



CLINICAL PAPER

# Pulseless electrical activity and unsuccessful out-of-hospital resuscitation: What is the cause of death?☆

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Pulseless electrical  
activity

## Summary

**Aims:** To study the cause of deaths after witnessed cardiac arrest followed by pulseless electrical activity and unsuccessful of out-of-hospital resuscitation; and to detect any differences between causes of death determined at autopsy and those inferred from clinical history.

**Methods:** In this prospective observational study, data were collected from 91 individuals treated by the emergency medical services in three urban communities in southern Finland.

**Results:** Cause of death was determined at autopsy in 59 cases and without autopsy in 32 cases. There were significantly more diagnoses of acute myocardial infarction and fewer of pulmonary embolism and aortic dissection and rupture among cases without autopsy compared with those followed by autopsy.

**Conclusion:** In unsuccessful resuscitation from out-of-hospital cardiac arrest with pulseless electrical activity as initial rhythm, an autopsy should be performed to determine the correct cause of death.

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## Introduction

Although ventricular fibrillation (VF) has been considered the most common initial rhythm (37–83%) in out-of-hospital cardiac arrest (OHCA), a major decline (50%) in its incidence has occurred during recent decades.<sup>1–3</sup> Concomitantly, the number of cases of pulseless electrical activity (PEA)

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as initial cardiac rhythm has increased.<sup>4–6</sup> Recent studies have shown the incidence of primary PEA to be 22–30% in OHCA,<sup>7–11</sup> and even 32–52% in in-hospital cardiac arrest.<sup>12,13</sup>

Whereas VF is strongly associated with coronary heart disease,<sup>14</sup> the conditions that cause PEA as initial cardiac rhythm in OHCA often reflect a non-coronary aetiology. Pulmonary embolism (PE) has been shown to be common (36%) in cases of unexpected cardiac arrest presenting with PEA,<sup>15</sup> and a study of people who died after primary PEA (previously called electromechanical dissociation) reported that cardiovascular rupture, PE or tension pneumothorax was the cause of death (COD) in 19 of 50 cases.<sup>16</sup> Another study involving 28 people with PEA as initial rhythm, who died after unsuccessful resuscitation, documented 11 cardiovascular ruptures and 6 PEs.<sup>17</sup> Courtney et al.<sup>18</sup> found that PE was the COD in 52% of cases of primary PEA in a study of witnessed prehospital cardiac arrests.

Obviously, the CODs presented above were based on autopsy findings. However, only a minority (26–39%) of persons who die after attempted resuscitation undergo autopsy.<sup>17,19,20</sup> In most cases, the patient's physician determines the COD according to clinical history. Only if the cause is unknown, if there are reasons to suspect a specific condition or there are legal requirements is an autopsy requested. We hypothesised that if the COD was determined on clinical grounds, based on previous medical history and the course of OHCA, this estimated COD would not be correct in considerable number of cases where the initial cardiac rhythm was PEA. Therefore, we conducted a prospective study of all cases of OHCA where the first recorded rhythm had been PEA and resuscitation was terminated as unsuccessful, and compared CODs determined after autopsy with CODs estimated without autopsy.

## Materials and methods

The study included patients in the emergency medical service (EMS) systems in the city of Tampere and the Turku and Helsinki urban areas in southern Finland. The organisation of these EMS systems has been described in recent papers.<sup>21,22</sup> In the Tampere EMS a person with cardiac arrest is reached by a basic life support unit within a mean 7.5 min, and the distribution of initial rhythms is ventricular fibrillation/tachycardia (VF/VT) 30%, PEA 34% and asystole (ASY) 36%.<sup>11</sup> The corresponding data are not available for the Turku and Helsinki areas because they consist of several individual EMSs covered by a helicopter unit. All patients more than 17 years of age, who suffered a witnessed prehospital cardiac arrest of presumed cardiac origin with PEA as initial cardiac rhythm and for whom resuscitation was unsuccessful in the field, were prospectively included. The cause of arrest was presumed to be cardiac if no obvious other cause was evident, e.g. trauma, intoxication, airway obstruction, bleeding or drowning. The patients were treated according to current European Resuscitation Council resuscitation guidelines.<sup>23</sup>

Finnish legislation states that a police inquiry must be conducted and a medicolegal autopsy performed to determine the cause of death:

when death is not known to be due to illness, or if the deceased has not been treated by a physician during the period of his/her last illness;  
when death is caused or suspected to have been caused by a crime, accident, suicide, poisoning, occupational disease or medical treatment procedure;  
in cases of otherwise unexpected death. In the event of prehospital death, the police are responsible for necessary further actions and they determine whether any of the above-mentioned conditions apply.

In this study, in the Helsinki area an autopsy was requested for all persons with primary PEA when resuscitation had been unsuccessful. The EMS physician on the scene recorded a recommendation for medicolegal autopsy because of a possible non-coronary cause for the arrest. In the two other study areas, the COD was determined according to current general practice, and no efforts to influence this practice were made. If considered by the police to be required by law, a medicolegal autopsy was performed, and in the remaining cases the treating physician of the deceased decided whether sufficient data existed to allow for a death certificate to be issued without an autopsy. The treating physician could request an autopsy to determine the COD before issuing the death certificate if considered necessary. Data on the COD as stated on the death certificates of individuals who did not undergo an autopsy were obtained from Statistics Finland. The corresponding data of those who were autopsied were retrieved from the autopsy records. The institutional review board of the Helsinki University Hospital approved the study protocol.

The association between CODs and mode of determining COD (autopsy or no autopsy) was analysed with the Pearson Chi-squared test and Fisher's exact test, where appropriate. The null hypothesis was that no such association exists. Statistical analyses were performed using SPSS® for Windows; *p*-values <0.05 were considered significant.

## Results

A total of 91 patients were included, 31 in the Helsinki area and 60 in the control areas. Their mean age ( $\pm$ S.D.) was  $73.5 \pm 11.9$  years, and 62% were men. In the Helsinki area the mean age ( $\pm$ S.D.) was  $73.3 \pm 7.7$  years, and 68% were men, whereas the corresponding figures in the combined control areas were  $73.6 \pm 13.7$  years and 58%, respectively. An autopsy was performed in 59 cases (65%), i.e. 81% of those in the Helsinki area and in 57% of those in the Tampere and Turku areas. The distribution of diagnoses between those who were autopsied and those who were not differed (Table 1). There were more diagnoses of acute myocardial infarction (AMI) and less PEs, aortic dissections and ruptures among cases without autopsy compared with those including autopsy. A suspicion of a specific COD was stated on the referral sheets for autopsy in six cases in the control areas. Five of these suspected diagnoses proved to be correct: two AMIs, two PEs and one ruptured acute abdominal aneurysm which was incorrectly suspected to be AMI. The clinical diagnoses in the six cases in the Helsinki area without autopsy (because of protocol violation) were AMI in four and chronic obstructive pulmonary disease in two.

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