

## **Defence Scientific Advisory Council Sub-Committee on the Medical Implications of Less-Lethal Weapons (DOMILL)**

### *Statement on the Medical Implications of Use of the Taser X26 and M26 Less-Lethal Systems on Children and Vulnerable Adults<sup>1</sup>*

#### **Background**

1. DOMILL<sup>2</sup> reports to the Secretary of State for Defence to provide:
  - (a) Advice on the biophysical, biomechanical, pathological and clinical aspects of generic classes of less-lethal weapons (LLWs);
  - (b) Independent statements on the medical implications of use of specific LLW systems given specific guidance to users;<sup>3</sup>
  - (c) Advice on the risk of injury from specific LLW systems striking specific areas of the body in a format that will assist users in making tactical decisions as well as developing guidance to users to minimise the risk of injury.
2. DOMILL has issued five previous statements relating to the medical implications of the Taser M26 and Taser X26 less-lethal systems.<sup>4</sup> The Taser X26 conducted energy device was introduced into UK policing in 2005 as a replacement for the Taser M26. Recent data from the Home Office Centre for Applied Science and Technology (CAST) indicate that the Taser X26 is the device primarily in use by the UK police.<sup>5</sup>
3. In 2007, the Northern Ireland Policing Minister formally tasked DOMILL with conducting an assessment of the medical implications of use of the Taser system on children and vulnerable adults. The present medical statement constitutes DOMILL's response to this tasking.

#### **Executive summary**

4. DOMILL has considered the medical implications of use of the Taser X26 and M26 systems on children (defined as persons less than 18-years-old) and vulnerable adults (namely, people with conditions or illnesses that may make them more susceptible to the Taser than otherwise healthy persons).

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<sup>1</sup> The first version of this medical statement was endorsed by DOMILL on 4<sup>th</sup> April 2011. This second DOMILL-endorsed version updates the original and contains a small number of clarifications.

<sup>2</sup> On 16 July 2009, DOMILL was replaced by the cross-government Scientific Advisory Committee on the Medical Implications of Less-Lethal Weapons (SACMILL). However, for administrative reasons, SACMILL is not a functional committee at the time of drafting of this medical statement. DOMILL has therefore agreed to continue providing medical advice to government until SACMILL becomes operational.

<sup>3</sup> The term 'system' applies not just to the weapon, but also to how the weapon is used operationally, how users are trained, how the weapon is maintained, and other aspects that have the potential to influence overall weapon safety.

<sup>4</sup> These statements may be found in Appendix B of the *Association of Chief Police Officers (ACPO) Policy and Operational Use of Taser by Authorised Firearms Officers December 2008* (<http://www.westmercia.police.uk/about-us/acpo-armed-policing.html>; retrieved October 2010).

<sup>5</sup> CAST was formerly known as the Home Office Scientific Development Branch (HOSDB).

5. DOMILL's principal findings, based on the evidence presented in the main body of this statement, are as follows:
- (a) A recent human study has shown that Taser discharge, applied through a barb that has penetrated the frontal chest in a region overlying the heart, is capable of inducing an inappropriately high heart rate by a mechanism known as cardiac capture. Although the device used in the study was neither the Taser X26 nor M26, DOMILL is concerned that a comparable effect could be elicited by these latter devices. While a short period of rapid cardiac capture in young and healthy individuals may not have major clinical implications, serious complications could arise in those with impaired heart function caused by an underlying heart condition or through the action of certain licit or illicit drugs. Cardiac capture from chest-penetrating barbs may be more likely to arise in children and thin adults as the heart will generally be closer to the source of discharge.
  - (b) The physiological burden arising from the Taser-induced muscle contractions and associated pain, combined with the stressful circumstances in which Tasers are likely to be used, may adversely affect certain groups. These susceptible groups include the elderly, those with heart conditions, people who have taken certain drugs, and those affected by asthma or other pulmonary conditions.
  - (c) Risks to the pregnant woman and fetus from Taser discharge are incompletely understood. While there is no evidence that abdominal application of Taser discharge is able directly to induce uterine muscle contraction, Taser-induced muscle contraction commonly leads to falls. Fall injuries in general have been associated with an increased probability of delivery by caesarian section and low birth weight.
  - (d) Others who may be at heightened risk of injury from Taser-induced falls include people whose protective reflexes may be impaired, such as those intoxicated with alcohol, illicit drugs or certain prescription medications. People affected by osteoporosis, young people during the adolescent growth period, individuals with a history of a bleeding or clotting disorder and those on anticoagulant or antiplatelet therapy, may also be more prone to an adverse outcome following a fall.
  - (e) Superficial burns from the discharge current passing through the skin are a recognised minor complication of Taser use. Children and vulnerable adults are unlikely to be differentially affected compared with notionally healthy adults.
  - (f) The intense muscle contractions induced by the Taser discharge may lead to musculoskeletal injury. Older people may be more prone to this type of injury.
  - (g) Children and thin adults may be at greater risk of internal injury from tissue-penetrating Taser barbs as body wall thickness generally will be less in these groups. Children and adults of short stature may also be at greater risk of injury to sensitive structures in the head and neck regions due to the closer proximity of these structures to the most commonly used point of aim (the frontal chest).
  - (h) There is equivocal evidence to indicate that Taser discharge may induce epileptic seizures following barb penetration of the scalp. There is also evidence to indicate that Taser discharge may trigger seizures in those affected by epilepsy, irrespective of barb location. Consistent with this, emotional stress and physical exertion, both of which are likely to feature in incidents involving administration of Taser discharge and many other forms of force, are among the seizure-precipitating factors reported by those affected by epilepsy.
  - (i) There is the potential for Taser discharge to be administered to individuals whose behaviour has been influenced by an underlying medical condition or with whom communication is in some way impaired due to non-medical reasons.

- Aggressiveness and non-cooperation may be manifested during and shortly after an epileptic seizure.
  - Adverse changes to behaviour may be exhibited by those with uncontrolled diabetes.
  - Language barriers and hearing or vision impairment may lead to difficulties in communication which may increase the likelihood of exposure to Taser discharge.
  - Mental health conditions, learning difficulties and neurodevelopmental or neurobehavioural conditions (for example, cerebral palsy and autistic spectrum disorders) may negatively influence how affected individuals interact with the police and thereby elevate the risk of exposure to Taser discharge or other forms of force.
- (j) The longer-term psychological implications of exposure to an extremely painful Taser discharge, especially among children, remain unexplored.
- (k) Taser discharge is unlikely to differentially affect persons fitted with cardiac pacemakers or implantable cardioverter defibrillators. However, the effect of Taser discharge on the function of other types of implantable electronic devices, such as vagus nerve stimulators and cochlear implants, is unknown.
6. The present statement concludes with a series of recommendations designed to mitigate and further inform the risks to children and vulnerable adults exposed to the Taser system.
7. Having reviewed the most recent evidence relating to the medical implications of the Taser X26 and M26 systems, and despite the potential injury mechanisms outlined above, DOMILL remains of the view that the overall risk of serious injury associated with UK use of these systems is low. This view is borne out by the low rate of reported serious adverse events in UK operational use of the Taser system. Incorporation into use policy and user guidance of a number of the recommendations made in this statement should help to ensure that the risk of serious injury continues to remain low.

### **Technical approach**

8. The evidence concerning whether children and other vulnerable groups may be at greater risk from the Taser less-lethal system was collated by the Defence Science and Technology Laboratory (Dstl) and presented to the Committee in the form of a comprehensive report. This report was designed to provide DOMILL with a technical and law enforcement foundation with which to explore the issues relevant to an assessment of the relative susceptibility to the Taser system of children and vulnerable adults, compared with notionally healthy adults.
9. DOMILL considered the Taser system as a whole, which included the device itself (use, performance and maintenance), user training, ACPO policy and guidance for use, the quality of data from post-incident medical audit, and the post-incident medical management of vulnerable individuals who have been subjected to Taser discharge.

### **Definitions**

10. For the purposes of the present medical statement, children are defined as people less than 18-years-old.

11. Vulnerable adults are defined as people aged 18 years or more who are affected by any condition that might render them more susceptible to the effects of the Taser. Among the susceptible groups considered by DOMILL are pregnant women, those with low body weight or small stature, persons under the influence of certain illicit or prescription drugs, those with mental health problems, neurological conditions (including epilepsy), heart disease, diabetes, osteoporosis, asthma or haemophilia, people with implanted pacemakers, and those among whom verbal communication may be an issue.

### **Injury mechanisms associated with Taser use**

12. Reports in the medical literature and the media highlight multiple possible injury mechanisms:<sup>6</sup>

- Interaction of the Taser discharge current with the heart.
- Adverse cardiac or respiratory outcomes triggered by the physiological stress imposed by the Taser discharge.
- Interaction of the Taser discharge current with cardiac pacemakers and other implantable devices.
- Spontaneous abortion and other implications for fetal well-being.
- Burns from an interaction of the Taser discharge current with the skin.
- Musculoskeletal complications arising from the intense muscle contraction induced by the Taser discharge.
- Injuries from Taser-induced falls.
- Injuries from tissue penetration of the Taser barbs.
- Triggering of epileptic seizures.
- Administration of Taser discharge to seemingly uncooperative and threatening persons.
- Special considerations among those with mental ill health, learning difficulties or neurodevelopmental and neurobehavioural conditions.
- Deaths associated with the use of the Taser.

13. DOMILL has considered whether children and other vulnerable groups may be differentially affected by these multiple potential injury mechanisms compared with notionally healthy adults.

### **Interaction of the Taser discharge current with the heart**

14. Until recently, none of the human volunteer studies investigating the cardiac effects of the Taser (mostly the X26 type) had shown a direct influence of the discharge current on heart rhythm. However, in none of these studies was the discharge applied to the frontal chest in a region directly over the heart. A recently reported human study using a pre-production variant of a new type of Taser device has illustrated the potential for this kind of adverse effect to occur in the circumstance where discharge is administered through a barb that has fully penetrated the frontal chest overlying the heart.<sup>7</sup> In this study, one subject showed ventricular capture at 240

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<sup>6</sup> Payne-James, J *et al* (2010). Medical implications of the Taser. *BMJ* 2010;**340**:c853.

<sup>7</sup> Ho, JD *et al.* (2011). *Forensic Sci Int* **204**:50-7.

beats per minute. The subject was reported to have an atypically thin chest wall, which the authors suggested led to the barb tip being unusually close to the heart.

15. Although the waveform characteristics of the pre-production Taser are unknown, DOMILL believes that, in the absence of human experimental evidence to the contrary, it would be prudent to assume that a similar effect could be exerted by the Taser X26 or M26, particularly in circumstances where one or both of the device's barbs have penetrated the frontal chest over the heart region and especially in individuals who may have smaller skin-to-heart distances (generally *children* and *thin adults*).
16. In forming a view of the medical implications of rapid ventricular capture, DOMILL obtained additional clinical opinion from two consultant cardiologists, one of whom is a paediatric cardiologist. These opinions are summarised below (*paras. 17-19*).
17. In a young individual with a healthy heart, rapid ventricular capture for 5 seconds (the maximum duration of Taser X26 or M26 discharge following a *single* activation of the trigger) would be unlikely to produce an arrhythmia sustained beyond the duration of the Taser discharge.<sup>8</sup> The acute effect of a 5-second period of rapid ventricular capture is likely to be minor – it would be unlikely to induce syncope (fainting) but the subject may be aware of palpitations. Similarly, rapid ventricular capture for 10-15 seconds (corresponding to 2-3 contiguous activations of the Taser trigger or to prolonged trigger depression) would not be expected to induce a sustained arrhythmia or syncope in a young individual with a healthy heart.
18. Individuals of any age with established *heart conditions* (for example, coronary artery disease, 'healed' myocardial infarct, dilated or hypertrophic cardiomyopathies, corrected congenital heart disease, primary inherited electrical conditions of the heart, such as Brugada syndrome<sup>9</sup> and long QT syndrome), are at greater risk of developing serious sustained ventricular arrhythmias, if provoked by abnormal heart stimulation.
19. The use of certain *recreational drugs* (particularly cocaine or amphetamine-like drugs), may lead to abnormal levels of cardiac stimulation or to active myocardial ischaemia by inducing prolonged spasm of otherwise normal coronary arteries. In such a context, random cardiac stimulation could have unpredictable implications, with induction of arrhythmias which would not normally occur under the same provocation without concomitant use of these drugs.
20. Two reports of ventricular fibrillation temporally associated with Taser discharge have been published.<sup>10</sup> There is one report of atrial fibrillation (fast and irregular beating of the atria) in a 16-year-old male that may have been triggered by Taser discharge.<sup>11</sup> Myocardial infarction associated with Taser discharge has been reported in a 20-year-old male.<sup>12</sup> In all of these case reports from the United States, the strength of the association between application of Taser discharge and arrhythmia development is difficult to determine.
21. Whether or not the discharge current from the Taser X26 or M26 is able directly to influence heart rhythm remains controversial. Additional human experimental studies with these devices

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<sup>8</sup> Rapid ventricular pacing is a technique used clinically in an effort to induce ventricular tachycardia (VT). Induction of VT in this way would be rare in patients with normal hearts.

<sup>9</sup> Brugada syndrome is an inherited heart rhythm disorder that can lead to sudden unexpected cardiac death in apparently healthy individuals. <http://www.brugada.org/about/about.html> (retrieved 25 Feb 2011).

<sup>10</sup> Kim, PJ and Franklin, WH (2005). *N Engl J Med* **353**:958-9; Naunheim, RS *et al* (2010). *Emerg Med J* **27**:645-6.

<sup>11</sup> Multerer, S *et al* (2009). *Pediatr Emer Care* **25**:851-3.

<sup>12</sup> Baldwin, DE *et al* (2010). *J La State Med Soc* **162**:291-5.

should help to clarify the risk from discharge applied to the frontal chest through skin-embedded Taser barbs.

### **Adverse cardiac or respiratory outcomes triggered by the physiological stress imposed by the Taser discharge**

22. The physiological impact of Taser discharge, combined with the stressful and emotionally charged circumstances in which Tasers (as well as other forms of less-lethal force) are likely to be used, have the potential to precipitate adverse cardiac effects in individuals with underlying **heart conditions**.
23. Adverse effects from application of Taser discharge or other forms of force could range from angina, arrhythmia or myocardial infarction through to sudden cardiac death in extreme cases.
  - Sudden cardiac death can strike at any age and has been associated with coronary atherosclerosis, dilated cardiomyopathy, hypertrophic cardiomyopathy, arrhythmogenic right ventricular dysplasia/cardiomyopathy and myocarditis.<sup>13</sup> In many cases no structural abnormality is evident, which may implicate “cardiac channelopathy” as the predisposing mechanism.<sup>13</sup>
  - Sudden cardiac death has been defined as an out-of-hospital death caused by any cardiac condition that occurs within one hour of onset of symptoms.<sup>13</sup>
24. Some drugs used in the treatment of certain **mental health conditions** exert effects on the heart that may predispose to an adverse cardiac event. For example, some antipsychotic and antidepressant drugs can induce electrocardiographic changes (Q-T interval prolongation) that have been associated with the development of potentially lethal arrhythmias.<sup>14</sup>
25. **Intoxication with recreational drugs**, including cocaine, ecstasy and methamphetamine, has been associated with cardiac complications.<sup>15</sup> Hence, the threshold for development of cardiac adverse outcomes in drug-intoxicated individuals subjected to Taser discharge or other types of force may be lowered.
26. Trigger factors known to acutely exacerbate **asthma** include strong emotions and exercise,<sup>16</sup> both of which may be present in asthmatic persons in the circumstances in which Taser or other form of force is deployed.

### **Interaction of the Taser discharge current with cardiac pacemakers and other implantable devices**

27. The effect of Taser discharge on the functioning of cardiac pacemakers and implantable cardioverter defibrillators has been recently reviewed.<sup>17</sup> The authors concluded that the evidence indicated that discharges from the conducted energy devices like the Taser do not exert effects on device function that would be injurious to health.

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<sup>13</sup> Fishbein, MC (2010). *Cardiovasc Pathol* **19**:326-8.

<sup>14</sup> [http://www.medscape.com/viewarticle/575632\\_4](http://www.medscape.com/viewarticle/575632_4) (retrieved 21 Sep 2010).

<sup>15</sup> Ghuran, A *et al* (2001). *BMJ* **323**:464-6.

<sup>16</sup> [www.asthma.org.uk/all\\_about\\_asthma/asthma\\_triggers\\_az/](http://www.asthma.org.uk/all_about_asthma/asthma_triggers_az/) (retrieved 21 Sep 2010).

<sup>17</sup> Vanga, SR *et al* (2009). *Conf Proc IEEE Eng Med Biol Soc* **1**:3199-204.

28. The possible effects of Taser discharge on other implanted electronic devices, such as vagus nerve stimulators used in the management of drug-resistant epilepsy and depression, are unknown.

### **Spontaneous abortion and other implications for fetal well-being**

29. The risks to the *pregnant woman and fetus* from Taser discharge are poorly understood.

30. A case report describes spontaneous abortion in an 11-week pregnant, 32-year-old woman seven days after being subjected to discharge from a conducted energy device.<sup>18</sup> One of the device's barbs had lodged in the abdominal skin overlying the uterus, while the second barb had lodged in the left thigh. Spotting occurred one day after exposure to discharge and the woman miscarried six days later.

31. Amnesty International report a second case in which fetal death was diagnosed some 12 hours after exposure to Taser discharge.<sup>19</sup>

32. In both of the above cases, the contribution of the Taser discharge (or of any other force used at the time) to the reported adverse outcomes is uncertain.

33. It has been suggested that Taser-induced muscle contractions in pregnant women may lead to induction of labour or other obstetric complications. DOMILL is unaware of any evidence either to substantiate or alleviate these concerns.

34. Fall injuries have been associated with a significantly increased probability of delivery by caesarian section and low birth weight<sup>20</sup>, and these may be additional factors to consider when planning to use a Taser on a woman who is known to be pregnant or in the post-incident medical management of a pregnant woman who has been subjected to Taser discharge.

35. No pregnancy-associated adverse outcomes in the UK have emerged during DOMILL's on-going review of injury data from Taser incidents.

### **Burns from an interaction of the Taser discharge current with the skin**

36. Although minor skin burns are a recognised complication in Taser use, there is no evidence to suggest that these have clinically significant implications (as gauged from the absence of clinical case reports relating to this type of injury).

37. There is no reason to believe that *children or other vulnerable groups* will be differentially susceptible to this form of superficial injury.

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<sup>18</sup> Mehl, LE (1992). *Acta Obstet Gynecol Scand* **71**:118-23.

<sup>19</sup> See: [www.amnesty.org/en/library/info/AMR51/010/2008/en](http://www.amnesty.org/en/library/info/AMR51/010/2008/en) (report ref: AMR 51/010/2008) (retrieved 13 Oct 2010).

<sup>20</sup> Weiss, HB *et al* (2008). *Accid Anal Prev* **40**:1088-95.

## Musculoskeletal complications arising from the intense muscle contraction induced by the Taser discharge

38. There are two case reports of compression fractures of the thoracic spine following exposure to Taser X26 discharge.<sup>21</sup> It is thought that these fractures, which were observed in young police officers during Taser training, resulted from discharge-induced muscle contraction.
39. It is conceivable that individuals affected by the age-related condition, *osteoporosis*, may be more susceptible to this type of injury, whether from the Taser-induced muscle contractions or from the application of other forms of physical force.<sup>22</sup>

## Injuries from Taser-induced falls

40. The muscle contractions induced by Taser discharge commonly lead to loss of the ability to maintain an upright posture and can lead to falls.
41. In the United States, at least six fatal head injuries have been linked to the use of Taser.<sup>6</sup> There are no reported cases of this type in the UK.
42. Individuals intoxicated with *alcohol, illicit drugs or certain prescription medications* may be at heightened risk of sustaining fall injuries, as postural control and any residual protective fall-arresting reflexes could be impaired. Falls from height may be a particular risk for persons whose perception of the environment has been impaired by alcohol or drug intoxication.
43. Persons affected by *osteoporosis* may be at greater risk of fractures from Taser-induced falls.
44. During the adolescent growth period (typically 12- to 14-years-old), children are at a heightened risk of bone fracture (particularly of the distal end of the radius or ulna).<sup>23</sup> During this period, *children* may be at greater risk of sustaining fractures following falls.
45. Falls could lead to cuts, abrasions and blunt trauma, which may be of particular concern in individuals with a *bleeding or clotting disorder* and those on *anticoagulant or antiplatelet therapy*.<sup>24</sup> In people affected by blood-borne pathogens (e.g. viral hepatitis, HIV) cuts and abrasions may be associated with a secondary risk to others who may come into contact with the affected individual.
46. People with *diabetes* who are taking antidiabetic drugs in the thiazolidinedione class (pioglitazone and rosiglitazone) may be at enhanced risk of fractures.<sup>25</sup>

## Injuries from tissue penetration of the Taser barbs

47. The Taser X26 barbs used in the UK have a length of nearly 10 mm. When striking compressible tissue, the effective penetration depth may be greater. The barbs therefore have the potential to injure deeper structures.

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<sup>21</sup> Winslow, JE *et al* (2007). *Ann Emerg Med* **50**:584-6; Sloane, CM *et al* (2008). *J Emerg Med* **34**:283-5.

<sup>22</sup> <http://www.nlm.nih.gov/medlineplus/ency/article/000443.htm> (retrieved 11 Oct 2010).

<sup>23</sup> Saggese, G *et al* (2002). *Best Prac Res Clin Endocrinol Metab* **16**:53-64.

<sup>24</sup> NICE Clinical Guideline 56: Head Injury (2009). <http://guidance.nice.org.uk/CG56/NICEGuidance/pdf/English> (retrieved 3 Mar 2011); Major, J and Reed, MJ (2009). *Emerg Med J* **26**:871-6.

<sup>25</sup> Douglas, IJ *et al* (2009). *PLoS Med* **6**:e1000154.

48. Because of the dispersion of impact points around the aim point, barbs that have been aimed at the frontal chest may present a hazard to sensitive structures in the head and neck regions, especially in *children* and *adults of small stature*.
49. There are four case reports (all from the U.S.) of ocular penetration by Taser barbs.<sup>26</sup> *Children* and *adults of small stature* may be at higher risk of sustaining this type of injury because the eyes may be closer to the barb aim point.
50. Two case reports describe barb penetration of the skull (in one case entering the brain superficially).<sup>27</sup> Age-related changes in skull thickness<sup>28</sup> carry the implication that *children* may be at greater risk of brain injury from skull-penetrating barbs.
51. Pneumothorax from a Taser barb has been reported in a 16-year-old male.<sup>29</sup> In general, the lesser body wall thickness of *children*<sup>30</sup> may place them at greater risk of sustaining injuries to the lung and other organs (e.g. liver) from Taser barbs that have penetrated to their full depth. This injury mechanism would also apply to *thin adults*.

### Triggering of epileptic seizures

52. A case report describes an apparent generalised tonic-clonic seizure with loss of consciousness after a Taser shot in which one barb entered the skin at the back of the head while the other lodged in the upper back.<sup>31</sup>
53. DOMILL is aware of one incident in the UK involving use of the Taser in which an epileptic seizure occurred during the discharge (which was applied through barbs located in the region of the lower back). It was subsequently established that the person had an existing *epilepsy* disorder.
54. It is recognised that emotional stress, alcohol intoxication and physical exercise are among the seizure-precipitating factors reported by those with epilepsy.<sup>32</sup> Poor compliance with anti-epileptic medication may further predispose to seizure induction during Taser deployment.

### Administration of Taser discharge to seemingly uncooperative and threatening persons

55. DOMILL is aware of an incident, widely reported in the press, in which UK police officers administered Taser discharge to an individual with *epilepsy* who had earlier collapsed, reportedly after experiencing “a major epileptic seizure”.<sup>33</sup>
56. While not able to comment on this specific incident, DOMILL notes that aggressiveness can sometimes be a feature of the ictal and post-ictal states.<sup>34</sup> Apparently intentionally threatening behaviour may not be under conscious control.<sup>34</sup>

<sup>26</sup> See: Han, JS *et al* (2009). *CJEM* **11**:90-3 (and references cited therein.); Teymoorian, S *et al* (2010). *Ophthal Plast Reconstr Surg* **26**:306-308.

<sup>27</sup> Rehman, T-U *et al* (2007). *Am J Emerg Med* **25**:733.e3-e4; Mangus, BE *et al* (2008). *Am Surg* **74**:862-5.

<sup>28</sup> Letts, M *et al* (1988). *J Bone Joint Surg [Br]* **70-B**:277-9.

<sup>29</sup> Hinchey, PR and Subramaniam, G (2009). *Prehosp Emerg Care* **13**:532-5.

<sup>30</sup> Sandler, G *et al* (2010). *Injury* **41**:506-9.

<sup>31</sup> Bui, ET *et al* (2009). *CMAJ* **180**:625-6.

<sup>32</sup> Nakken, KO *et al* (2005). *Epilepsy Behav* **6**:85-9.

<sup>33</sup> <http://www.timesonline.co.uk/tol/news/uk/crime/article7096598.ece> (retrieved 21 Sep 2010).

<sup>34</sup> Marsh, L and Krauss, GL (2000). *Epilepsy Behav* **1**:160-8; Ito, M *et al* (2007). *Epilepsy Behav* **10**:611-4.

57. Police officers should be aware of the possibility that some displays of aggression and violence by individuals may be linked to an underlying epilepsy disorder. This would be particularly relevant in situations in which a person is known by the police to be affected by epilepsy, where post-incident medical intervention should be sought as early as possible.
58. People with *diabetes* who have marked hypoglycaemia can display confusion, drowsiness, changes in behaviour, coma and seizure. Under certain circumstances, these symptoms and signs may lead to the use of Taser. Officers should be alert to the possibility that altered behaviour may be linked to poorly controlled blood sugar and seek medical assistance if in doubt.
59. Individuals for whom English is not their first language may have an impaired comprehension of spoken English and, as a result, may not respond appropriately to instructions issued by police officers. This may raise the risk of Taser and other forms of force being used within this group and consequently may increase injury rates. Similar communication barriers (and potential for increased injury rates) may apply to those who are *hearing impaired* or who have significant *visual impairment*.

### **Special considerations among those with mental ill health, learning difficulties, neurodevelopmental conditions or neurobehavioural conditions**

60. *Mental ill health, learning difficulties, neurodevelopmental conditions or neurobehavioural conditions* have the potential to negatively influence how affected individuals interact with the police.<sup>35</sup> For this reason, there is the possibility that people in these groups may be at an elevated risk of exposure to Taser discharge or to other forms of force and may experience higher injury rates as a consequence.
61. The short-, medium- or longer-term psychological impact of exposure to the Taser system, and of adverse interactions with the police in general, are unexplored. In this respect, *children* may be more (or less) vulnerable than adults.

### **Deaths associated with the use of the Taser**

62. Amnesty International has published a report documenting 334 deaths in the United States that were associated temporally with application of Taser discharge.<sup>36</sup>
63. The report summarises autopsy findings for 283 of the 334 deaths. In 203 of these, three factors emerge as having been causal or contributory in the deaths: (a) drugs (mostly cocaine or methamphetamine), (b) alcohol, and (c) some form of delirium (variously described as agitated psychosis, excited delirium or psychotic delirium).
64. Heart disease, positional asphyxia (due to the method of police restraint), head trauma and cardiac arrhythmia/arrest feature prominently among the remaining 80 deaths for which autopsy data were available.

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<sup>35</sup> ACPO Guidance on Responding to People with Mental Ill Health or Learning Disabilities. [www.npia.police.uk/en/docs/Mental\\_ill\\_Health.pdf](http://www.npia.police.uk/en/docs/Mental_ill_Health.pdf) (retrieved 21 Sep 2010).

<sup>36</sup> Amnesty International report no. AMR 51/146/2008: <http://www.amnestyusa.org/uploads/ListOfDeaths.pdf> (retrieved 21 Sep 2010).

65. Deaths *associated* with use of Taser continue to be reported in the international media, particularly that emanating from the United States. A high profile Taser-associated death in Canada in 2007 led to the Braidwood Inquiry, which concluded that death in this case was contributed to by the physiological stress imposed by multiple applications of Taser discharge.<sup>37</sup>
66. Deaths from various causes in police custody, while not commonplace, do occur. In the UK, there were 17 deaths in or following police custody in the 12 months from April 2009 to March 2010, with 37 deaths reported in the preceding 24 month period.<sup>38</sup>
67. To date, there have been two deaths in the UK following administration of Taser discharge. In one case, death occurred three days after exposure to the Taser; the Coroner found that the death was linked to profound atherosclerotic coronary artery disease and the Taser was deemed not to have been a causal factor.<sup>39</sup> A second death in association with Taser discharge and use of irritant spray is currently under investigation by the Independent Police Complaints Commission (IPCC).<sup>40</sup>

## Conclusions

68. DOMILL has conducted an evidence-based review centred around the particular susceptibilities of children and other vulnerable groups to the Taser less-lethal system.
69. DOMILL considered the susceptibilities of these vulnerable populations with reference to the multiple known (and plausible) injury mechanisms that the Taser system may invoke.
70. Inevitably, DOMILL's review cannot be exhaustive. In addition to the susceptibilities considered in the present statement, there are many other conditions, and combinations of conditions, that may render those affected more likely to experience an adverse response as a consequence of use of the Taser (or other form of force). This underlines DOMILL's view that the medical evaluation of persons detained in custody following Taser deployment should be conducted by a Forensic Medical Examiner. This approach should help to ensure that the low rates of serious injury or death associated with use of the Taser in the UK remain low.
71. DOMILL considers that it is important to remain alert for any upward trends in the incidence of death or serious injury occurring in association with use of the Taser system in the UK. This can only be effectively achieved through an efficient system of post-incident medical audit.
72. The recommendations below may have implications for the medical management of individuals exposed to the Taser system. There may also be implications for use policy and user guidance and training.
73. Several of the recommendations point to the need for additional research to inform further the analysis of the medical risks associated with Taser use, but DOMILL remains of the view that the risk of serious adverse medical outcome from exposure to the Taser is low, **provided the system is employed by trained users in accordance with ACPO policy and guidance.** This

<sup>37</sup> <http://www.braidwoodinquiry.ca/> (retrieved 04 Jan 2011).

<sup>38</sup> *Deaths during or following police contact: Statistics for England and Wales 2009/10*. IPCC Research and Statistics Series: Paper 18. [http://www.ipcc.gov.uk/deaths\\_report\\_2009-10\\_v5.pdf](http://www.ipcc.gov.uk/deaths_report_2009-10_v5.pdf) (retrieved 04 Jan 2011).

<sup>39</sup> [http://www.thenorthernecho.co.uk/news/1651953.family\\_attacks\\_inquest\\_ruling\\_on\\_taser\\_death/](http://www.thenorthernecho.co.uk/news/1651953.family_attacks_inquest_ruling_on_taser_death/) (retrieved 21 Sep 2010).

<sup>40</sup> <http://www.cumbria.police.uk/news/latest-news/ipcc-continue-investigating-death-of-dale-burns> (retrieved 03 Jan 2012).

view is confirmed by the consistently low incidence of reports of adverse outcomes arising from use of the Taser system in the UK, together with the relatively low rates of reported adverse outcomes internationally.

74. No evidence has come to light in this most recent review of evidence relevant to the Taser X26 and M26 systems to contradict the views expressed in DOMILL's earlier statements concerning the overall medical implications of these less-lethal options.<sup>4</sup>

## Recommendations

75. For the majority of known Taser injury mechanisms (*para. 12*), reducing the physiological burden imposed by the discharge would likely reduce the risk of adverse outcome. DOMILL, therefore, considers that the duration of application of Taser discharge should be limited to that necessary to achieve the desired operational effect. Multiple discharges should be avoided where tactically feasible. These recommendations further reinforce advice given to users in the ACPO Guidance on Operational Use of Taser.<sup>41</sup>
76. It is not known whether there is a risk of cardiac capture with the Taser X26 or M26 (*paras. 14-21*). If there is a risk, then children and thin adults may be more vulnerable to discharge administered through barbs that have penetrated the frontal chest in the region overlying the heart. Although DOMILL does not provide operational advice on Taser point-of-aim, the Committee notes that any risk that does exist would be mitigated by avoiding, where tactically feasible, the firing of barbs into the frontal chest overlying the heart. While the outcome of a short (five second) period of rapid cardiac capture, should it occur in an otherwise healthy individual, would likely be benign (*para. 17*), those with established heart conditions or who are under the influence of certain drugs may be at higher risk (*paras. 18-19*). There is a need for further human experimental studies to inform the risk of cardiac capture from the Taser devices currently available for police use in the UK.
77. Individuals with heart disease, or who have taken certain prescription or recreational drugs, may be more likely to experience adverse cardiac effects as a result of Taser discharge (*paras. 22-25*). DOMILL considers that all Tasered individuals with an existing heart condition should be assessed by a physician at the earliest opportunity. Individuals without a diagnosed heart condition but who report symptoms consistent with a possible cardiac adverse event (for example, palpitations, chest or arm pain, shortness of breath) should be similarly assessed.
78. Use of Taser discharge may trigger respiratory distress in those with asthma (*para. 26*) or trigger seizures in those affected by epilepsy (*para. 52-54*). Police officers should be alert to these possibilities and seek urgent medical assistance if considered necessary.
79. The evidence for Taser-induced malfunction of cardiac pacemakers and implantable cardioverter defibrillators is limited, while data for other forms of implantable electronic device is scant (*paras. 27-28*). DOMILL will continue to maintain a watch for adverse medical outcomes involving persons fitted with these devices.
80. The medical implications of exposure of pregnant women to Taser discharge are not well-documented (*paras. 29-35*). DOMILL recommends that women who are pregnant, or who

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<sup>41</sup> <http://www.westmercia.police.uk/about-us/acpo-armed-policing.html> (retrieved 24 Sep 2010).

suspect they may be pregnant, receive specialist obstetric review as part of the post-incident medical assessment.

81. Post-incident medical assessment should seek evidence for sudden-onset back pain consistent with spinal compression fracture occurring around the time the Taser was discharged (*paras. 38-39*). Evidence for other types of musculoskeletal injury should also be sought. Those with osteoporosis may be more susceptible in this regard, although musculoskeletal injury is not confined to the older age group (*para. 38*).
82. Several categories of vulnerable person may be more likely to sustain injuries from Taser-induced falls (*paras. 34, 40-46*). Post-incident medical assessment should be guided by this. Investigation of head injury should be undertaken by a physician and appropriate follow-up diagnostic procedures requested if considered necessary. Follow-up of fall-associated blunt trauma of any form may be particularly important for individuals with a history of a bleeding or clotting disorder and those on anticoagulant or antiplatelet therapy (*para. 45*).
83. Children may be at higher risk of internal injury from barbs that have penetrated the torso (*para. 51*). Penetrating torso injuries in children (and thin adults) should be carefully evaluated. DOMILL further recommends that X26 firing trials should be conducted using a suitable skin/tissue simulant to establish how depth of barb penetration varies with target distance. This will help subsequently to inform guidance on operational use of the device.
84. Injuries to the eye and other sensitive regions in the head and neck region may be more likely to arise in children and adults of short stature (*paras. 49-50*). DOMILL recommends that systematic firing trials are conducted over a range of distances using anthropometrically relevant targets in order to understand the extent of this perceived increase in risk to shorter people and to inform user guidance. Additionally, ACPO should consider revising Taser guidance and training to recommend a lower aim point for children and small adults, where tactically feasible.
85. Certain conditions (e.g. hypoglycaemic and post-ictal states) could induce behaviour that may evoke administration of Taser discharge (*paras. 55-58*). Officers should be aware of this possibility and seek medical support if required. A similar vulnerability could exist in those who may respond inappropriately to directions from police officers as a result of language barriers, hearing disorders, visual impairment, mental health issues, neurodevelopmental and neurobehavioural disorders or learning difficulties (*paras. 59-60*).
86. The psychological impact of exposure to the Taser less-lethal system is unexplored (*para. 61*). DOMILL recommends that a review of the psychological issues is undertaken, with a focus on the potential implications for children and other vulnerable groups (particularly those highlighted in *para. 60*).
87. The post-incident medical management of individuals exposed to Taser discharge would be enhanced by the introduction of a Taser-specific medical assessment form to guide post-incident medical examinations in line with the injury mechanisms associated with use of the device. DOMILL recommends that such a form is implemented nationally for use by Forensic Medical Examiners and other medical assessment staff.
88. DOMILL notes that medical audit information is mostly unavailable from incidents in which individuals exposed to Taser discharge have been transferred directly to hospital. Paradoxically, this means that DOMILL is unable to review outcomes in cases that are likely to be at the more

serious end of the injury spectrum. DOMILL, therefore, recommends that Forensic Medical Examiners separately review the hospitalised patient using the proposed Taser-specific medical assessment form (*para. 87*).

89. DOMILL is aware that the manufacturer of the Taser has issued technical guidance for confirming that the output parameters of the device (charge per pulse, peak voltage per pulse, pulse duration and pulse repetition rate) are within specification. The Committee is concerned that there is no mechanism in place in the UK through which the output of individual Taser devices is routinely monitored. The output of the Taser is key in determining its ability to induce muscular incapacitation and consequently underpins its operational effectiveness. Use of a device that is only partially effective (or ineffective) due, for example, to a below-specification pulse charge, may carry indirect medical implications. Conversely, above-specification output parameters may directly increase the risk of occurrence of a medical adverse outcome. DOMILL therefore recommends that consideration should be given to the design and implementation of a nationwide quality control programme, with clear guidelines on the management of Tasers found to be out-of-specification. This may become increasingly important as the age of deployable Tasers in the UK increases.
90. DOMILL welcomes this opportunity to examine the issues associated with use of the Taser less-lethal system on children and vulnerable adults. Whilst recognising that training is already given to police officers on interacting with people having many of the conditions considered in this document, DOMILL recommends that a review of the ACPO Guidance on Operational Use of Taser is undertaken to ensure that the correct lessons are identified for the training of personnel and the deployment of the Taser system in the UK.
91. DOMILL recommends that CAST<sup>5</sup> continues to notify the Committee in a timely fashion of any adverse events associated with operational use of the Taser system in the UK. DOMILL also recommends that CAST continues to compile annual Taser use reports for subsequent review by the Committee.

*[signed on original]*

Chairman, DOMILL