Comment


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Summary — Military research, testing, and surgical and resuscitation training, are aimed at mitigating the consequences of warfare and terrorism to armed forces and civilians. Traumatisation and tissue damage due to explosions, and acute loss of blood due to haemorrhage, remain crucial, potentially preventable, causes of battlefield casualties and mortalities. There is also the additional threat from inhalation of chemical and aerosolised biological weapons. The use of anaesthetised animal models, and their respective replacement alternatives, for military purposes — particularly for blast injury, haemorrhaging and resuscitation training — is critically reviewed. Scientific problems with the animal models include the use of crude, uncontrolled and non-standardised methods for traumatisation, an inability to model all key trauma mechanisms, and complex modulating effects of general anaesthesia on target organ physiology. Such effects depend on the anaesthetic and influence the cardiovascular system, respiration, breathing, cerebral haemodynamics, neuroprotection, and the integrity of the blood–brain barrier. Some anaesthetics also bind to the NMDA brain receptor with possible differential consequences in control and anaesthetised animals. There is also some evidence for gender-specific effects. Despite the fact that these issues are widely known, there is little published information on their potential, at best, to complicate data interpretation and, at worst, to invalidate animal models. There is also a paucity of detail on the anaesthesiology used in studies, and this can hinder correct data evaluation. Welfare issues relate mainly to the possibility of acute pain as a side-effect of traumatisation in recovered animals. Moreover, there is the increased potential for animals to suffer when anaesthesia is temporary, and the procedures invasive. These dilemmas can be addressed, however, as a diverse range of replacement approaches exist, including computer and mathematical dynamic modelling of the human body, cadavers, interactive human patient simulators for training, in vitro techniques involving organotypic cultures of target organs, and epidemiological and clinical studies. While the first four of these have long proven useful for developing protective measures and predicting the consequences of trauma, and although many phenomena and their sequelae arising from different forms of trauma in vivo can be induced and reproduced in vitro, non-animal approaches require further development, and their validation and use need to be coordinated and harmonised. Recommendations to these ends are proposed, and the scientific and welfare problems associated with animal models are addressed, with the future focus being on the use of batteries of complementary replacement methods deployed in integrated strategies, and on greater transparency and scientific cooperation.

Key words: aerosolised biological weapons, anaesthetised animal models, animal welfare, chemical weapons, computer modelling, coordination, haemorrhage, harmonisation, increased transparency, mathematical modelling, military research, organotypic cultures, resuscitation training, surgical training, traumatic brain injury, validation.

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Introduction

Overview of military animal use

The principal categories of animal use in military research and testing are: a) weapons testing for efficacy and developing safety measures (1); and b) the study of battlefield injuries (from both ballistic and blast incidents) to make more-effective weapons, and to improve the treatment of traumatised and injured victims via the provision of life support measures. Animals are also used for surgical and resuscitation training (Table 1; 2). This