are entrusted

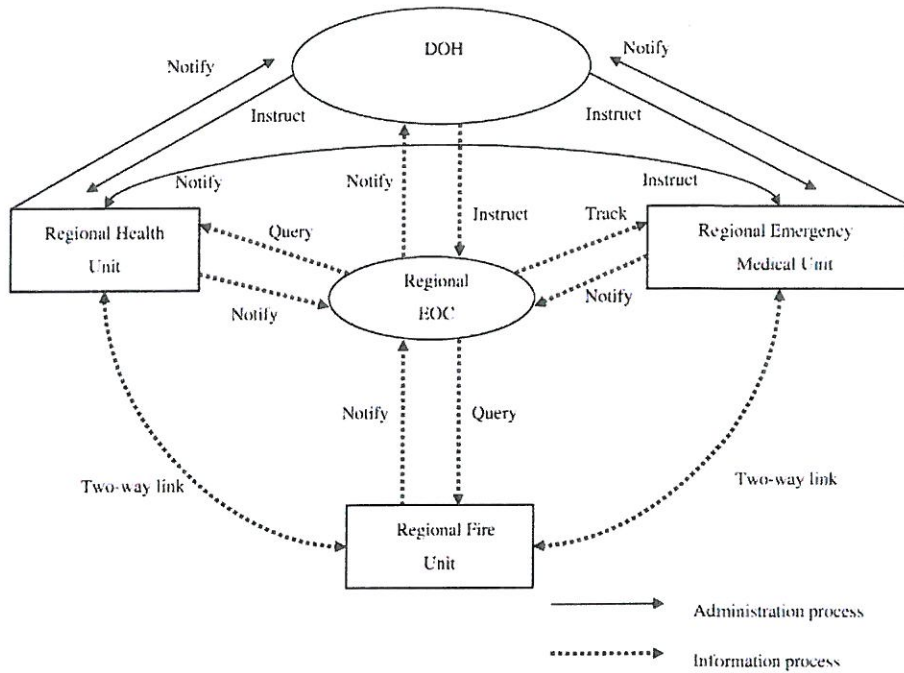
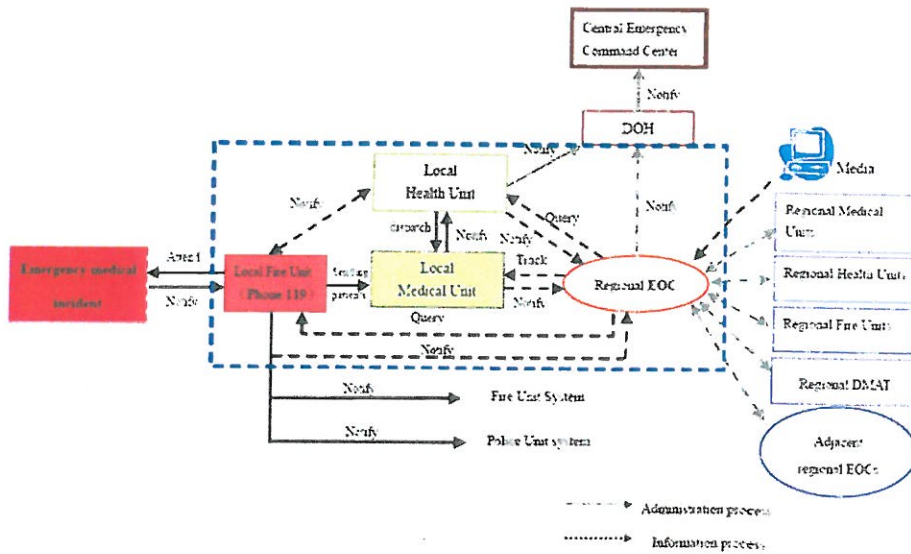


Fig. 8 The proposed coordinating operation mode for an emergency medical incident

as an academic research unit and funded by research projects. It is important to consider on long-term operation methods and funding. Moreover, there is a need for regional EOCs to cross-integrate different professional administrative fields; EOCs should jointly establish the disaster information and medical resource exchange platform in the future. This is similar to the comprehensive collaborative network approach that needs to handle various disaster relief works used in other countries (Mattox et al. 2007), and in the meanwhile, still allowing the health, fire, and medical units to experience the great benefits that the EOCs can provide them and so be willing to initially seek help from the EOCs.

The proposed coordinating operation mode (Fig. 8) for emergency medical incidents stipulates that the regional health unit and fire unit have the obligation to report the complete event to the EOCs and that the responsibility of the EOCs is to provide query services to the regional health unit and fire unit. Meanwhile, the regional medical units should report the status of the unit's emergency medical information to the EOCs, and the EOCs must follow-up on the medical status of the medical units. After receiving the feedback of information from the three units, the EOCs may collect and analyze the information, store them in the established medical information database, and provide real-time accurate medical information to the regional health unit and fire unit. When an emergency medical incident strikes, then the EOCs are able to coordinate among the health, fire, and medical units to offer query service and real-time accurate information to enhance the efficiency of the emergency medical incident response.

In Fig. 8, the solid line in the diagram refers to the administration process, indicating a direct affiliate relationship in administration or mission between the units, while the dotted line refers to the information process, denoting the indirect cooperative relationship.



**Fig. 9** Proposed mode of the emergency medical incident notification process

*4.2.2 Proposed model of the emergency medical incident notification process*

Currently, the notification system of the regional EOCs with the fire, health, and medical units is indirect, and the regional EOCs have to obtain the information by listening attentively to media reports, coupled with lack of horizontal contacts between the health unit and the fire unit results in some limitations causing the regional EOCs unable to integrate information effectively. For this reason, establishing a direct communication channel between the local fire unit and the EOCs was suggested. Since the emergency medical dispatchers are the entry point of the emergency medical service (Ma et al. 2007), it is necessary to strengthen the professional competency of the local fire unit (phone 119). The regional EOCs in the case of urgent personnel dispatch should be able to provide rapid and correct medical resource messages to the frontier rescue personnel of the local fire unit. This will help to increase the reliance of the health, fire, and medical units on tracking medical messages of the regional EOCs. The regional EOCs play the role of an integrated communication platform, allowing for a closer connective relationship among the three units.

The proposed mode of the emergency medical incident notification process is shown in Fig. 9. The blue-dash rectangular represents the scope of information flow among the EOCs, the fire unit, the health unit, and medical unit for an emergency medical incident. The dotted rectangular block shown in the diagram refers to the message process, which is the notification network of the EOCs with the health, fire, and medical units; the solid line refers to the administrative process, indicating a direct affiliated relationship in the administration or mission between the units. Since the EOCs are the staff division of the DOH, in the event of a major disaster, the EOCs' duty is to notify the phone 119 of the local fire unit, health unit, and medical unit near the event location, as well as to notify the DOH. During the responding process of an incident, the EOCs should also listen attentively to the units' radios to secure the on-site handling conditions, help provide the rescue personnel with medical resource information on nearby medical units that are capable of

admitting injured patients, and inform the medical units on the number of injured patients that would be sent there and the injury or illness involved to help the medical units offer relevant pre-medical services. During the course of an incident, the EOCs should also continue to monitor the injury handling process and conditions involving use of medical resources, assist the local health unit or medical units to login the disaster conditions on the emergency medical management system until the closure of the incident, record the event information, complete the closure of the case, and review the reports.

## 5 Conclusion

A successful operation of emergency medical service relies on integrating information and the coordination center to coordinate and communicate among the regional EOCs, the health, fire, and medical units with a protocol. Results show that the service performance of six regional EOCs in Taiwan from 2005 to 2007 has generally increased. From the existing coordinating operation scheme, the regional EOCs are limited to information transferring rather than being in charge of coordination. The regional EOCs did not be given a proper position for assistance and coordination during the event of medical incident. Moreover, lack of horizontal contacts between the health bureau and fire bureau results in some limitations causing the regional EOCs unable to integrate information effectively.

As Taiwan's fire unit, health unit, and medical unit belong to different administrative systems, a key factor for regional EOCs to provide real-time information delivery and query services is to establish a successful coordination operation and notification mode. In addition, the establishment of a common disaster information and medical resource exchange platform is necessary. Moreover, the law that allows EOCs to be the officially dedicated units should also be amended. Finally, the regional EOCs must be given regulatory power and responsibility to execute their services, which allows them to play an active role. This would effectively help to integrate the fire, health, and medical units uniformly in the rescue response operation of disaster incidents and allow the frontier rescue personnel at the disaster scene to send the injured patients to the nearest and most appropriate hospitals in the fastest time possible to effectively demonstrate the efficiency of the emergency medical service.

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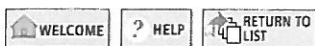
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2011 JCR Science Edition

Journal: NATURAL HAZARDS

Mark	Journal Title	ISSN	Total Cites	Impact Factor	5-Year Impact Factor	Immediacy Index	Citable Items	Cited Half-life	Citing Half-life
	NAT HAZARDS	0921-030X	2012	1.529	1.710	0.183	262	5.6	8.8
Cited Journal			Citing Journal	Source Data	Journal Self Cites				



Journal Information

Full Journal Title: NATURAL HAZARDS

ISO Abbrev. Title: Nat. Hazards

JCR Abbrev. Title: NAT HAZARDS

ISSN: 0921-030X

Issues/Year: 12

Language: ENGLISH

Journal Country/Territory: UNITED STATES

Publisher: SPRINGER

Publisher Address: 233 SPRING ST, NEW YORK, NY 10013

Subject Categories: GEOSCIENCES, MULTIDISCIPLINARY

**Eigenfactor<sup>®</sup> Metrics**  
 Eigenfactor<sup>®</sup> Score  
 0.00650  
 Article Influence<sup>®</sup>  
 Score  
 0.590



Journal Rank in Categories: JOURNAL RANKING

Journal Impact Factor

Cites in 2011 to items published in: 2010 = 171    Number of items published in: 2010 = 167  
 2009 = 280    2009 = 128  
 Sum: 451    Sum: 295  
 Calculation:  $\frac{\text{Cites to recent items}}{\text{Number of recent items}} = \frac{451}{295} = 1.529$

5-Year Journal Impact Factor

Cites in {2011} to items published in: 2010 = 171    Number of items published in: 2010 = 167  
 2009 = 280    2009 = 128  
 2008 = 175    2008 = 108  
 2007 = 247    2007 = 129  
 2006 = 153    2006 = 68  
 Sum: 1026    Sum: 600  
 Calculation:  $\frac{\text{Cites to recent items}}{\text{Number of recent items}} = \frac{1026}{600} = 1.710$

Journal Self Cites

The tables show the contribution of the journal's self cites to its impact factor. This information is also represented in the cited journal graph.

<b>Total Cites</b>	2012	<b>Self Cites</b>	282 (14% of 2012)
<b>Cites to Years Used in Impact Factor Calculation</b>	451	<b>Self Cites to Years Used in Impact Factor Calculation</b>	87 (19% of 451)
<b>Impact Factor</b>	1.529	<b>Impact Factor without Self Cites</b>	1.234

Journal Immediacy Index

Cites in 2011 to items published in 2011 = 48  
 Number of items published in 2011 = 262  
 Calculation:  $\frac{\text{Cites to current items}}{\text{Number of current items}} = \frac{48}{262} = 0.183$

Journal Cited Half-Life

The cited half-life for the journal is the median age of its items cited in the current JCR year. Half of the citations to the journal are to items published within the cited half-life.

**Cited Half-Life: 5.6 years**

Breakdown of the citations *to the journal* by the cumulative percent of 2011 cites to items published in the following years:

Cited Year	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001-all
# Cites from 2011	48	171	280	175	247	153	161	136	192	61	388
Cumulative %	2.39	10.88	24.80	33.50	45.78	53.38	61.38	68.14	77.68	80.72	100

**Cited Half-Life Calculations:**

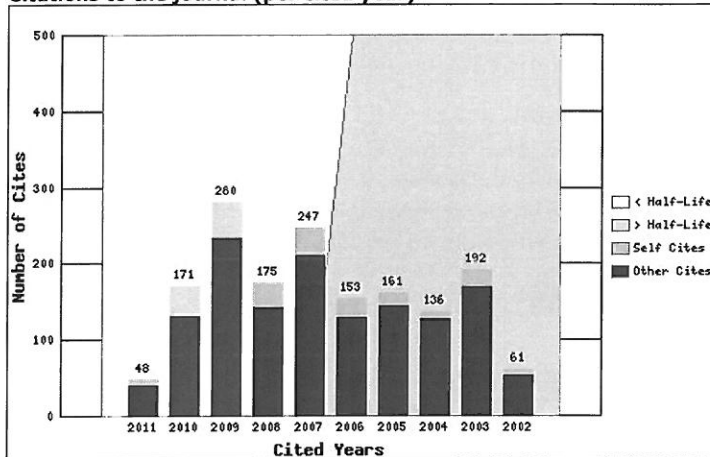
The cited half-life calculation finds the number of publication years from the current JCR year that account for 50% of citations received by the journal. Read help for more information on the calculation.

**Cited Journal Graph**

[Click here for Cited Journal data table](#)

This graph shows the distribution by cited year of citations to items published in the journal NAT HAZARDS.

**Citations to the journal (per cited year)**



- The white/grey division indicates the cited half-life (if < 10.0). Half of the journal's cited items were published more recently than the cited half-life.
- The top (gold) portion of each column indicates Journal Self Citations: citations to items in the journal from items in the same journal.
- The bottom (blue) portion of each column indicates Non-Self Citations: citations to the journal from items in other journals.
- The two lighter columns indicate citations used to calculate the Impact Factor (always the 2nd and 3rd columns).

**Journal Citing Half-Life**

The citing half-life for the journal is the median age of the items the journal cited in the current JCR year. Half of the citations in the journal are to items published within the citing half-life.

**Citing Half-Life: 8.8 years**

Breakdown of the citations *from the journal* by the cumulative percent of 2011 cites to items published in the following years:

Cited Year	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001-all
# Cites from 2011	47	368	578	742	670	669	667	567	464	434	4111
Cumulative %	0.50	4.45	10.66	18.62	25.81	32.99	40.15	46.24	51.22	55.88	100

**Citing Half-Life Calculations:**

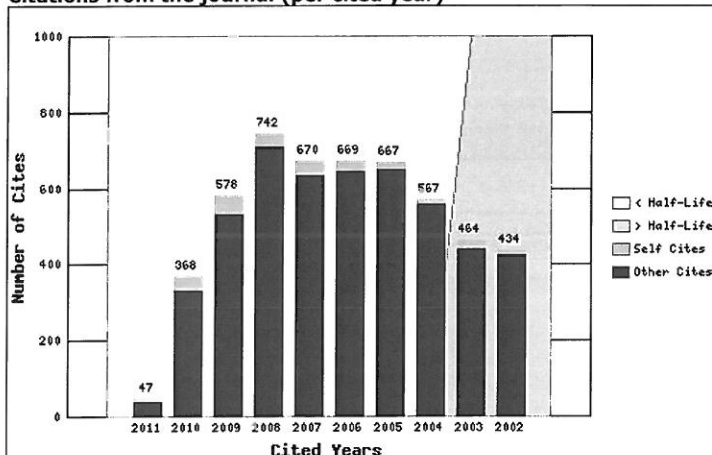
The citing half-life calculation finds the number of publication years from the current JCR year that account for 50% of citations in the journal. Read help for more information on the calculation.

**Citing Journal Graph**

[Click here for Citing Journal data table](#)

This graph shows the distribution by cited year of citations from current-year items in the journal NAT HAZARDS.

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**Journal Source Data**



	Citable items			Other items
	Articles	Reviews	Combined	
<b>Number in JCR year 2011 (A)</b>	261	1	262	5
<b>Number of references (B)</b>	9246	21	9267	50.00
<b>Ratio (B/A)</b>	35.4	21.0	35.4	10.0

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