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ABSTRACT

Introduction: In December 2005, updated resuscitation Guidelines (G) were introduced worldwide and will be revised again in 2010. This study sought to elucidate how long it takes to implement new guidelines.

Methods: This was a prospective observational study. From July 2005 to January 2008, we included all patients with an out-of-hospital cardiac arrest of suspected cardiac cause. We analyzed Emergency Medical System (EMS) Guideline usage via defibrillator recordings of the continuous ECG and impedance signals. We excluded patients with missing or otherwise unusable ECGs. All shocks and CPR cycles were individually classified. The same Guideline needed to be applied for at least 75% of all shocks and CPR cycles. If no shocks had been given, continuous ECGs were classified by its CPR status only. Continuous ECGs were classified as G1992, G2000 or G2005. If at least 75% of the shocks were given according to G2000 and at least 75% of the CPR was according to G2005, the Guideline protocol was classified as intermediate. All analyses that did not fulfill any Guideline criteria were classified as indeterminate.

Results: Of 1672 analyzable resuscitations, 31 (2%) used G1992, 826 (49%) G2000, 608 (36%) G2005, and 125 (7%) intermediate Guidelines. The Guideline protocol could not be identified for the remaining 81 (5%) patients. It took 17 months (from publication) until EMS personnel applied GL2005 in over 80% of cases.

Conclusion: Our experience shows it took one-and-a-half years to effectively implement new resuscitation Guidelines. We believe improvements in implementation can shorten this to six months.

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Introduction

The European Resuscitation Council was founded in August 1989, and published its first evidence based resuscitation Guidelines in 1992 in a cooperative venture with the American Heart Association.1,2 Over subsequent years, there was a growing awareness of the importance of early defibrillation, as advised in the resuscitation Guidelines of 2000.3,4 The most recent resuscitation Guidelines were published in 2005, and placed a renewed emphasis on the importance of high quality, minimally interrupted CPR.5 The Guidelines are scheduled to be revised again in 2010.

The publication of resuscitation Guidelines is the start of an implementation process that consists of several links. First, countries need to evaluate the ERC Guidelines for possible adaptation to national practical and legal requirements. Second, countries that do not have English as their native language need to translate the Guidelines. Third, training material needs to be developed in accordance with the new Guidelines. Fourth, trainers need to be trained, who in turn will be responsible for the training of thousands of paramedics. It obviously takes a lot of time to train this many people.

The purpose of this study was to elucidate how long it took for Emergency Medical System (EMS) personnel to implement the 2005 resuscitation Guidelines.

Methods

Setting

The Dutch province of North Holland has a population of 2.6 million people and covers approximately 2671 km² including both urban and rural communities. Medical emergency calls are immediately transferred to the regional EMS dispatch centre. When suspecting a cardiac arrest, the EMS dispatcher sends out two ambulances of a single tier. All EMS personnel are qualified to perform Advanced Life Support (ALS) according to the guidelines of the European Resuscitation Council,6,7 and are equipped with a manual defibrillator (LIFEPAK 12, Physio Control, Redmond, WA).
Elements of the resuscitation Guidelines by which the ECGs were analyzed.

December 2005, the Netherlands Resuscitation Council adapted the Guidelines to the EMTs of The Netherlands Ambulance Institute, which is responsible for the training of both local EMS services and dispatchers. The Netherlands Ambulance Institute also develops protocols and issues the manual describing all EMS protocols.

Guideline implementation process

After the publication of the ERC resuscitation Guidelines in December 2005, the Netherlands Resuscitation Council adapted and translated the Guidelines and published them online on March 23, 2006. The Netherlands Ambulance Institute had planned to issue a new edition of all treatment protocols, including ALS, in December 2006. To bridge the time period between publication of the resuscitation Guidelines and the publication of all EMS protocols, the medical directors of the EMS services introduced an intermediate form of the Guidelines in August 2006: ALS according to the Guidelines 2000 with the exception of a 30:2 compression to ventilation (C:V) ratio. Beginning in December 2006, 3800 EMS personnel were provided ALS training according to the recommendations of resuscitation Guidelines 2005, of whom 550 served the study area.

Data sources

After each resuscitation attempt, EMS paramedics routinely downloaded and sent the continuous ECG and impedance recordings from their manual defibrillators to the study centre by modem. These data were stored and analyzed with dedicated software (Code Stat Reviewer 7.0, Physio Control, Redmond, WA, USA). Data items concerning the resuscitation were collected according to the Utstein recommendations. The Medical Ethics Review Board of the Academic Medical Centre, Amsterdam approved the study and gave a waiver for the requirement of (written) informed consent.

Data collection

Between July 2005 and January 2008, we prospectively collected data on all patients in whom resuscitation was attempted by EMS personnel after an out-of-hospital cardiac arrest of suspected cardiac cause. Arrests were considered non-cardiac if the paramedics applied one or more of the following: (1) gave CPR with a C:V ratio of 5:1 with a maximum 10% deviation in the number of chest compressions (4–6), or (2) gave CPR in 1 min cycles when no shocks were required. A CPR cycle was classified as G2000 if the paramedics applied one or more of the following: (1) gave CPR with a C:V ratio of 15:2 with a maximum 10% deviation in the number of chest compressions (13–17), or (2) gave CPR in 3 min cycles when no shocks were required. A CPR cycle was classified as G2005 if the paramedics applied one or more of the following: (1) gave CPR with a C:V ratio of 30:2 with a maximum 10% deviation in the number of chest compressions (27–33), or (2) gave CPR in cycles of 2 min.

A continuous ECG was classified as G1992 if at least 75% of the shocks were given according to G2000 and at least 75% of the CPR was given according to G1992. A continuous ECG was classified as G2000 or G2005 if at least 75% of the shocks and at least 75% of the CPR cycles satisfied the same Guideline protocol. A continuous ECG was classified as intermediate Guideline if at least 75% of the shocks were given according to G2000 and at least 75% of the CPR cycles were given according to G2005. If no shocks were delivered, the continuous ECG was classified by the CPR cycles only. All continuous ECGs that did not fulfil any of the above criteria were classified as indeterminate. Figure 1A and B show two examples of a continuous ECG recording where EMS paramedics followed G2000 and G2005 respectively.

The usage of each Guideline protocol as a percentage of total resuscitation attempts was calculated per month.

<table>
<thead>
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<th>Guideline classification</th>
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| Two researchers (JB and AS) determined which Guidelines protocol had been followed for each continuous ECG recording. The key elements of the various resuscitation protocols are summarized in Table 1. First, all shocks were individually classified as G2000 or G2005. Second, all CPR cycles were classified as G1992, G2000 or G2005. A shock was classified as ‘G2000′ if the paramedics applied one or more of the following: (1) performed a post-shock pause in CPR, possibly for rhythm analysis, of 5 s or more, (2) administered a shock stack of 2 or more shocks, (3) gave a second shock within half a minute after the first shock without a post-shock pause in CPR of 5 s or more, or (4) gave a single shock of 200 J with a monophasic defibrillator, followed by ROSC. A shock was classified as ‘G2005′ if the paramedics applied one or more of the following: (1) immediately continued CPR within 5 s after a shock, (2) recharged the manual defibrillator after an unsuccessful shock, but did not give the second shock within the next 2 min of CPR, or (3) gave a single shock of 360 J with a monophasic defibrillator, followed by ROSC. Chest compressions and ventilations were evaluated with respect to the C:V ratio and CPR cycle length. The C:V ratio was analyzed until the airway was secured by intubation and rescuers started uninterrupted CPR. A CPR cycle was classified as G1992 if the paramedics applied one or more of the following: (1) gave CPR with a C:V ratio of 5:1 with a maximum 10% deviation in the number of chest compressions (4–6), or (2) gave CPR in 1 min cycles when no shocks were required. A CPR cycle was classified as G2000 if the paramedics applied one or more of the following: (1) gave CPR with a C:V ratio of 15:2 with a maximum 10% deviation in the number of chest compressions (13–17), or (2) gave CPR in 3 min cycles when no shocks were required. A CPR cycle was classified as G2005 if the paramedics applied one or more of the following: (1) gave CPR with a C:V ratio of 30:2 with a maximum 10% deviation in the number of chest compressions (27–33), or (2) gave CPR in cycles of 2 min.
Figure 1. (A and B) Continuous ECG recordings. The duration of each row is 10 s. Compressions can be identified from the impedance trace, and are indicated with arrows and the << mark. The other trace represents the ECG. (A) shows the use of resuscitation Guidelines 2000. The ECG shows three stacked shocks of 200, 200 and 360 J, followed by 15 continuous chest compressions. (B) shows the use of resuscitation Guidelines 2005. The ECG shows a single shock of 200 J. The first of 30 continuous chest compressions are given within 5 s of the shock.

Results

Characteristics of study subjects

During the study period of 30 months, 2115 patients suffered an OHCA of presumed cardiac cause and underwent attempted resuscitation by EMS paramedics. We excluded 154 patients due to lack of a continuous ECG recording. Another 289 patients were excluded for various reasons (Figure 2). The clinical and operational characteristics of the patients in our study are shown in Table 2.

Guidelines usage

Of the 1672 analyzable ECGs, we found that 31 (2%) had been treated according to G1992, 826 patients (49%) according to G2000, 608 (36%) according to G2005 and 125 (7%) according to the intermediate Guideline (G2000 with a C:V ratio of 30:2). The Guideline protocol could not be identified for the remaining 81 (5%) patients; their resuscitations were classified as indeterminate. Figure 3 shows the percentage of patients in whom resuscitation was attempted according to G1992, G2000, G2005, intermediate Guideline and indeterminate protocol over the duration of the study. Before July 2006, more than 80% of patients were treated according to G2000. Beginning in May 2007, more than 80% of patients were treated according to G2005. The intermediate Guideline was mainly used from August 2006 until January 2007. The percentage of resuscitation attempts without an identifiable Guideline protocol was constant over time and never exceeded 10% of

<table>
<thead>
<tr>
<th>Variables</th>
<th>N=1672</th>
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<tbody>
<tr>
<td>Age, y, average ±SD</td>
<td>65 ±15</td>
</tr>
<tr>
<td>Male gender, n (%)</td>
<td>1236 (74)</td>
</tr>
<tr>
<td>Witnessed collapse, n (%)</td>
<td>1322 (79)</td>
</tr>
<tr>
<td>Bystander CPR, n (%)</td>
<td>1108 (66)</td>
</tr>
<tr>
<td>Location of collapse at home, n (%)</td>
<td>1193 (71)</td>
</tr>
<tr>
<td>Initial rhythm VF/VT, n (%)</td>
<td>875 (52)</td>
</tr>
</tbody>
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SD, standard deviation; CPR, cardiopulmonary resuscitation; VF, ventricular fibrillation; VT, ventricular tachycardia.

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Discussion

The major finding of this study is that it took one-and-a-half years to implement the 2005 resuscitation Guidelines in the Dutch EMS system, and reach a point where at least 80% of patients were being treated according to the new Guidelines. Several factors influenced the duration of this time interval. First, the translation of the Guidelines into Dutch could only be initiated after they had been officially published in December 2005. Second, the training of EMS personnel could only start after their protocols had been approved and issued by the Netherlands Ambulance Institute (December 2006). Third, the training of EMS personnel needed to be organized...
simultaneous with that of policemen and fire fighters, since they all were expected to apply the same protocol at the same time in the field. Once the training had started, it took 5 months for G2005 usage to increase from 20% to more than 80%.

A Norwegian study described that the Norwegian G2005 were implemented in Autumn 2006. However, the authors do not describe how implementation was defined or how Guideline compliance was verified. A Danish study surveyed via e-mail the extent of implementation of G2005 among medical emergency services. Some EMS services claimed to have implemented G2005 within six months, while other EMS services implemented G2005 during 2007.

Several studies claimed the G2005 were fully implemented as of a certain time point, but did not verify which Guideline the EMS personnel actually used to treat their patients. Our study clearly shows that there was not one single date at which the G2005 protocol could be considered implemented; some professional rescuers still applied G1992 8 years after the introduction of G2000.

**Protocol compliance**

Our study showed the transition between two Guidelines was associated with high protocol compliance. Ninety-five percent of all resuscitation attempts were executed according to one of the four Guidelines for at least 75% of the case duration; only 5% of the cases could not be categorized by usage of one specific Guideline protocol. This compares well to earlier published studies. Blunt trauma resuscitation protocol adherence showed a much lower percentage of 43%; the protocol compliance among EMS dispatchers was 52% of all cardiac arrest calls.

**How to improve the implementation process**

It takes about half a year to train all EMS personnel. It is not likely that this time period can be shortened. Making the protocols of national EMS authorities readily available shortly after publication of the ERC Guidelines 2010 could expedite the start of training. In order to expedite the publication of updated national protocols, the embargo until formal Guidelines publication on release of Guidelines changes to national translators, policy makers and educators should be abolished. By doing so, the national acceptance and translation process can take place before publication of the new Guidelines, and policy makers can clearly define the implementation process beforehand.

**Should Guidelines be revised every five years?**

The International Liaison Committee on Resuscitation (ILCOR) process of Consensus on Science and Treatment Recommendations, followed by the issue of new Guidelines by individual Councils, now iterates every 5 years. The time required for implementation takes a substantial part of the 5-year cycle. Changes are being discussed before existing Guidelines are fully implemented. The relatively short cycle prevents a full evaluation of the (beneficial or detrimental) effects of the existing Guidelines before changes are introduced. As a result, Guideline committees have too little time to determine if changes that are effective when studied separately are equally effective in concert with other changes. Moreover, rapid successions of Guidelines may negatively influence their acceptance in the field.

There is no optimal interval of revision of Guidelines. Our priority should be to improve implementation with proper evaluation of outcomes rather than to repeatedly introduce changes within short cycles. Of course, when new findings are truly compelling, advisory statements should swiftly be adapted. This would be more practical than revisions at fixed intervals. The issue of new Guidelines at the end of 2010 offers an opportunity to study the implementation process among all involved partners: lay rescuers, EMS and hospital personnel.

**Limitations**

A relatively large number of cases (22%) could not be analyzed for various reasons. The baseline characteristics of patients whose ECG could not be analyzed were similar to the patients analyzed in this study (data not shown).

The four-month delay observed in our study due to the need for translation does not apply to countries with English as the native language. We therefore expect the implementation process to be quicker in English speaking countries.

Our analysis only evaluated whether shocks and CPR were performed according to a specific Guideline. We were not able to document or analyze the medication therapy applied by the paramedics on scene. However, we found 95% protocol compliance (irrespective of whether the applied protocol matched the Guidelines for that time period), indicating the EMS paramedics consistently treated patients according to the Guidelines they were taught to use.

**Conclusion**

It takes one-and-a-half years to implement new resuscitation Guidelines in the Dutch EMS system. The half-year it takes to train all personnel is unavoidable. However, a one-year delay is avoidable by abolishing the embargo on release of Guidelines changes to translators and policy makers, and adjusting the publication date of the national EMS protocols to the publication date of the new resuscitation Guidelines.

**Acknowledgement**

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**References**


