A Coordinated Emergency Response: A Color Dust Explosion at a 2015 Concert in Taiwan

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A Coordinated Emergency Response: A Color Dust Explosion at a 2015 Concert in Taiwan

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In June 2015, nearly 500 concert attendees suffered injuries from smoke inhalation and severe burns following a color-dust explosion at a waterpark in Taiwan.

We report on the progressions of the incident and government responses, share cross-departmental mobilization and case management lessons, and reflect on clinical and complex policy issues emerged.

The timely and coordinated emergency responses, a high-quality universal health care system, and dedicated clinicians voluntarily working overtime resulted in an unprecedented 2.4% mortality rate (international statistics predicted 26.8%). (*Am J Public Health*. Published online ahead of print July 26, 2016: e1–e4. doi:10.2105/AJPH.2016.303261)

On June 27, 2015, a "color play" event at the Formosa Fun Coast waterpark in New Taipei City, Taiwan attracted more than 4000 young participants. Hundreds gathered to dance in an oversized drained swimming pool at sunset, when suddenly they were forced to flee from an explosion of colored powder. Alerted by the local government, the National Fire Administration immediately activated its Emergency Operations Center, which was supervised by the Ministry of Health and Welfare and the Central Disaster Prevention and Response Council. Nearly 300 emergency vehicles were dispatched from fire and health departments, police stations, military stations, hospitals, and private organizations from across 5 cities and counties, along with 1235 first responders.

Within 6 hours, 499 victims were delivered to 34 hospitals. Most wore flammable swimwear, causing large total body surface area burns (TBSA; TBSA averaged 44%: 363 people with burn area > 20%, 277 with > 40%, and 29 with > 80%; mean age = 23 years; SD = 4.46).[1] Overnight, hundreds of medical personnel were called and many more volunteered to work overtime in the crowded emergency departments and intensive care units. By day two, 437 patients were properly admitted to 46 hospitals in 8 cities and counties (Figure 1 shows the response timeline; Table A, available as a supplement to the online version of this article at http://www.ajph.org, shows the injury and hospitalization status and recovery progress over 3 months). This was the largest medical emergency in Taiwan since the 1999 earthquake, which had a 7.6 magnitude.[2] In the United States, only 3.1% of burn victims suffered more than 40% TBSA in the past decade; the mortality rates of all burn victims with 40%–50% TBSA and 80%–90% TBSA were 26.8% and 71.4%, respectively (it was lower for younger patients; Table 1).[3]

CROSS-DEPARTMENTAL COORDINATION AND MOBILIZATION

The Ministry of Health and Welfare immediately assembled a multidivision taskforce to manage and mobilize medical services and provide administrative and logistical support, making every effort to subvert the expected mass mortality. The minister also commanded a medical advisory board to map out a comprehensive, integrated care plan, with priorities on (1) intensive infection control, (2) prompt distribution of medical instruments and supplies, and (3) counseling for victims and families.

To minimize financial barriers to medical access, on day 2 the National Health Insurance Administration and New Taipei City instituted a policy waiving copays and out-of-pocket expenses for victims (including foreigners) for 3 months following this event.[4] Saving lives was the top priority, and all possible clinical measures, including expensive extracorporeal-membrane oxygenation, were used, regardless of cost. As Taiwan's universal health care system was well established and widely used with a unified claim and record structure, it reported the real-time progress of all patients daily to a centralized database for assessment and deployment. Every 6 hours, available and vacated intensive care units and burn unit beds were tabulated nationally to coordinate referral and transfer needs. Moreover, a platform listing available physicians and nurses (including off-duty and retired clinician volunteers and former hospital employees who offered to help) was established to meet surging and fluctuating demands across the country (coordination flowchart is shown in Figure A, available as a supplement to the online version of this article at http://www.ajph.org). With the severity of burns, many victims required 2 to 6 nurses for 1 dressing change that could last for more than 2 hours and could occur more than once a day.

Concurrently, the Taiwan Food and Drug Administration monitored inventories of essential medical instruments, burn injury supplies, and pharmaceuticals at hospitals and factories to ensure sufficient stock at any

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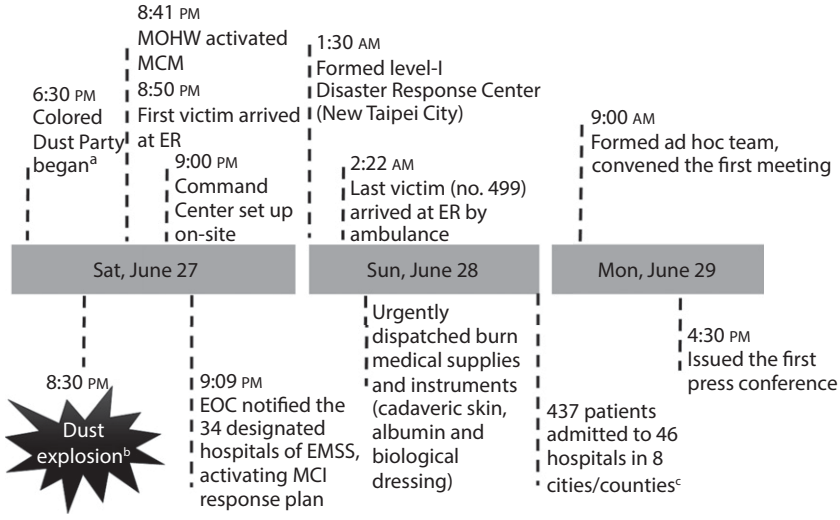

Note. EMSS = Emergency Medical Service System; EOC = Emergency Operations Center; MCI = Mass Casualty Incident; MOHW = Ministry of Health and Welfare; MCM = Mass Casualty Mechanism; TBSA = total body surface area.

Source. American Burn Association's 2015 National Burn Repository and National Health Insurance Administration, Taiwan Ministry of Health and Welfare.

[a]The first modern road running event advertised for spraying colored cornstarch powder for fun was introduced in Arizona in 2011. The use of colored powder on participants of large gatherings was likely inspired by India's Holi "Festival of Colours" that takes place every spring. Hundreds of similar events have been held across 50 countries since (e.g., musical festivals and marathons). Most event organizers, attendees, and the public are unaware of the potential risks.

[b]Investigation later determined the cause of the explosion was an overheated stage projection light that reached over 750°F and combusted. The concentration of the powder or dust and airstream turbulence as people ran caused the fire to spread.

[c]As most participants were dressed in swimwear rather than regular clothes that could have provided better protection for the body, the victims' burns tended to be more severe and covered larger body areas (TBSA averaged 44%: 363 people with burn area > 20%, 277 > 40%, and 29 > 80%; average age = 23 years). Global statistics indicated the overall mortality rate of burn patients was 3.2% in 2012, of which > 75% of the victims suffered burns to < 10% TBSA. The mortality rate of US patients with 40%–49.9% TBSA was 26.8%, or 10.5% for people aged 20–29 years.

FIGURE 1—Timeline and Actions of Initial Response in the First 48 Hours After Color Dust Explosion: New Taipei City, Taiwan, 2015

particular time. This was accomplished by consolidating purchases and distributions of materials such as artificial dressing and cadaveric skin, rushing productions, and expediting import licensing when necessary. The agency also managed charitable donations of supplies; all monetary donations were funneled to the New Taipei City government to determine use, distribution, and prevention of resource duplication.

Important lateral partners included the Ministries of Economic Affairs, Finance, Justice, Foreign Affairs, and Education as each ministry took charge of specific tasks (the division of responsibilities across departments is shown in Figure B, available a supplement to the online version of this article at http://www.ajph.org). Local governments also stood side by side with the central government to continue providing care. Furthermore, the public played a vital role in backing the recovery stage, commiserating with the victims and families with both tangible assistance and camaraderie. Volunteers contributed logistical, spiritual, and psychological support for more than 6 months.

LONG-TERM CASE MANAGEMENT

In addition to covering almost unrestricted medical and related expenses (through emergency reserve funds and anticipated subrogation),[4] the government stationed social workers in each hospital to provide one-stop onsite and ongoing consultation for welfare assistance and counseling to victims and families as well as clinical personnel. A hotline for the public seeking psychological support and referral was also established.[5]

Moreover, the Ministry of Health and Welfare and New Taipei City coordinated the "0627 One Person–One Case" Postacute Care Program. Case managers worked closely with health care and social services to create individualized plans for each victim and family. They assisted in interhospital communication for transferring stabilized inpatients to community hospitals near victims' homes and helped facilitate long-term rehabilitation. The program also worked to prevent posttraumatic stress disorder and promoted victims' ability to reenter society and the job market after long-term treatment and with unsightly scars. Family caregivers' lost wages and physical and psychological stress were taken into consideration for welfare assistance, too.

LESSONS AND REFLECTIONS

After 3 months of extensive patient care, the overall mortality rate was an unprecedented 2.4% (12/499), compared with the predicted 26.8% (or 4.3% vs the US 31.2%, adjusted for age 16–39 years with > 40% TBSA; Table 1).[1,3] Although the accumulated expenses topped US $43.8 million by year end,[5] separating financial consideration from the evidence-based, victim-centered care was effective in reducing mass fatality. Overall, the unified postdisaster command system, a robust National Health Insurance system, and teams of committed clinicians proficient at delivering expeditious treatments were essential in productively implementing the emergency response plan.

Yet some coordination logistics could benefit from further improvements. (1) Ambulances have communication with hospitals to determine where patients should be delivered on the basis of medical needs, distance, and hospitals' capacity. During a mass casualty incident, other vehicles transporting victims may not be informed about the initially available beds filling up while en route, resulting in delays because of the requirement to send patients elsewhere.

TABLE 1—Taiwan 2015 Incident Mortality Rate Compared With US 2005–2014 Statistics by Age and Burn Size

	% Total Body Surface Area Burned				
Age Group	40%–59.9%, % Mortality (No. Died/No. Burned)	60%–79.9%, % Mortality (No. Died/No. Burned)	> 80%, % Mortality (No. Died/No. Burned)	Subtotal (≥ 40%), % Mortality (No. Died/No. Burned)	Total[a] (All TBSA Sizes), % Mortality (No. Died/No. Burned)
16–19.9 y					
United States	4.1 (7/172)	22.7 (17/75)	63.8 (44/69)	21.5 (68/316)	1.0 (92/9 022)
Taiwan	. . .	. . .	. . .	. . .	2.45 (3/122)
20–29.9 y					
United States	12.8 (60/468)	32.6 (78/239)	70.3 (142/202)	30.8 (280/909)	1.4 (381/26 686)
Taiwan	. . .	. . .	. . .	. . .	2.15 (7/326)
30–39.9 y					
United States	13.6 (61/447)	39.5 (90/228)	81 (153/189)	35.2 (304/864)	2.0 (446/22 374)
Taiwan	. . .	. . .	. . .	. . .	3.9 (2/51)
Subtotal[b] (16–39.9 y)					
United States	11.8 (128/1 087)	34.1 (185/542)	73.7 (339/460)	31.2 (652/2 089)	1.6 (919/58 082)
Taiwan	2.5 (4/160)	3.4 (3/88)	17.2 (5/29)	4.3 (12/277)	2.4 (12/499)
Total[c] (all ages)					
United States	30.5 (1 024/3 354)	48.9 (764/1 563)	78.1 (1 005/1 286)	45.0 (2 793/6 203)	3.2 (5 636/178 186)
Taiwan	2.5 (4/160)	3.4 (3/88)	17.2 (5/29)	4.3 (12/277)	2.4 (12/499)

Note. TBSA = total body surface area. For the 499 Taiwanese burn victims, the average age was 23 years (SD = 4.46 years) and average TBSA was 44% (SD = 23%). We selected these age groups and burn size data to compile this table because the 12 who died within the first 3 months were aged 18–35 years, and all had more than 50% TBSA (i.e., the mortality rate in Taiwan for victims with < 50% TBSA was 0% for any age group).

Source. Taiwan National Health Insurance official reports and press releases; American Burn Association's 2015 National Burn Repository of Data from 2005–2014.

[a]Of the Taiwanese victims, 277 (55.5%) had > 40% TBSA. In the United States, only 3.1% of burn victims in 2005–2014 suffered > 40% TBSA. Because there was such a large difference in burn size distribution, we listed the US–TW pairs for reference purposes only; these should not be considered meaningful or adequate comparisons.

[b]By the end of month 3, 12 persons had died from this explosion, resulting in an overall mortality rate of 2.4%, or 12/499. Adjusted for age and injury severity, Taiwan's mortality rate was 4.3% for victims in the 16-39 y age group who suffered > 40% TBSA, whereas the US mortality rate was 31.2% for the same age group/burn size; the US mortality rate was 45% for victims of all ages who suffered > 40% TBSA.

[c]Because all Taiwanese victims were in the age group 16–39.9 years, the Taiwan statistics were the same for the subtotal and total rows, which was not the case for the US statistics.

(2) Regularly overcrowded emergency departments hinder hospitals' ability to handle demand surges in crises and properly prioritize their treatments on the basis of urgency. Conversely, when disaster victims need hospitalization for an extended time, adjustments may be required, such as transferring stabilized patients to community clinics, to ensure adequate care for all patients.

Additionally, several issues generated public debates that called for change. Many countries offered assistance as well as medical supplies and instruments.[6] However, international clinical experts and volunteers could provide only consultations, not treatments, because of previous regulations prohibiting foreign medical personnel from practicing in Taiwan. Other outdated or loosely defined laws governing the risk management of large public events also received criticism (e.g., there was no clear mandate requiring organizers to undergo venue inspection or purchase adequate insurance). Some countries, including Taiwan, have since banned or cancelled colored dust events.[7–10] The Taiwanese government is evaluating past cases as it discusses policy amendments and reexamines the Emergency Medical Services Act to ensure the safety and well-being of the public.

Other questions raised pertained to equity: (1) It is difficult and involves clinical expertise and political wisdom to establish criteria (e.g., whether injury severity or estimated survival rate should be the top priority) for equitable distribution of critical supplies, such as cadaveric skin, that are in short supply. The medical community, families, and the public had different opinions on the appropriate allocations of expensive or limited materials. (2) Setting boundaries for "free" clinical services and welfare provision after the incident is also complex; government's financial capacity and the public's sentiment are important to consider in achieving social justice. These experiences and issues pose meaningful policy implications and may serve as valuable lessons to ponder for health departments and public agencies around the world. AJPH

CONTRIBUTORS

All of the authors contributed equally to this article.

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HUMAN PARTICIPANT PROTECTION

Human participant protection was not required because no human participants were involved.

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