CASE REPORT

Semiautomated external defibrillator errors in recognizing ventricular fibrillation

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We report 3 cases of semiautomated external defibrillator error during analysis of ventricular fibrillation. The first involved operator-dependent error, in which ambulance motion led to failure to order a shock. The other 2 cases involved defibrillator-dependent error, in which signals from a pacemaker apparently led to the automatic decision not to shock even when ventricular fibrillation was detected. [Emergencias 2013;25:119-122]

Keywords: Heart arrest. Cardiopulmonary resuscitation. Emergency health services. Ventricular fibrillation. Defibrillators. Pacemaker, artificial. Diagnostic error.

Introduction

Ventricular fibrillation (VF) is the initial rhythm most frequently found in sudden cardiac arrest. This arrhythmia, estimated to be responsible for 59-65% of sudden cardiac deaths[1,2], is potentially reversible by early electrical treatment administered by a defibrillator. Compliance with norms on the use of semiautomatic defibrillators (SAED) in first responders has significantly increased survival rates in patients with out-of-hospital sudden cardiac arrest (SCA)[3]. The sophisticated technology of these devices has allowed training of non-health professional s who can use them with a high level of safety and reliability.

SAED are highly complex microprocessor-based devices which record and analyze ECG signals to determine if they are compatible with VF / ventricular tachycardia (VT). They offer high specificity and moderately high sensitivity. Observed errors and omissions are scarce, mainly attributable to operator error[4]. However, the US institute ECRI estimated that in 2011, SAED malfunction was one of the 10 most important potential technological health risks[5]. We here describe failures in SAED recognition and treatment of VF during resuscitation by an outpatient emergency team of basic life support (BLS) in the Basque Country (Spain).

Clinical cases

Case 1: An 81 year old woman developed SCA during ambulance transfer to hospital. Given the proximity of the hospital, it was decided to continue with the transfer while beginning cardiopulmonary resuscitation (CPR) with SAED support. On the first analysis, the device did not recommend electric shock administration; In the second, the device aborted the operation despite having detected a shockable rhythm. During the journey, the SAED performed five analyses and did not indicate the need for shock treatment at any time. The patient was admitted to the hospital emergency department with SCA. The final outcome of this event is unknown. Subsequent download of the data recorded in the device memory showed that FV was detected in the first two analyses. The movements of the ambulance probably affected the SAED reading and the diagnosis (Figure 1, Table 1).

Case 2: the emergency coordinating center requested a BLS unit for a home visit to attend an

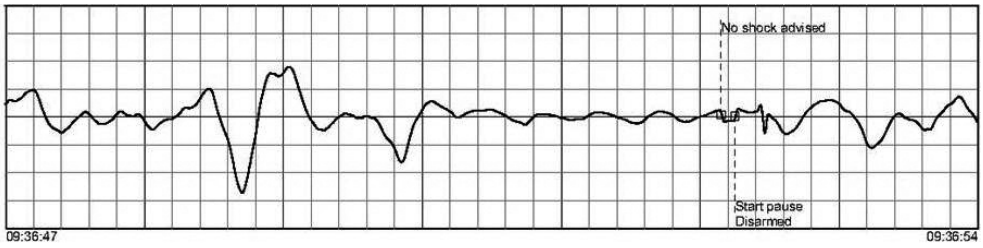

Figure 1. Recording retrieved from SAED in Case 1. The electrocardiogram showed ventricular fibrillation, but the SAED did not recommend shock treatment. The presence of artifacts (due to moving ambulance) is the most likely cause of the inadequate analysis (2 div/mV, 5 div/sec).

Table 1. Case 1, chronology of events

Analysis	Time	Shock indicated	ECG Rhythm
1	0:00	No	Ventricular fibrillation
2	2:29	Yes-aborted	Ventricular fibrillation
3	2:56	No	Asystole
4	5:30	No	Asystole
5	8:14	No	Asystole
6	9:15	No	Asystole
7	10:38	No	Asystole

Table 2. Case 2, chronology of events

Analysis	Time	Shock indicated	ECG Rhythm
1	0:00	No	Ventricular fibrillation
2	2:24	No	Ventricular fibrillation
3	4:54	No	Idioventricular rhythm at 30 bpm (non-conductive pacemaker spikes).

apparently unconscious 60 year-old man with a pacemaker. Fifteen minutes after receiving the call, the BLS team located the patient, unconscious and not breathing. CPR was started and advanced life support (ALS) was requested. The SAED performed 3 rhythm analysis but did not indicate the need for shock. After seven minutes of resuscitation, the ALS unit took over but ceased their maneuvers some minutes later and the patient was declared dead. Subsequent analysis of the incident showed that the rhythm recorded in the first two analysis was shockable. The pacemaker spike was also perfectly visible during the whole recording. The SAED diagnostic failure was attributed to interaction with the pacemaker activity (Figure 2, Table 2).

In Case 3, a BLS unit attended an 81 year-old woman at a home for the elderly. She had a history that included type 2 diabetes, ischemic cardiopathy and a pacemaker. On arrival of the BLS unit, the woman had SCA and CPR was started immediately. ALS was requested. During the CPR maneuvers, the SAED performed 7 analyses, indicating the need for shock treatment after the third and fourth analyses only. After 10 minutes of CPR by the BLS unit, the ALS unit took over but, as in Case 2, ceased their maneuvers some minutes later and the patient was declared dead. FV

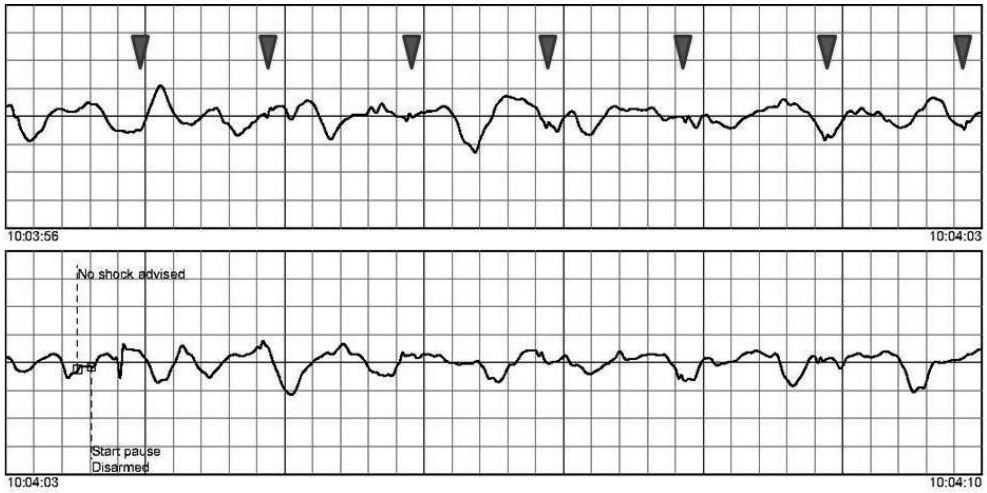

Figure 2. SAED recording in Case 2. The electrocardiogram showed ventricular fibrillation, but the SAED did not recommend shock treatment. Pacemaker spikes at 60 ppm (arrows) (2 div/mV, 5 div/sec).

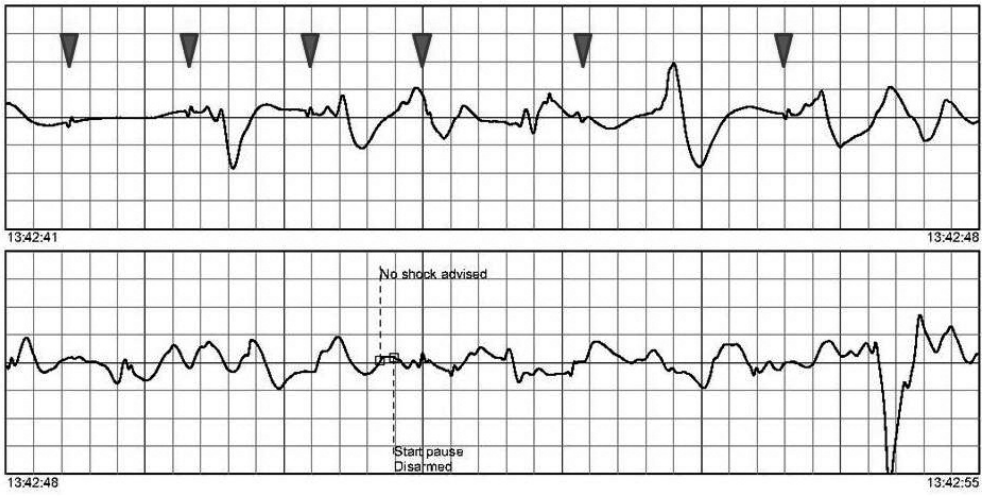

Figure 3. SAED recording in Case 2. Again, the presence of an artificial pacemaker may have interfered with the recognition of ventricular fibrillation during SAED analysis (2 div/mV, 5 div/sec).

was the initial rhythm detected on the first six analyses but electric shock treatment was not indicated by the SAED. As in Case 2, pacemaker activity was recorded during the event and could have caused the SAED device's diagnostic error (Figure 3, Table 3).

Discussion

SAED are simple, reliable devices that require minimal training for proper application. Their use in detecting heart rhythm is crucial in many cases, since VF/VT is the most common initial rhythm in the first few minutes after SCA[6].

SAED errors presented here were discovered by chance during the evaluation of local BLS attention of SCA performed in the period 2006-2010. During this time, there were 87 CPR events with SAED support, of which 13 had shockable arrhythmias. The same defibrillator device model, a Philips Heart Start FR2 was used in all, with updated software according to the European Resuscitation Council guidelines of 2005[7]. The review of incidents and analysis was performed manually using Utstein records of each event and the application of Heart Start Review Express version 3.1 for visualization and study of ECG tracings. Management of the devices was conducted by health emergency technicians trained in CPR and AED in accordance with current regional norms[8] and these technicians collaborated in the investigation of the findings in the three cases presented.

Table 3. Case 3, chronology of events

Analysis	Time	Shock indicated	ECG Rhythm
1	0:00	No	Ventricular fibrillation
2	2:19	No	Ventricular fibrillation
3	4:31	Yes-aborted	Ventricular fibrillation
4	4:50	Yes-aborted	Ventricular fibrillation
5	5:09	No	Ventricular fibrillation
6	7:30	No	Ventricular fibrillation
7	7:52	No	Asystole (non-conductive pacemaker spikes).

In Case 1, artifacts caused by the ambulance movement could have caused the error in the analysis, which prevented recognizing the initial VF and therefore did not indicate the need for electric shock for safety reasons. Ambulance vibration and movement, chest compressions during SAED analysis and even involuntary movements of the victim (gasping)[8] may interfere with correct rhythm diagnosis leading to erroneous omission of shock treatment, as reflected in this case. Despite the emphasis in training programs on preventing movement, it remains a cause of error which is operator-dependent. First responders must not only be trained to use these devices but also be made highly aware of safe use requirements[5].

Cases 2 and 3 illustrate how implanted bipolar pacemakers may interfere with the operation of the SAED. The possibility of patient movement causing artifacts during the initial rhythm analysis phase was ruled out after interviewing the BLS team members involved. Information about the interaction of implanted pacemakers and defibrillators during analysis or electric shock delivery is practically anecdotal. However, similar cases have been reported previously by other authors[10-13]. The SAED manufacturer's manual[14] indicates that the defibrillator device has a system to detect and remove artifact caused by the pacemaker, but the

cases described here were the only situations of SAED use in patients with FV and a pacemaker.

The actual incidence of this type of event is unknown, and we believe it is important to start investigating the prevalence of SAED error in recognizing VF in pacemaker carriers and the factors associated with such errors.

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Errores del desfibrilador semiautomático en el reconocimiento de la fibrilación ventricular

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Presentamos tres casos clínicos de errores del desfibrilador semiautomático (DESA) durante el análisis de la fibrilación ventricular (FV). El primer caso corresponde a un error operador dependiente, en el que las vibraciones de la ambulancia provocan una omisión en la orden de desfibrilar. Las otras dos situaciones, DESA dependientes, constatan que la actividad eléctrica del marcapasos influye en la decisión de no desfibrilar en el contexto de una FV. [Emergencias 2013;25:119-122]

Palabras clave: Paro cardiaco. Resucitación cardiopulmonar. Servicios médicos de urgencia. Fibrilación ventricular. Desfibriladores. Marcapaso artificial. Errores diagnósticos.