# Care of victims of suicide bombing

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**Summary**

Suicide bombers often target crowds. This commentary discusses the additional features required in a medical response beyond conventional mass casualty care, including forensic documentation, preservation of evidence, suspect tissue identification and viral status, victim counselling and postexposure prophylaxis. We propose a pathway for care of victims of a suicide bomb, adapting elements from protocols for child abuse, sexual assault and needle-stick exposure.

Suicide terrorism is not a modern phenomenon. In the 1st century, the Roman-occupied Judea saw the rise of the Jewish Sicarri ("small daggers") sect, which used suicide attacks against the occupiers, and in the 11th century, the Muslim group al-Hashashin ("assassin") used public knife attacks by self-sacrificing assailants to terrorize opponents.[1,2] In the Second World War, the Japanese Kamikaze ("divine wind") were suicide attacks by military aviators against United States Navy fleets.[3] Suicide terrorism, rising around the world since the 1970s, is strategically planned, rather than randomly performed by individual fanatics. It occurs in clusters as a part of a larger campaign with a specific political goal. Between 1974 and 2016 there were a total of 5261 suicide attacks causing 53 566 deaths and 131 253 wounded.[4] Lethality (10.2 deaths and 25 wounded per suicide bomb) is higher than that seen in nonsuicide bombings, most likely because of greater target accuracy.[5–7]

Besides injuries from the blast and infections from the local environment that affect all blast victims, there is concern that the long-term health of suicide bomb survivors may be compromised by infection due to implantation of biological material from the suicide bombers themselves.[8] Reports so far show the concern to be overestimated. In 2002, 20 of 21 victims of a suicide bomb in a semiconfined market location in Israel had penetrating fragment (metal screw) injuries, but none had any biological materials embedded. The environment was thought to have been the source of candidemia in seven patients.[8] Eshkol and colleagues[9] reviewed the cases of 94 patients with blast and fragment injuries caused by suicide bombers in 12 separate events in Israel. Three patients had penetrating injuries caused by bone fragments from the suicide bombers. The bone samples from one of the suicide bombers tested positive for hepatitis B, but none of the patients developed clinical signs of hepatitis B virus (HBV), human immunodeficiency virus (HIV) or hepatitis C virus (HCV). Braverman and colleagues[10] described 1 of 32 victims of a suicide bomber with a bone fragment in the neck. The bone fragment was found to be positive for hepatitis surface antigen (HBsAg) and negative for HIV.[10] The patient was treated with active and passive HBV vaccinations. Leibner and colleagues[11] reported the case of a 12-year-old boy who was vaccinated prophylactically after being injured by bone from a suicide bomber. The London bombing in 2005 was the result of four suicide bombers detonating explosive devices in a coordinated attack on the city's

public transit systems. Wong and colleagues[12] reported that 5 of 194 patients treated at the Royal London Hospital, who were found to have implantation of foreign bone fragments, received HBV vaccination, and one also received antiretroviral medications for HIV prevention. Serum was stored for later testing if required. Also, all the recovered bone fragments were given to the police forensics department at the time of débridement, but none of the specimens were tested for any potential infections.[12] Patel and colleagues,[13] who looked after eight survivors of the same incident with allogenic bone fragments from the suicide bomber, recommend all victims with an open wound should receive prophylaxis against HBV and surveillance for HIV and HCV infection. de l'Escalopier and colleagues[14] reported on two French military personnel who were victims of a suicide bomber in front of the French embassy in Africa. They followed the Centers for Disease Control and Prevention (CDC) recommendations for postexposure prophylaxis (PEP) in people wounded by bombing and other mass-casualty events.[14] Both solders received wound care and antibiotics and were repatriated back to France 48 hours later. One of the soldiers was discovered to have screws in various parts of his body and a bone fragment of the suicide bomber in his penis. Both soldiers had been immunized against tetanus and HBV before deployment, but were not given antiretroviral therapy. Both remained negative for HBV, HCV and HIV when serially tested for six months.

Three factors determine the transmissibility of HBV: the duration of viremia, the concentration of infectious HBV particles in the plasma, and the kind and frequency of contacts allowing transfer of HBV from the infected host to another susceptible recipient.[15] Hepatitis B virus is 50–100 times more infectious than HIV, it is able to survive outside the body for at least seven days, and it is capable of causing infection if it enters the body of a person who is not protected by the vaccine. On average, the incubation period of HBV is 75 days, but can vary from 30 to 180 days.[16] The virus may also be detected within 30 to 60 days after the infection and can develop into chronic HBV. The risk of seroconversion through occupational exposure to known infected blood via membrane splash to needle stick injury varies from 18% to 30%.[17] The availability of a safe and effective vaccine to prevent HBV infection and its wide adoption among health care and public safety workers has decreased the occupational risk of acquiring HBV infection. Unfortunately, the nonimmunized or incompletely protected population is still at risk for the infection. Hepatitis A virus (HAV) is theoretically more easily transmitted than HBV, but no examples have been recorded.

The CDC reports that HCV transmission after percutaneous exposure to the blood of an HCV-positive patient occurs at an average rate of 1.8% (range 0%–10%).[18] The stability of HCV in serum and plasma stored at 4°C is high, and HCV RNA can be detected in serum spotted and dried on to filter paper held at room temperature for up to four weeks.[19–21]At the present time, there is no viable HCV vaccine. The virus has a highly variable strain, and quick mutation makes development of an effective vaccine very difficult. However, strategies to cure the infection have evolved dramatically since the discovery of HCV. Recently, oral directly acting antiviral agents (DAA) that target various stages of the HCV lifecycle have resulted in cure rates approaching 100%.[22]

The HIV epidemic has shifted over the past 30 years, from the first reported cases in the 1980s to 37 million new infections estimated in 1997 to drastic reductions in new infections and mortality throughout the 2000s owing to the expansion of antiretroviral therapy.[23] However, the frequency of contact of health care workers with people living with HIV has increased. The reported average risk of HIV transmission is 0.3% after percutaneous exposure to an HIV-positive blood source and 0.09% after mucous membrane exposure.[24] The virus can also remain stable in blood at room temperature and may persist for weeks in dried blood at 4°C. In human corpses stored at the usual mortuary temperature of 2°C, HIV can be recovered between 11 and 16 days after death.[25–27]

Tetanus is an uncommon disease in developed countries; however, in countries where primary immunization programs and PEP are not effective, tetanus remains a major problem, and approximately 800 000 to 1 million deaths from tetanus occur worldwide each year.[28] Tetanus is caused by two toxins secreted by *Clostridium tetani*, a gram-positive, spore-forming, obligate anaerobic bacillus. These vegetative bacteria grow optimally at 37°C. Wound sites contaminated by soil and with low oxygen tension are optimal locations for germination of *C. tetani*. The spores are noninvasive and require a skin break for germination. The incubation period for tetanus varies from one or two days to one month or more; most patients have onset of symptoms within one to two weeks of the initial injury.

There are noninfectious considerations for responders to suicide bombing: forensic material must be kept for intelligence and prosecution services, and victims and their families may need additional counselling because of the nature of the bomb. Civilian first responders and emergency departments are familiar with working in crime scenes and often care for victims of crime.[29] Protocols used in the care of patients who have been subjected to sexual assault, child abuse, domestic violence and criminal assault may be adapted to develop an appropriate response for mass casualties from suicide bombs. Most features of the following protocol would constitute good practice in a mass-casualty event, even if suicide bombing was not a feature.

### Proposed response to multiple patients injured by a suicide bomb

1. The protocol to be used by a team should be modified by the team for their particular situation, accounting for their environment and external support. The protocol should be tested in exercises and refined by debriefing participants.
2. All team members, medical and combat, should be vaccinated against HBV and checked for an appropriate antibody response to prove immunity.
3. Additional equipment should be stored in an easily located basket to include evidence bags for foreign materials and biological specimen kits. The evidence bags should be sealable with tags to record the chain of custody. The biological specimen kits are similar to those used for sexual assault. Collected materials must be properly identified and securely stored. Foreign biological material should be retained for DNA identification and infectious disease screening. Because DNA identification uses amplification, contamination with DNA from the victim or emergency responders is highly likely. Verified DNA from the victim or health care worker may be required to isolate the perpetrator's identity.
4. The medical response should proceed as for all traumas. Documentation must be scrupulously complete to include the location and orientation of the patient at the time of the blast, with a careful description of all wounds and the position of fragments, biological or otherwise, within the patient's body. Blood from victims should be stored for baseline viral studies. Surveillance tests should be repeated at six weeks and six months. Biological specimens from the bomber should be sent for viral nuclear studies.
5. Antibiotic and antitetanus prophylaxis should be administered as for any trauma.
6. Victims without proven immunity to HBV who are injured by a suicide bomber who is either HBV-positive or of unknown status should receive vaccination against HBV. Using the combined vaccine against HAV and HBV (Twinrix) is likely a good precautionary choice. Victims of an HBV-positive suicide bomber should be considered for passive immunization with HBV immunoglobulin as well as vaccination. If the suicide bomber is found to be HBV DNA-negative or if the victim is HBV-immune, surveillance is adequate. Patients who seroconvert should be treated by a hepatologist with one or more protease inhibitors.
7. If the suicide bomber is found to be HIV-positive, a victim penetrated by a biological fragment should be offered PEP within 72 hours. The regime, which consists of a combination of antiviral agents as determined by the team's infectious disease expert for needle-stick prophylaxis, should be continued for four weeks. If the perpetrator is shown to be HIV-negative, surveillance for six months is advised. If the HIV status of the suicide bomber is unknown, PEP or surveillance may be chosen according to the wishes of the victim.
8. The infectivity of HCV is considered sufficiently low and the response to modern protease inhibitor regimes sufficiently good that surveillance for six months is advised regardless of the status of suicide bomber.
9. Counselling of victims should emphasize the low likelihood of disease transmission by suicide bombing and the efficacy of modern therapies should an infection be found. In addition, the risk of sexual transmission of any acquired virus is sufficiently low to not require a change in practice. If there are concerns, barrier prophylaxis during sex would be sufficient precaution. These regimes are effective if the protocols, which have been developed in analogous situations, are followed. Written plans for surveillance and care should be given to the victim. The patient will also be reassured to know that the team has taken a scrupulous approach to evidence gathered during their care that may be useful to combat the crime of suicide bombing.

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