Prospective cohort study of change of practice from Manual to AED-mode defibrillation in Oslo and Akershus ambulance service

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Abstract
Background: In 2013, an improved AED-mode was implemented as standard mode for using defibrillators during cardiopulmonary resuscitation (CPR) in the ambulance service in Oslo and Akershus. We wanted to study which effects this change had on CPR quality in the ambulance service.

Methods: We included all patients suffering from out-of-hospital cardiac arrests (OHCA) that received CPR from ambulance personnel and had readable electrocardiograms (ECG) and transthoracic impedance recordings in saved data files. The previously used manual mode and AED-mode were compared regarding inappropriate (IS) and delayed shocks (DS), analysis pause, pre- and post-shock pauses and No-flow-fraction.

Results: We included 338 OHCA episodes in manual mode and 226 in AED-mode. The IS-rate was not different between manual mode and AED-mode: 5.6 % versus 4.0 % (P=0.5). The DS-rate and the duration of the delay (s) (median (Q1, Q3)) were higher in manual mode than in AED-mode: 29 % versus 18 % (P=0.007), and 50 (14, 195) versus 15 (5, 65) (P=0.004), respectively. None of the pauses were different between manual mode and AED-mode (s) (median (Q1, Q3)): 9.4 (6.1, 15.9) versus 10.4 (8.6, 13.4) analysis, 3.6 (1.3, 12.4) versus 3.3 (1.6, 5.7) pre-shock, and 0.0 (0.0, 1.5) versus 0.0 (0.0, 1.7) post-shock. The No-flow-fraction was lower in manual mode than in AED-mode (median (Q1, Q3)): 12 % (8, 18) versus 15 % (10, 19) (P=0.003).

Conclusions: Use of AED-mode reduced the DS-rate and the duration of the delay, but not the IS-rate. Shock related pauses and No-flow-time remained basically unchanged.
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**Background**
The first recorded rhythm in cardiac arrest patients is ventricular fibrillation in 20-40% of the cases. (1) Survival for these patients depends on the swift use of a defibrillator to terminate the malignant arrhythmia and restore spontaneous circulation. (2) Semiautomatic defibrillators (AED) are capable of automatic interpretation of cardiac rhythms and have high sensitivity and specificity. (3) Even minimally trained laypersons can use AEDs without risk of harm for patient or rescuer. (2)

Retrospective analyses indicate that shorter time between chest compressions and shock (pre-shock pause), and shorter pauses in chest compressions (No-flow-fraction), is related to chance of successful defibrillation. (4-6) Studies also indicate that AED-mode is associated with longer pre-shock pauses and variable delays. (7) To facilitate quicker analyses and shorter pre-shock pauses, much time and energy has been invested in training paramedics in manual rhythm interpretation. (8) However, a retrospective study indicate that shorter pre-shock pauses in manual mode come with a cost of more than 26% of the shocks being delivered on non-shockable rhythms. (7) The ambulance service in Oslo and Akershus use defibrillators mainly in manual mode (Fig. 1a), due to the concerns with long pre-shock pauses in AED-mode (Fig. 1b). Recent software developments have made it possible to re-program defibrillators in AED-mode to include 17 seconds of chest compressions during charging, without disrupting the charging process (Fig. 1c).
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We hypothesized that a change from use of defibrillator in manual mode to use in the new AED-mode would retain the high sensitivity, specificity and safety of the AED-mode analysis and defibrillation, while optimizing the pre-shock pause time similar to the ideal use of defibrillators in manual mode. Timing of rhythm analyses and shocks might also improve due to timed voice prompts.

Materials & Methods
Description of the EMS-service in Oslo and Akershus

Oslo and Akershus covered 5,372 km² and had a population of 1,232,575 (1. January 2015). Oslo and Akershus had a single-tiered community run EMS system, where all the ambulances were manned with paramedics or EMTs. A physician-manned car, staffed by paramedics and an anaesthesiologist, was in service on weekdays between 07.00 and 22.00 until September 2013, and after that operating continuously. All ambulances were equipped with multi-monitor defibrillators (Lifepak 15, Physio-Control, Wa, USA), and CPR performed according to European guidelines with modification of CPR-cycle length.(9) Endotracheal tube or iGel (Intersurgical, Berkshire, UK) for advanced airway management and routine medication (Epinephrine and Amiodarone) were available in all ambulances. A mechanical chest compression device (LUCAS 2, Jolife AB/ Physio-Control, Lund, Sweden) was dispatched to all cardiac arrests with the first or second resource.

During the second half of 2013, the standard operating procedures (SOP) in the ambulance service in Oslo and Akershus were changed from use of defibrillators
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in manual mode to the modified AED-mode, and we wanted to evaluate this change as part of our continuous quality assurance program.

The process of implementation

The training of personnel was divided into an internet-based theoretical course and an attendance-based training course in the practical use of the defibrillators with the new AED-mode. Training was compulsory and paid for all employees.

Design and Recruitment

We included all patients suffering from out-of-hospital cardiac arrests (OHCA) that received CPR from ambulance personnel and had readable electrocardiograms (ECG) and transthoracic impedance recordings in saved data files. The before-period (PRE) was July 2012 to June 2013, and the after-period (POST) was January 2014 to June 2014 with interposed training and wash-in during the second half of 2013.

The Regional Ethical Board found the project to be a local quality assurance study and thus deferred formal approval (2014/540). The Local Data Integrity and Safety Officer approved the data collection process and recommended that there was no need for individual consent (2012/17238). After collection of all data and evaluation of the results by the ambulance department, data were anonymized.

Data collection and processing
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For every cardiac arrest episode, the defibrillator recorded ECG and transthoracic impedance, which were transferred to a data-server by the ambulance personnel. We viewed and annotated recordings manually, using proprietary software CODE-STAT 9.0 (Physio-Control). Cardiac rhythms were mainly determined in chest compression pauses, as compression artefacts in the ECG waveform makes rhythm annotation difficult. When we recognized a rhythm in a chest compression pause, we traced it backwards and, if visible during compressions, annotated it at the earliest point discernible. The transthoracic impedance waveform was used to detect chest compressions, and together with Utstein data, used to distinguish between PEA and ROSC.(10)

We defined *inappropriate shock* (IS) as shock delivered on any other rhythm than VF or VT. We calculated sensitivity, specificity, positive (PPV) and negative predictive value (NPV) for AED analyses and PPV for manual shocks. We measured the duration of VF before each shock and defined *delayed shock* (DS) as >3.5 minutes of VF or VT without shock, and the *duration of the delay* as the number of seconds after this time limit until shock.

In manual mode, we defined the analysis pause as a pause in compressions <30 seconds before shock (Fig. 1d, I). In AED-mode, we defined it as the pause where the analysis was marked by the defibrillator software. The pre-shock pause is the pause between the last compression before shock and the shock (Fig. 1d, II). The post-shock pause is the pause between the shock and the first compression after the shock (Fig. 1d, III). Because there is no recording of ECG or transthoracic impedance the first 2-4 seconds after shock, we measured the post-shock pause
from the re-appearance of recorded signals to the first chest compression. We measured the duration of each pause using the proprietary software. To maintain independent samples, we analysed the averaged pause durations (analysis, pre-shock, and post-shock) for all shocks per cardiac arrest episode.

We compared Utstein characteristics, No-flow-fractions and compression rates between PRE and POST (Fig. 2 marked “a”). We compared the averaged shock related pauses; analysis pause, pre-shock pause and post-shock pause for only those episodes with at least one shock in manual mode during PRE and in AED-mode during POST (Fig. 2 marked “b”). Comparisons of inappropriate and delayed shocks were performed on the total number of shocks, with each shock as an independent sample, before and after the implementation (Fig. 2 marked “c”).

**Statistical analysis**

We organized the data using Microsoft Excel 2007 (Microsoft Corporation, Redmond, Washington, USA) and performed the statistical analyses using IBM SPSS Statistics 22 (IBM, Armonk, New York, USA). We compared continuous data with Mann-Whitney U-tests, and proportions with Chi squared tests with continuity correction. Results are expressed as medians with 25- and 75-percentiles, and 95 % confidence intervals (95 % CI) are provided when appropriate. P-values are two-tailed and considered significant if less than 0.05. A power analysis to detect a change in proportion of erroneous shocks from 20 % to 5 % with a power of 0.80, led us to include at least 80 cases in each group.
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To detect a change in pre-shock pause from 5 to 10 s with a standard deviation of 4 s, a similar power analysis resulted in 11 episodes required in each group.

Results
This study included 564 episodes of CPR with recorded ECGs and transthoracic impedance waveforms (338 before and 226 after the implementation) out of 649 registered out-of-hospital cardiac arrests in the study periods. Demographics are displayed in table 1 with comparisons of the groups marked “a” in fig. 2. Comparisons between the two cohorts concerning gender, age, bystander CPR and presumed aetiology are presented in table 1.

After the SOP change in 2013, we expected the patients to receive CPR in AED-mode. However, in 28/226 (12 %) episodes the defibrillator was used in both AED-mode and manual mode, and in 50/226 episodes (22 %) AED-mode was not used at all. The use of AED-mode increased during POST (fig. 3). In episodes entirely in manual mode, 99/338 (29 %) patients received at least one shock, versus 50/226 (22 %) in AED-mode (Fig. 2 “b”). The number of shocks delivered/advised in manual or AED-mode during PRE and POST respectively, was 360 and 224 (Fig. 2 “c”).

Inappropriate shocks
The rate of IS was not different in manual mode and AED-mode (P=0.5). The personnel delivered 20/360 (5.6 %) manual shocks and 9/224 (4.0 %) AED-shocks on non-shockable rhythms. Most IS were delivered on PEA (85% in manual mode, 89% in AED-mode), the rest during asystole (Table 2).
In manual mode, we found 360 shocks with a PPV of 94.4% (95% CI; 91.8–96.5). In AED-mode, we found 928 analyses (analyses during compressions excluded) with a sensitivity of 98.6% (95% CI; 96.5–99.7), specificity 98.7% (95% CI; 97.7–99.4), PPV 96.0% (95% CI; 92.9–98.0) and NPV 99.6% (95% CI; 98.9–99.9).

**Delayed shocks**

The rate of DS was higher in manual mode (103/360, 29 %) than in AED-mode (40/219, 18 %) (P=0.007). The median duration of the delay in manual mode was 50 seconds (14, 195), which was longer than in AED-mode (16 seconds (5, 65)) (P=0.004) (Table 2).

**CPR quality**

The PRE group had a lower No-flow-fraction and a higher number of compressions per minute (Table 1) (Fig 2 “a”). Median duration of all AED-analysis pauses was 13.2 s (11.1, 17.7). For the episodes with at least one shock (Fig 2 “b”), pause times are described in table 3. Including only the analyses preceding shocks, analysis-, pre-shock-, and post-shock pauses were not different in AED- and manual mode (P>0.05).

**Discussion**

The results from this prospective evaluation of a defibrillation protocol change in one ambulance service demonstrate a clear benefit from using AED-mode regarding the rate of delayed shocks and duration of delay but no reduction in
rate of inappropriate shocks. This is important because delaying shocks leaves the heart in an energy consuming VF and other evidence suggest a strong relationship between time from collapse to the first shock and survival after OHCA.(2)

**Inappropriate shocks**

The last study describing IS in the ambulance-service in Akershus used data from 2002-2005, and showed an IS rate of 26% in manual mode.(7) The rate of IS in AED-mode was expected to be 4-5%; (11) this was one of the main reasons for wanting to implement AED-mode in our SOP. However, we found the rate of IS to be 5.6% in manual mode before the SOP change. This reduced the potential benefit from implementing the AED-mode and shows that continuous quality assessment is necessary to estimate the potential benefit of an intervention.

We cannot know if pauses in manual mode not preceding a shock, are caused by rhythm analysis or other activity, e.g. pulse check or moving of the patient. Thus, the exact occurrence of rhythm analyses (except for those resulting in a shock decision) remains unknown in manual mode. In AED-mode however, all analyses are marked, and we can determine sensitivity, specificity, positive (PPV) and negative predictive value (NPV) for AED-mode, but only PPV (100 – IS rate) for manual mode. Our results confirm the high precision of automatic shock detection algorithms in AED-mode, but also demonstrate that trained paramedics are able to detect shockable rhythms with high precision. We choose to define shocks delivered after prolonged periods of chest compressions during VF as delayed shocks. If undetected shockable rhythms instead are classified as
false negatives, we could also have calculated sensitivity for manual mode. However, we were not able to detect systematic pauses at the prescribed 3-minute intervals in many of the manual mode episodes. Twenty-five of the 103 delayed shocks in manual mode were delayed for more than two three-minute cycles. Sensitivity based on these numbers, will be 93 %, and this does not take into account that some of the delays extend for even more three-minute cycles.

Delayed shocks
Norwegian guidelines prescribe three-minute CPR cycles. Added to that, is time needed for a new analysis and charging of the defibrillator. Thus, we would expect a new shock within 3.5 minutes and used this as our cut-off for DS. Our study shows a clear benefit from using the AED-mode in reducing delayed shocks.

To estimate the duration of a CPR-cycle is difficult during the stressful circumstances of on-going resuscitation. During manual CPR, this needs special attention and even extra equipment such as stopwatches, which may account for the high rate and the long and varying duration of delay in manual mode. In AED-mode, voice prompts and a large timer displayed on the screen help personnel keep track of time. Based on this, the difference between DS in manual (29 %) and AED-mode (18 %) was smaller than we anticipated. However, when looking at the duration of delay the effect became evident. The median duration of delay beyond 3.5 minutes was reduced from 50 seconds with a wide dispersion in manual mode to 16 seconds in AED-mode. Some of the shocks in AED-mode (7 %) were delayed >30 seconds, but most were delayed for just a few seconds.
more. The probable cause of delays in AED-mode is sub-optimal use of the defibrillator, e.g. failing to press the analyse-button, or to deliver shock when prompted.

**Pause times**

Disappointingly, the median analysis pause for all analyses was 13 seconds in AED-mode. As the manual analyses that do not end in defibrillations are not marked in the defibrillator files, it is unfair to compare all AED-analysis pauses to manual analysis pauses. When we compared only analysis pauses preceding shocks, pauses were not different between the two modes (table 3). Additionally, the actual time interval the defibrillator used for automatic analysis (median 5.5 seconds (5.4, 5.7 s)) was much less than the total pause duration. A close review of the downloaded files showed that the personnel stopped compressing 2.2 seconds (1.2, 3.8) before the start of the analysis and started compressing 5.0 seconds (3.1, 8.1) after the end of the analysis (Fig. 1d, IV and V). This suggests that pauses could be shortened, and even be shorter than in manual mode. Waiting for the voice prompts to end might delay personnel's actions, and future training should emphasize on how to use AED-mode more efficiently.

There were no significant differences between manual mode and AED-mode regarding pre- and post-shock pauses, and both were shorter than or similar to previously reported values.(4, 6, 7, 12) The post-shock pause was rarely longer than the interval with no recording, and was therefore set to 0 seconds in most of the cases.
There seems to be a positive correlation between increasing chest compression (CCF) fraction and ROSC/survival to hospital discharge, with a possible plateau after reaching 80-90 %.

(13, 14) We found slightly increased No-flow-fraction (which corresponds to 100 – CCF %) after the implementation. The reason for this may be suboptimal use of the defibrillator, caused by ambiguity using the new software, but fractions for both manual- and AED-mode are low compared to other published reports. The effect of No-flow-fraction (CCF) on survival considering whole episodes is complex, (15) and effect on survival for other rhythms than VF have barely been studied.

Use of AED-mode – pitfalls and pearls

The proportion of patients receiving CPR in AED-mode still increased during POST (Fig. 3), and we observed recurring cases of sub-optimal use of the defibrillator, indicating that 6 months may have been too short time interval for both training and wash-in. In 17/224 AED-advised shocks, the personnel terminated the automatic charging and delivered a shock in manual mode instead. This prolonged the pre-shock pause and possibly the rate of delayed shocks. Reports from the personnel indicate that the cause of these charge-terminations was a push on the wrong button. Improved training and cleverer design of user interface might improve this. In seven appropriately AED-advised shocks, the personnel failed to deliver a shock altogether, despite voice prompts.

In 82 of a total 1010 AED-analyses, the personnel performed chest compressions during the analysis. In most of these cases, the AED advised “no shock”. However, in 20 (24 %) cases, the AED did advise shock, and out of these 5 (25 %) were
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inappropriate. Thus, the rate of inappropriate shocks when performing chest compressions during the AED-analysis seems to be higher than when using the AED correctly (4.0 %).

There were also 29 cases of switching between modes not related to shock, which may have increased the overall No-flow-fraction.

We suggest that manufacturers develop AED-mode for professional rescuers, acknowledging that professionals can manage more in-put and complexity than laypersons. The main features of professional AED-mode should be automatized rhythm analysis and aided CPR cycle adherence. We have previously demonstrated that automatic launching of a shock detection algorithm during pauses is feasible, (16) and that very fast recognition of shockable rhythms is possible.(17, 18)

Experiences from the implementation process:

Initially, some of the personnel had concerns about switching from manual to AED-mode, mainly due to worries that it would prolong the pre-shock pause. However, positive experiences with the AED-mode reduced the doubts, and the training was completed without any major challenges.

Limitations

This study is based on data collected as part of routine reporting of performance in our system, and anonymized before the analysis. Thus, a high number of missing data entries could not be corrected for the purpose of this study, but
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initiated a set of measures in the service to increase routine reporting of patient report forms with Utstein data and electronic files. Missing reports might not have randomly distributed characteristics, and poses a risk of bias. However, data for electronic analysis of CPR quality were present in more than 90% of the reported cases and constitutes the basis for our main analysis. In many cases the physician staffed ambulance arrived at the scene some minutes after the first ambulance, and we have not tried to analyse their exact arrival and influence on the CPR performance. The physicians are probably responsible for some of the switching between defibrillator modes and many of the manual-mode shocks in the POST period, even though they were also informed and trained in the new software for AED-mode.

In the secondary analysis of inappropriate shocks and delayed shocks, we have compared the groups with each defibrillation as the variable. Obviously, this invalidates the basic assumptions of independent observations because in an episode with several defibrillations, we would expect some intra-episode correlations as the same patient was treated with the same equipment and the same team. A mixed-model statistical approach could allow for valid analysis given such data characteristics. However, in most episodes the number of shocks was low (median number of shocks in the episodes with at least one shock was three (both PRE and POST)), and secondly, we have no way to know if it was the same or multiple persons handling the defibrillator during each episode or, if applicable, when they changed.
Conclusion
In this prospective evaluation of the change from manual to AED-mode use of defibrillators in a large ambulance service, we found that use of AED-mode improved the adherence to cycle time in the CPR algorithm. We did not see a reduction in inappropriate shocks mainly due to high performance before implementation. Overall CPR quality, including peri-shock pauses, remained basically unchanged. We suggest better design of AED-software and user interfaces adapted to professional users, and we will continue our evaluation of all changes in practice and procedures.
Acknowledgements
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### Change from Manual mode to AED-mode defibrillation

#### Tables

**Table 1** Patient demography and CPR quality

<table>
<thead>
<tr>
<th></th>
<th>PRE group (n=338)</th>
<th>POST group (n=226)</th>
<th>P-value</th>
<th>Missing values (PRE, POST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male gender, n (%)</td>
<td>185 (66)</td>
<td>150 (76)</td>
<td>0.020</td>
<td>57, 29</td>
</tr>
<tr>
<td>Age, years</td>
<td>68 (54, 80)</td>
<td>62 (50, 75)</td>
<td>0.006</td>
<td>54, 33</td>
</tr>
<tr>
<td>Cardiac aetiology, n (%)</td>
<td>166 (69)</td>
<td>90 (54)</td>
<td>0.003</td>
<td>96, 58</td>
</tr>
<tr>
<td>Location of arrest, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Home</td>
<td>179 (61)</td>
<td>122 (61)</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>▪ Public</td>
<td>73 (25)</td>
<td>46 (23)</td>
<td>0.695</td>
<td></td>
</tr>
<tr>
<td>▪ Other</td>
<td>40 (14)</td>
<td>31 (16)</td>
<td>0.663</td>
<td></td>
</tr>
<tr>
<td>Bystander CPR, n (%)</td>
<td>212 (74)</td>
<td>169 (87)</td>
<td>0.001</td>
<td>53, 31</td>
</tr>
<tr>
<td>Use of LUCAS, n (%)</td>
<td>65 (23)</td>
<td>47 (24)</td>
<td>0.786</td>
<td>52, 32</td>
</tr>
<tr>
<td>First recorded rhythm, n (%)</td>
<td></td>
<td></td>
<td>1, 0</td>
<td></td>
</tr>
<tr>
<td>▪ VF/VT</td>
<td>87 (26)</td>
<td>58 (26)</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>▪ PEA</td>
<td>89 (26)</td>
<td>62 (27)</td>
<td>0.864</td>
<td></td>
</tr>
<tr>
<td>▪ Asystole</td>
<td>159 (47)</td>
<td>92 (41)</td>
<td>0.153</td>
<td></td>
</tr>
<tr>
<td>▪ Unspecified non-shockable</td>
<td>2 (0)</td>
<td>14 (6)</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Response time, min</td>
<td>11 (8, 14)</td>
<td>10 (8.13)</td>
<td>0.054</td>
<td>70, 29</td>
</tr>
<tr>
<td>ROSC at arrival in hospital, n (%)</td>
<td>86 (30)</td>
<td>72 (37)</td>
<td>0.118</td>
<td>50, 32</td>
</tr>
<tr>
<td>Compression/minutes</td>
<td>93 (87, 98)</td>
<td>89 (84, 95)</td>
<td>0.000</td>
<td>1, 1</td>
</tr>
<tr>
<td>Compression rate (min⁻¹)</td>
<td>109 (103, 116)</td>
<td>106 (102, 112)</td>
<td>0.002</td>
<td>2, 0</td>
</tr>
<tr>
<td>No-flow-fraction</td>
<td>12% (8, 18)</td>
<td>15% (10, 19)</td>
<td>0.003</td>
<td>1, 0</td>
</tr>
</tbody>
</table>

*Proportions are compared using chi-square tests with continuity correction. All continuous variables are reported as median with interquartile range and compared using the Mann-Whitney U-test.*

*VF = ventricular fibrillation, VT = pulseless ventricular tachycardia, PEA = pulseless electrical activity.*
**Table 2** Characteristics of 584 (advised) shocks in manual and AED-mode

<table>
<thead>
<tr>
<th></th>
<th>Manual, n=360</th>
<th>AED, n=224</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inappropriate shocks (IS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fraction of IS on an organized rhythm</td>
<td>20 (6%)</td>
<td>9 (4%)</td>
<td>0.525</td>
</tr>
<tr>
<td>Delayed shocks, rate</td>
<td>103 (29%)</td>
<td>40 (18%)</td>
<td>0.007</td>
</tr>
<tr>
<td>Delayed shocks, duration</td>
<td>50 (1, 195)</td>
<td>16 (5, 65)</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Proportions are compared using chi-square tests with continuity correction. All continuous variables are reported as medians with interquartile range and compared using the Mann-Whitney U-test.
### Table 3 Pause times

<table>
<thead>
<tr>
<th></th>
<th>Manual mode (n=99)</th>
<th>AED-mode (n=50)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis pause</td>
<td>9.4 s (6.1,15.9)</td>
<td>10.4 s (8.6,13.4)</td>
<td>0.531</td>
</tr>
<tr>
<td>Pre-shock pause</td>
<td>3.6 s (1.3,12.4)</td>
<td>3.3 s (1.6,5.7)</td>
<td>0.374</td>
</tr>
<tr>
<td>Post-shock pause</td>
<td>0.0 s (0.0,1.5)</td>
<td>0.0 s (0.0,1.7)</td>
<td>0.959</td>
</tr>
</tbody>
</table>

Results are provided per episode for only those analyses preceding shocks. Continuous variables are reported as medians with interquartile range and compared using the Mann-Whitney U-test.
Change from Manual mode to AED-mode defibrillation

Figures

Figure 1

a) CPR ANA CPR CPR

b) CPR ANA PAUSE CPR

c) CPR ANA 15s CPR CPR

d) CPR ANA V 15s CPR CPR

IV

I

II

III
Change from Manual mode to AED-mode defibrillation

Figure 2
Change from Manual mode to AED-mode defibrillation

Figure 3
Legends to the figures

Figure 1:

a) Manual mode: Manual analysis and an unknown duration of CPR during charging. b) Previous AED-mode: Chest compressions paused during automatic analysis and charging because of concerns that chest compressions will disrupt analysis and charging process. Scarcely used. c) New AED-mode: Automatic analysis and a predefined 17 s of chest compressions during charging. d) Various pauses illustrated; I: Analysis pause, II: Pre-shock pause, III: Post-shock pause, IV: Early compression stop, V: Late compression start

Figure 2:

Included and excluded patients a) Groups compared for demographics and overall CPR characteristics. b) Groups compared for peri-shock pause durations. c) Groups compared for inappropriate and delayed shocks

Figure 3:

Increasing compliance using AED-mode first half of 2014. The columns show the number of episodes in the different groups (left y-axis); Dark gray: AED-mode; hatched: Mixed episodes; white: Manual mode. The line show the increasing proportion of defibrillation attempts in AED-mode (right y-axis).
Change from Manual mode to AED-mode defibrillation

References