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The London Attacks - Preparedness: Terrorism and the Medical Response

[Perspective]

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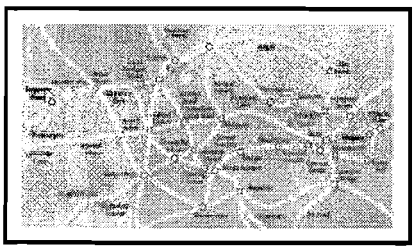
Although Britain is no stranger to terrorist attacks, the pattern of activity has changed in recent years. Irish bombers first attacked London in 1867, but bombings peaked between 1969 and 2000, with 1972 alone seeing 1500 separate incidents - and 5005 casualties - in the United Kingdom. With the recent accessibility of information over the Internet have come new risks: in 1999, a single person used such information to construct and deploy three devices in central London, killing 3 people and injuring more than 120. The London attacks of July 7, 2005, however, represent a shift to a new scale and a new modus operandi.

At approximately 8:50 A.M. on that day, simultaneous explosions occurred below ground on three subway trains (see map [Figure 1]). The first occurred some 100 m from the station platform at Edgware Road, killing seven persons at the scene. Within three hours, the nearest hospital had received 4 critically injured patients, 8 who were seriously hurt, and 14 with minor injuries. By the time the scene was cleared, at least 80 casualties had been triaged close to the scene, and the hospital had received 38. Of these, 24 were in critical or serious condition.

Figure 1. Map Showing Sites of Explosions in London on July 7, 2005.



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The second device exploded on the floor of the third carriage of a train, 200 m from the Aldgate station platform. More than 100 persons were wounded, 16 of them severely, and 7 died at the scene. Patients were triaged and transported (by ambulance and three buses) to the nearest hospital, which received 208 casualties from this and other sites, of whom 27 were admitted.

A third device exploded in the front carriage of a subway train between the King's Cross and Russell Square stations, through both of which evacuation occurred. Staff from two nearby specialist hospitals (the National Hospital for Neurology and Neurosurgery and Great Ormond Street Hospital for Sick Children) attended at the scene. Approximately 236 persons (36 of them severely injured) were transferred to local hospitals. Two adults were admitted to the Children's intensive care unit. Twenty-five people died at the scene.

At 9:47 A.M., at Tavistock Square, a device exploded aboard a double-decker bus. Fourteen doctors, many from the nearby British Medical Association, provided immediate care. Thirteen persons died at the scene.

All told, four suicide bombers had left approximately 700 persons injured. Fifty-six of them (8.0 percent) were dead - a proportion identical to that after the train bombing in Madrid in March 2004, when 191 (8.0 percent) of the 2253 injured persons died. [1] In both attacks, most who died did so at the scene.

These parallels (many casualties, high mortality, and severe injuries) reflect the location and timing of the attacks. When an explosive device detonates, a small volume of explosive is rapidly transformed into a large volume of gas. A high-pressure blast wave expands outward at the speed of sound and, in interacting with the body, causes primary injuries (mainly at air interfaces such as the lung, ear, and bowel). The resultant blast wind propels solid matter into the patient (secondary injury) or the patient into solid matter (causing tertiary injury). Quaternary injury is caused by heat, flames, or the inhalation of smoke and hot gases. Confined spaces exacerbate such effects: surface reflections amplify and prolong the blast wave, the blast wind is channeled, and heat and gases are contained. The severity of injuries and the resultant mortality are thus greater. [2] The total number of persons endangered is increased by detonation within a rush-hour commuter environment.

Among the survivors, traumatic tympanic perforation was common. Secondary injuries, including penetration by biologic material, were frequent, as were traumatic amputation and smoke inhalation.

The attacks were unprecedented in scale and severity for London, but they were anticipated: the question, experts had said, was "not if but when." All the emergency services had prepared extensively for such attacks: in September 2003, our own hospital engaged in an all-agency response to a hypothetical explosion in a deep subway tunnel, and major exercises had been held only weeks before this event. For National Health Service facilities, preparedness is mandatory: chief executives are legally responsible for planning and practicing for conventional, chemical, nuclear, biologic, and radiologic attacks. Such intensive preparation is what permitted London's medical response system to work as well as it did.

Despite such planning and rehearsal, however, the attacks did present difficulties. First, the simultaneous detonation of devices at multiple locations put pressure on emergency services. More than 100 ambulances were deployed by the London Ambulance Service, staffed by more than 250 professionals. The underground locations of some of the explosions added problems of site access and safety, as well as the need for specialist training and extrication skills. Working conditions were restricted, ventilation poor, temperatures high, and lighting problematic.

Second, the demand for communication among individuals and organizations after any major incident is amplified when multiple sites are involved. Moreover, the conventional communications infrastructure may fail at such times - telephone lines fail, and mobile telephone networks soon become overloaded by civilian use. Such breakdowns hamper communication between operational medical teams and their control centers and hospitals, and even mobile person-to-person communication within hospitals.

Finally, the targeting of the transportation infrastructure causes unique problems. The closing of bus and subway services leads to road congestion. At any other hour, such closings might have prevented medical and paramedical staff members from reaching their posts (but at the time of the bombing they were already there), as well as preventing the ready discharge of patients in order to clear beds. It may also hinder the rapid deployment of personnel to the scenes - a difficulty that was partially overcome by the (planned) deployment by the London Ambulance Service of paramedic crews on bicycles.

What, then, can we learn at this early stage? And what provision should we make for the future? Clearly, the nature of these bombings demonstrates the value of planning and rehearsal. Such preparation should recognize the changing nature of the threat.

Today, ready access to information on bomb construction facilitates the use of explosive devices by any number of aggrieved persons and organizations, and we should probably anticipate sporadic, smaller-scale attacks. In addition, the use of suicide bombers increases the difficulty of recognizing threats: one no longer seeks simply the classic unattended package. Biologic or chemical agents might be released at the time of a conventional blast, as sarin gas was released into the Tokyo subway system in October 1995. Furthermore, unlike other recent terrorist bombings against the United Kingdom, which generally targeted commercial property or military personnel, the attacks in London and Madrid targeted civilians, and the detonation of devices at multiple sites and in densely packed, confined areas increased the number of casualties and the severity of injuries.

Given these considerations, we should train individuals, in addition to undertaking regional or organizational preparations. If doctors are to assist meaningfully at the scenes of explosions, they should understand the workings of emergency services. Such training should not be restricted to a few "experts":

many "passerby" doctors engaged in casualty care at each of the scenes. Specialists must be trained in new skills, such as extrication, triage, and transport. In London, a pool of such doctors - medical incident officers - already exists. The Royal London Hospital's helicopter emergency service, augmented by fast-response cars, can also deliver senior expert medical staff. On this occasion, 24 such senior staff were deployed.

Each city should review the provision of such services and ensure that training and equipment are adequate and that these professionals can function in a structured and reliable fashion. Sufficient numbers should be available, and their means of transportation - even when the standard infrastructure fails - ensured. All doctors should learn to recognize and meet the needs of blast victims: the unique mechanisms of explosive injury and the combinations of primary, secondary, tertiary, and quaternary lesions in one person are not encountered in any other situation. [3]

Above all, as the events of July 21 showed, we cannot be complacent. We must recognize that our future challenges may be far vaster in scale and that future attacks may be neither geographically nor temporally remote.

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