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Quality and efficiency of bystander CPR

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Abstract

Incorrectly performed bystander CPR might compromise survival of the cardiac arrest patient. We therefore evaluated the outcome in 3306 out-of-hospital primary cardiac arrests of which 885 received bystander CPR. bystanders performed CPR correctly in 52%, incorrectly in 11%, 31% performed only external chest compressions (ECC) and 6% only mouth-to-mouth ventilation (MMV). The initial ECG in cases without bystander CPR was ventricular fibrillation in 28% (95% confidence interval: 27–30%); 45% (41–50%) and 39% (29–48%), respectively when bystander CPR was performed correctly or incorrectly; 43% (37–49%) when only ECC was applied and 22% (11–33%) when only MMV was practiced. Long term survival, defined as being awake 14 days after CPR, was 16% (13–19%) in patients with correct bystander CPR; 10% (7–14%) and 2% (0–9%), respectively when only ECC or only MMV was performed; 7% (6–8%) when no bystander was involved; 4% (0–8%) when bystander CPR

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was performed incorrectly. Bystander CPR might have a beneficial effect on survival by maintaining the heart in ventricular fibrillation by ECC. A negative effect of badly performed bystander CPR was not observed compared to cases which had not received bystander CPR.

Key words: Cardiac arrest; Outcome; bystander; CPR

1. Introduction

bystander CPR has been advocated as an important link in the chain of survival after out-of-hospital cardiac arrest [1]. Therefore, citizen-CPR training programs were organised in many countries and millions of people were trained in basic CPR. Quality control of the CPR training program and of the teaching performance of CPR instructors is difficult to achieve. In addition, retention of well trained CPR trainees decays rapidly after 1–2 years [2]. Despite the fact that literature provides information that bystander CPR is overall beneficial, one cannot exclude a harmful effect in case the bystander applied bad quality CPR. In this study we investigated retrospectively whether long-term survival was negatively influenced when bad quality bystander CPR was applied compared to cases where no bystander CPR was performed.

2. Methods

A detailed description of the applied methodology, the registration form and general results of the Belgian Cerebral Resuscitation Study Group were reported before [3]. Seven two-tiered emergency medical service teams, using a central telephone dispatch (dial '100') and mobile intensive care units (MICU), registered all cardiac arrest events during 1983–1989. The registration form was completed by a MICU nurse or physician as soon as possible after the resuscitation procedure. Only cases of out-of-hospital cardiac arrest, confirmed by ECG monitoring and where advanced life support was initiated, were included in the registration. In this analysis, only patients with an acute cardiac event as underlying disease and where it was known whether bystander was performed or not, were studied (n = 3306). The type of cardiac arrest on arrival of the MICU was classified as ventricular fibrillation (including ventricular tachycardia causing collapse), asystole or electromechanical dissociation (EMD). bystanders were identified as lay or as health care workers (e.g. general practitioners and nurses) and it was specified whether only external chest compressions, only mouth-to-mouth ventilation or both were performed, either correctly or incorrectly. Quality of bystander CPR was judged by observation of chest movements and by palpation of peripheral arteries during chest compression. The technique of CPR performance, compared to the Guidelines of American Heart Association, was judged subjectively by the MICU team on arrival. Quality of the CPR performance was recorded as: correct (good technique with good effect, good technique with weak effect) or incorrect (bad technique). A CPR attempt was considered as a failure if the patient died before hospital admission. Long term survival was defined as consciousness 14 days after the cardiac arrest event. Short term survival meant that the patient was admitted and had died within 14 days after the cardiac arrest or remained unconscious.

Table 1
Prevalence and quality of bystander CPR performed by layman and health care workers (HCW) in 885 cases of primary out-of-hospital cardiac arrest. The status of the bystander is not known in 27 cases (3%). (Chi-square: $P < 0.05$)

bystander CPR performance	Lay (%)	HCW (%)	Total (*n*)
Correct	42	58	448
Incorrect	20	6	96
Only ECC	26	33	263
Only MMV	11	3	51
Total	100 ($n = 326$)	100 ($n = 532$)	858

ECC, external chest compression; MMV, mouth-to-mouth ventilation.

Data are presented in frequency distributions with 95% confidence intervals. Mean values are not significantly different when confidence intervals overlap.

3. Results

bystander CPR was performed in 885 cases (27%) of the 3306 primary cardiac arrests registered (Table 1). Genuine laymen represented 37% of these interventions and health care workers 60%. The status of the bystander is unknown in 3% of cases. Health care workers were scored significantly more frequently to perform CPR correctly (58%) and to do only ECC (33%), and were scored less frequently to perform incorrect CPR (6%) and only MMV (3%) as compared to lay bystanders (respectively, 42, 26, 20 and 11%; Chi-square: $P < 0.05$).

When bystander CPR was performed correctly, 45% (41–50%) of the patients

Table 2
Type cardiac arrest on arrival of the mobile intensive care unit according to quality of bystander CPR. Data are expressed as percentages with 95% confidence intervals. Type of cardiac arrest is not known in 239 cases

bystander CPR performance	VF (%)	Asystole (%)	EMD (%)	Total (*n*)
Correct	45	47	8	453
	41–50	42–52	5–11	
Incorrect	39	57	4	98
	29–48	47–67	0–8	
Only ECC	43	46	11	265
	37–49	40–52	7–15	
Only MMV	22	72	6	50
	11–33	60–84	0–12	
No bystander CPR performed	28	62	10	2201
	27–30	60–64	9–11	

ECC, external chest compression; MMV, mouth-to-mouth ventilation.

Table 3
Type respiratory arrest (RA) on arrival of the mobile intensive care unit according to quality of bystander CPR. Data are expressed as percentages with 95% confidence intervals. Type of respiratory arrest is not known in 239 cases

bystander CPR performance	Complete RA (%)	Gasping (%)	Total (*n*)
Correct	73	27	452
	69–77	23–31	
Incorrect	86	14	97
	79–93	7–21	
Only ECC	76	24	265
	71–81	19–29	
Only MMV	84	16	51
	74–94	6–26	
No bystander CPR performed	83	17	2202
	81–85	16–19	

ECC, external chest compression; MMV, mouth-to-mouth ventilation.

were in ventricular fibrillation on arrival of the MICU (Table 2); when performed incorrectly 39% (29–48%). In cases where only ECC or only MMV was applied, this was, respectively 43% (37–49%) and 22% (11–33%). When no bystander CPR was performed, the prevalence was 28% (27–30%).

The type of respiratory arrest on arrival of the MICU was gasping in 27% (23–31%) when bystander CPR was performed correctly, 14% (7–21%) when performed incorrectly and, respectively 24% (19–29%) and 16% (6–26%) when only ECC or only MMV was applied (Table 3). In cases where no bystander CPR was performed this was 17% (16–19%).

Table 4
Outcome after out-of-hospital primary cardiac arrest according to quality of bystander CPR. Data are expressed as percentages with 95% confidence intervals. Outcome not known in 271 cases

bystander CPR performance	Not admitted (%)	STS (%)	LTS (%)	Total (*n*)
Correct	72	12	16	443
	68–76	9–15	13–19	
Incorrect	84	12	4	98
	77–91	6–19	0–8	
Only ECC	79	11	10	263
	74–84	7–14	7–14	
Only MMV	76	22	2	51
	64–88	10–33	0–9	
No bystander CPR performed	80	13	7	2180
	78–82	12–15	6–8	

ECC, external chest compression; MMV, mouth-to-mouth ventilation; STS, short-term survival; LTS, long-term survival.

Table 5
Outcome after out-of-hospital primary cardiac arrest in ventricular fibrillation according to quality of bystander CPR. Data are expressed as percentages with 95% confidence intervals. Outcome or type of cardiac arrest is not known in 114 cases

bystander CPR performance	No ROSC (%)	STS (%)	LTS (%)	Total (*n*)
Correct	52	18	31	188
	45–59	12–23	24–37	
Incorrect	71	21	8	38
	57–85	8–34	1–16	
Only ECC	68	12	20	113
	59–77	6–17	13–28	
Only MMV	45	45	9	11
	16–74	16–74	0–26	
No bystander CPR performed	61	24	15	615
	57–65	21–28	12–18	

ECC, external chest compression; MMV, mouth-to-mouth ventilation; STS, short-term survival; LTS, long-term survival; ROSC, restoration of spontaneous circulation.

Long term survival after out-of-hospital primary cardiac arrest was 16% (13–19%) when bystander CPR was performed correctly and 4% (0–8%) when performed incorrectly (Table 4). When only ECC or MMV was applied long-term survival was, respectively 10% (7–14%) and 2% (0–9%). When no bystander CPR was performed long-term survival was 7% (6–8%). In patients presenting with ventricular fibrillation on arrival of the MICU, long-term survival was 31% (24–37%) when bystander CPR was performed correctly, 8% (1–16%) when performed incorrectly and, respectively 20% (13–28%) and 9% (0–26%) when only ECC or only MMV was applied (Table 5). When no bystander intervened, long-term survival was 15% (12–18%).

4. Discussion

Outcome studies of out-of-hospital cardiac arrest demonstrate a beneficial effect of bystander CPR. This is especially the case in EMS systems where intervention times of the MICU team exceed 8 min [4,5]. Because of these epidemiologic data citizen-CPR has been promoted throughout the Western countries [1]. Despite intelligent teaching programs and intensive training courses long-term retention of basic CPR skills and knowledge is poor [2]. In addition, it is impossible to predict the behaviour and performance of a layman in case of emergency. Furthermore, one might assume that some bystanders do not perform CPR as prescribed by the American Heart Association criteria.

Few studies report on the quality of the bystander CPR performed [5,6]. The most obvious and probably the only possible method to collect sufficient data on the influence of bad quality bystander CPR on survival, is the retrospective analysis of cardiac arrest events. However, the registration of bystander CPR quality can be biased by the fact that at the moment of registration the status of the bystander and the

immediate outcome of the CPR attempt are known. As such, quality of bystander CPR during a successful CPR attempt might have been scored better than it was and vice versa in case of an unsuccessful attempt. Similarly, it might have been possible that CPR techniques of general practitioners were scored better than the performance of a genuine lay person. Another major methodological drawback is the fact that study groups might not be completely comparable. For example, it is known that cardiac arrest patients receiving bystander CPR have shorter intervention times and thus better chances to survive than patients not receiving bystander CPR [5].

Our data show that the majority of the bystanders are health care workers (nurses and general practitioners), which identifies these citizens as one of the primary target group for CPR training. When health care workers do not perform CPR correctly they mostly apply only ECC. Genuine lay bystanders perform less correct CPR compared to health care workers and more frequently apply only MMV. Patients who received correct bystander CPR have the highest prevalence of ventricular fibrillation and gasping on arrival of the MICU and have the best chance to survive. Whether this is due to the bystander CPR, the selection of patients or the bias induced by the status of the bystander or the immediate outcome of the CPR attempt or other factors, cannot be determined. It is more relevant to observe that long-term survival is not significantly different between those patients which received incorrect or incomplete bystander CPR and those which did not receive bystander CPR at all. This suggests that overall bad quality bystander CPR is probably not harmful for the patient.

The prevalence of ventricular fibrillation on arrival of the MICU might positively be influenced by applying only ECC, compared to cases where only MMV or incorrect CPR was applied. This is in accordance with the assumption of Kouwenhoven et al. in the early days of 'closed chest massage' that basic CPR maintains more patients in ventricular fibrillation [7]. Therefore, when mouth-to-mouth ventilation cannot be applied, it is advisible to perform at least external chest compressions while maintaining free airway to allow some ventilation of the lungs by changes in intrathoracic pressure.

5. References

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