Summary

Introduction

Given that police personnel must regularly deal with violent people in potentially dangerous situations, appropriate equipment is important. The use of firearms comes with risks for the offenders as well as the police officers and in some cases also for bystanders. In recent years, there has been a shift to alternative, effective, "less-lethal" law enforcement tools such as conducted electrical/"electroshock" weapons, pepper spray and batons. In this report, the focus lies explicitly on what we call a 'Taser'. The term 'Taser' (Thomas A. Swift Electronic Rifle) refers to a specific type of conducted electrical weapons, produced by Axon (formerly TASER International). The Taser was developed in the United States and is, as in many other countries worldwide, part of the basic police equipment.

Several pilot tests have been carried out on the use of Tasers by the Dutch police. The investigation of possible health effects during these pilot studies was limited and only concerned mild injuries. Media attention has increased on this topic, partly in the light of a critical report from Amnesty International and a database of Reuters news agency. To further consider whether the use of the Taser can be allowed by all police units, it is crucial to have a detailed picture of the scientific evidence on the potential health effects of exposure to this weapon.

Systematic literature review & research questions

A systematic literature review synthesizes and critically evaluates the scientific evidence/knowledge that has been produced on a particular topic, within a specific time-frame, following rigorous and replicable methods. In the present systematic review, the following research questions are addressed:

1. Are there studies of sufficient scientific quality on the possible effects of the use of Tasers on human health in the international literature?
2. What is the probability of a serious injury or serious complications when being exposed to a Taser? Which risk groups can be distinguished?
    a. What are the possible risks for specific groups such as people with psychological problems and agitation, pregnant women, the elderly, drug or alcohol intoxicated individuals, or people with a heart condition?
    b. Are the possible health risks associated with the duration of the electric current and the affected body location?
    c. What specific health effects could occur in each of the organ systems?

Several types of Taser exist (Appendix A) as well as different deployment methods. A Taser can be used in two ways: the first is by firing the barbed darts and the second is by using the so-called "stun mode". The first option produces an electric current that causes all muscles to contract, leading to a temporary incapacitation of the victim, while the second option only causes pain. The stun mode is not covered in the present report.

Methods

A number of major inclusion/exclusion criteria were a-priori established. More specifically, studies were included in the main results section of the review, if the following criteria were met (See also Appendix C):

- *Published between January 2000 and March 2019*
- *Primary scientific studies on original data*
- *Written in English, Dutch, French, German or Spanish*
- *Published in peer-reviewed journals*
- *With an explicit focus on the use of Tasers (in the context of law enforcement);*
- *Assessed specific (self-reported or diagnosed/objectively assessed) health problems and conditions, health status/symptom scores and/or physiological measures as dependent variables*
- *Focused exclusively on humans*
- *A lower risk of methodological bias*

There was no restriction in terms of demographic characteristics or health outcomes. A literature search strategy protocol was developed, based on a number of relevant terms found in the identified papers, exchange of feedback within the project team. The literature search strategy was based on an exhaustive literature search of major databases. A wide range of relevant keywords regarding Taser exposure was used to form the search strategy.

The identified articles were independently assessed by the authors in terms of scope/relevance, methodological bias and general quality in different stages of screening. For the extraction of study characteristics and outcome data, a (previously piloted) data collection form was used. Inter-rater reliability was also assessed and discrepancies were solved by discussion and consensus between the authors/project team members. The study methodology is described in the form of a protocol registered in the PROSPERO platform.[1]

Findings

Research question 1. Are there studies of sufficient scientific quality on the possible effects of the use of Tasers on human health in the international literature?

Twelve studies were identified, with a low risk of bias, as well as sufficient study quality in general. These studies showed a few or no acute health effects, apart from the wounds caused by the darts. Furthermore, no long-term effects were observed. It is therefore not possible to make definite statements about possible serious (long-term or chronic effect or mortality) health effects of using the Taser on health. The vast majority of studies were performed on healthy subjects, in a controlled setting, with short exposure duration (5 seconds), in which the darts were replaced by grippers ('alligator clips'). A relatively large part of the studies was funded by the manufacturer (Axon; Taser International) or was conducted by researchers affiliated with the manufacturer.

The aforementioned studies are included in Chapter 3, together with an overview of health effects and other study characteristics, such as a quality assessment. In the same Chapter, also relevant studies (N = 22) with a higher risk of bias are included in a separate Table. The present findings are in agreement with previously published reviews (Appendix B) which also showed limited health effects. In addition, we have also identified and documented solely descriptive studies on the topic (Appendix F) as well as case-studies

[1] PROSPERO. https://www.crd.york.ac.uk/prospero/

(Appendix E). Although these are informative, their design limits any causal inferences and generalizability.

Research question 2. What is the probability of a serious injury or serious complications when being exposed to a Taser? Which risk groups can be distinguished?

Based on the findings of the reviewed studies, the risk for health effects due to Taser exposure can be estimated as low. Most studies focused on outcomes such as physiological stress responses ("excited delirium", agitation), heart rate, blood pressure, arrhythmias, blood acidity or (neuro) cognitive performance. There was no clear evidence for adverse health outcomes. Considering that in most of the cases, subjects participating in experimental studies are generally healthy and fit and therefore not representative of the population that usually encounters a Taser deployment, it is not possible to draw solid conclusions regarding exposure effects in potentially vulnerable populations or high risk groups such as pregnant women, people with psychiatric problems or those under the influence of substances.
Exposure to Taser is also very rarely documented as the sole cause of death (in case-studies and descriptive studies). Moreover, in some of the articles it is not reported what type of Taser was used and what the exposure duration exactly was. Additionally, it is not possible to make a statement about specific health effects per Taser model or maximum exposure duration thresholds. Taser X2 is currently being used in the Netherlands, while the vast majority of the studies presented here (after 2000) used Taser X26, an older Taser model.

Conclusion
The present systematic review rigorously assessed the literature on health effects of exposure to Tasers, published in the past two decades. The methodological quality of the included studies has been carefully considered. However, it is not possible to draw conclusions about the extent to which the existing evidence constitutes a good representation of real-life field situations. Most of the existing studies recruited healthy and fit individuals and have methodological limitations. For instance, many studies relied on small samples, and most of the studies (22 out of 34) had a high risk of methodological bias. In almost all cases only the possible effects of Taser X26 were examined. Additionally, all reviewed studies were conducted in the United States, a country with legal, cultural and systemic differences compared to the Netherlands. On the basis of the reviewed material, it therefore appears that there are no adverse effects in healthy people, but it is unclear whether these findings are applicable to the Dutch situation.

In this review, an additional distinction was made based on the funding source of each study. We were not able to demonstrate that the results of the Axon-financed studies generally differed from studies that were financed by other sources. An observed difference though, was that the Axon-sponsored studies seemed to analyze more often small sample sizes.

The health warning issued by Axon does not appear to be based on the scientific literature. However, that certainly does not mean that the warning should be ignored: Research evidence on the dose-response effects on potential high risk groups is currently nonexistent and of course not feasible due to ethical restrictions.

Following the precautionary principle, use of a Taser on pregnant women or people with a compromised health status should be prevented. In field situations though, multiple parameters play a role and it will not always be clear whether people belong to such a specific risk population. Nevertheless, specific risk groups such as drug/alcohol intoxicated individuals are overrepresented among cases in which the Taser is used. By systematically evaluating the effects of Taser use in daily policing practice in the Netherlands, it will become clear to what extent the results reported in this review apply to the Dutch context. The

involvement of a doctor or nurse in the health evaluation of cases where the Taser was used would provide further insight into the possible acute effects for the members of risk groups.