



Original communication

Sudden death victims <45 years: Agreement between cause of death established by the forensic physician and autopsy results



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ARTICLE INFO

Article history:

Received 27 November 2014

Received in revised form

8 May 2015

Accepted 20 May 2015

Available online 29 May 2015

Keywords:

External examination

Forensic physician

ICD10

Cause of death

Autopsy

Agreement

ABSTRACT

Purpose: The goal of this study was to ascertain accordance between cause of death established by the forensic physician and autopsy results in young sudden death victims in the Netherlands.

Methods: Sudden death victims aged 1–45 years examined by forensic physicians operating in the participating regions which also underwent an autopsy between January 2006 and December 2011 were included ($n = 70$). Cause of death established by the forensic physician based on the external medicolegal examination was compared with autopsy findings using the ICD10-classification.

Results: Autopsy findings revealed that the majority of sudden death victims have died from a cardiac disease ($n = 51$, 73%). Most of the presumed heart disease related cases were confirmed by autopsy ($n = 13$, 87%). On the contrary, a large number of deaths caused by circulatory diseases were not recognised by the forensic physician ($n = 38$, 75%). In most of these cases, the forensic physician was forced to report an undetermined cause due to the lack of a solid explanation for death. Cause of death reported by the forensic physician appeared to be in agreement with the autopsy results in 12 cases (17%).

Conclusions: Cause of death determination in young sudden death victims is a difficult task for forensic physicians due to the limited tools available during the medicolegal examination. An effort should be made to standardize extensive post-mortem investigation after sudden death in the young. Autopsy can provide valuable information regarding the cause of death, which is of great importance in view of the identification of inheritable diseases among decedents and their families.

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1. Introduction

The accuracy of death certificates is crucial as it is an important source of information for mortality statistics, epidemiological research, funding and other policy decisions. Autopsy is still considered as the gold standard to assign the cause of death. It is widely recognised as a tool to confirm, clarify, and correct clinical

diagnoses. However, diagnoses on death certificates are nowadays predominantly based on medical history and external examination findings due to the declining autopsy rates. Over the past decades, the reliability of death certificates has been extensively investigated and debated. Significant discrepancies in underlying cause of death between death certificates and autopsy findings have been demonstrated.^{1–3} Nevertheless, in most performed studies on this issue, the study population consisted of hospitalized patients.

There is a paucity of data on the accuracy of cause of death determined by forensic physicians. The objective of this study was to assess agreement between the cause of death established by the forensic physician (based on medical history, circumstances

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of death and inspection of the corpse) and autopsy results in a population of sudden death victims aged 1–45 years in the Netherlands. In the Netherlands, a significant proportion of these cases is examined by forensic physicians. The main goal of the external examination performed by forensic physicians is to clarify the cause and manner of death. This is a challenging task for forensic physicians because a substantial number of sudden death cases occur out-of the hospital with little medical information available.

2. Material and methods

2.1. Study population

Cases were selected from the CAREFUL study.⁴ In short, this prospective population-based follow-up study aimed to evaluate and improve the usual care after sudden death in young individuals in the Netherlands. Between January 2006 and December 2011, all deceased individuals aged 1–44 years in the Amsterdam, Utrecht, Leiden and Groningen regions were included in the CAREFUL study when death (or the event leading to death) occurred suddenly, unexpectedly and a natural cause of death was likely or could not be excluded on the basis of clinical findings ($n = 390$). The definition of *sudden death* previously described by Hendrix et al.⁴ was modified based on new studies and recommendations.⁵ In resuscitated individuals, *sudden death* was defined as cardiac arrest that occurred within 1 h of the onset of acute cardiovascular symptoms. Unwitnessed deaths were included when the victim was seen alive and apparently well within 24 h previously. Cases in which these time definitions could not be assessed were excluded. We excluded victims who deceased after a long Intensive Care Unit (ICU) admission due to ICU-acquired complications. Sudden death victims were not included when the cardiac arrest occurred in a hospital (except for the emergency room). Death was considered *unexpected* when the victim was not suffering from a terminal illness. Together, the study regions cover approximately 31% of the total Dutch population aged 1–44 years. For the present study, we focused on those deaths examined by forensic physicians operating in the participating regions which also underwent an autopsy.

2.2. Determination of cause of death

2.2.1. Death certificates

In the Netherlands, forensic physicians act as the medical examiner if a non-natural death is suspected or cannot be excluded. In addition to obvious unnatural deaths such as suicides, accidents or homicides, forensic physicians are also contacted to examine sudden unexpected or unattended deaths. Any signs of certain diseases or external causes of morbidity and mortality on the corpse or the surrounding are examined during the external examination. If possible, the forensic physician collects relevant information from bystanders, family members and health care professionals to get insight into the medical and family history but also in the acute circumstances preceding death. On average, an external examination takes 1–2 h. Promptly after the external examination, the forensic physician precisely reports all findings according to the guideline of the Dutch Forensic Medical Society. Additionally, based on the findings, the forensic physician completes the death certificate form. For the present study, records of the sudden deaths examined in the present study were reviewed and causes of death were converted to International Classification of Diseases 10th revision (ICD10)-codes. ICD is often used as a diagnostic tool for epidemiology, health management and clinical purposes.

2.2.2. Autopsy

Of the 198 sudden deaths examined by forensic physicians, seventy-seven cases underwent an autopsy (39%). Usual care after sudden death of young individuals in the Netherlands has been described.⁴ Briefly, if a natural cause of death is declared by either the treating physician or the forensic physician, a clinical autopsy can be requested in the nearest hospital after granted permission of the victims' relatives. However, if a non-natural cause of death is suspected the corpse can be confiscated by the public prosecutor to initiate a judicial autopsy performed by the Netherlands Forensic Institute (NFI). Autopsy diagnoses, reflected as ICD10 codes, were obtained from the Pathological-Anatomical National Computerized Archive (PALGA) ($n = 60$) and the NFI ($n = 10$). Seven autopsy reports of the NFI were not available and therefore these cases were excluded from further analysis.

2.3. Data analysis

Cause of death according to the forensic physician and the autopsy derived cause of death were considered in agreement when they were assigned the same three digit ICD10-code or different codes within the same block of an ICD10-chapter. Moderate agreement was defined as assignment of ICD10-codes in different blocks within the same chapter whereas no agreement was defined as assignment of ICD10-codes of two different chapters. Furthermore, the concordance of cause of death reported by the forensic physician and autopsy results were examined by determining their sensitivity and positive predictive value.² Sensitivity was calculated as true positives divided by the sum of true positives and false negatives and the positive predictive value was calculated as true positives divided by the sum of true positives and false positives.⁶ High values of these measures indicate accurate conclusions of the forensic physician. Data are presented as means \pm standard deviations, absolute numbers, or percentages. The influence of several characteristics on the extent of agreement on the cause of death was tested by using Chi-square test (dichotomous variables) or the independent samples T-test (continuous variables). Data were analysed with SPSS for Windows version 21.0 (SPSS Inc, Chicago, Illinois).

3. Results

3.1. Characteristics of sudden death cases examined by the forensic physician

In total, 70 sudden death victims were included in the study. An overview of baseline characteristics is given in Table 1. Overall, 67% of decedents were male and average age at death was 35.6 (12.7) years.

3.2. Cause of death diagnosed by the forensic physician

In the majority of cases, the forensic physician could not find a solid explanation for death and reported an unspecified cause of death ($n = 44$, 63%). Fifteen cases were classified as 'diseases of the circulatory system' (21%), including 7 specific cardiac diagnoses and 8 general diagnoses (e.g. 'cardiac cause' and 'heart rhythm disorder'). In five cases (7%) an external cause of death was suggested by the forensic physician, such as a transport accident, an accidental poisoning and a fall. According to the forensic physician, the remaining deaths belonged to chapter 'certain infectious and parasitic diseases' ($n = 2$), chapter 'diseases of the nervous system' ($n = 2$), chapter 'diseases of the respiratory system' ($n = 1$) and chapter 'pregnancy, childbirth and the puerperium' ($n = 1$), respectively.

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