 doi:10.20944/preprints202107.0447.v1

Article

Factors influencing physician decision making to attempt advanced resuscitation in asystolic out-of-hospital cardiac arrest

Charles Payot[1], Christophe A. Fehlmann[1, 2, 3], Laurent Suppan[1], Marc Niquille[1], Christelle Lardi[4], François P. Sarasin[1], Robert Larribau[1,*]

[1] Division of Emergency Medicine, Department of Anaesthesiology, Clinical Pharmacology, Intensive Care and Emergency Medicine, Geneva University Hospitals, Geneva, Switzerland
[2] School of Epidemiology and Public Health, University of Ottawa, K1G 5Z3 Ottawa, Ontario, Canada
[3] Ottawa Hospital Research Institute, ON K1Y 4E9 Ottawa, Ontario, Canada
[4] CURML, University Center of Legal Medicine, Geneva University Hospitals, Geneva, Switzerland

* Correspondence: robert.larribau@hcuge.ch ; Tel: 0041-79-553-94-00

Abstract: The objective of this study was to identify the key elements used by prehospital emergency physicians (EP) to decide whether or not to attempt advanced life support (ALS) in asystolic out-of-hospital cardiac arrest (OHCA). From 01.01.2009 to 01.01.2017, all adult victims of asystolic OHCA in Geneva, Switzerland, were retrospectively included. Patients with signs of "obvious death" or with a Do-Not-Attempt-Resuscitation order were excluded. Patients were categorized as having received ALS if this was mentioned in the medical record, or, failing that, if at least one dose of adrenaline had been administered during cardio-pulmonary resuscitation (CPR). Prognostic factors known at the time of EP's decision were included in a multivariable logistic regression model. 784 patients were included. Factors favourably influencing the decision to provide ALS were witnessed OHCA (OR=2.14, 95%CI:1.43–3.20) and bystander CPR (OR=4.10, 95%CI:2.28–7.39). Traumatic aetiology (OR=0.04, 95%CI:0.02–0.08), age >80 years (OR=0.14, 95%CI:0.09–0.24) and a Charlson comorbidity index greater than 5 (OR=0.12, 95%CI:0.06–0.27) were the factors most strongly associated with the decision not to attempt ALS. Factors influencing the EP's decision to attempt ALS in asystolic OHCA are the relatively young age of the patients, few comorbidities, presumed medical aetiology, witnessed OHCA and bystander CPR.

Keywords: out-of-hospital cardiac arrest; emergency physician; medical decision; asystole; advanced life support; Charlson comorbidity index; emergency medical service; prehospital emergency;

1. Introduction

When a patient suffers an out-of-hospital cardiac arrest (OHCA), healthcare professionals providing advanced life support (ALS) measures during the pre-hospital phase must take crucial decisions whilst in the field [1], notably when to provide prehospital ALS which is a real challenge [2 3].

Firstly, these professionals must decide whether or not to start resuscitation when it has not already been started by a bystander [3]. Secondly, elements related to the circumstances of the OHCA and the patient's wishes and clinical condition are collected, which may lead to a decision to stop resuscitation manoeuvres early [4]. Finally, in the case of prolonged asystole with more than 20 minutes of cardio-pulmonary resuscitation (CPR) without a treatable cause, they must decide whether or not it is possible to transport with on-going CPR [5-7].

Normally, without overt clinical signs of irreversible death (e.g., post-mortem lividity, rigor mortis, decapitation, decomposition), or (in Europe) a valid Do Not Attempt Resuscitation (DNAR) order, advanced life support (ALS) providers must initiate CPR [3]. There are local recommendations to guide emergency medical services (EMS) as to whether or not to start resuscitation for OHCA, but international guidelines have not yet been issued [8-10]. Some studies show

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 July 2021 doi:10.20944/preprints202107.0447.v1

that early CPR is less often initiated when the OHCA is not witnessed or when asystole is present, even in the absence of obvious signs of death or a DNAR order [11-13].
To avoid the futile transport of OHCA patients to hospital with virtually no chance of survival, the termination of resuscitation (TOR) rules are currently used as a guide for discontinuing CPR in the field. For ALS providers, these rules are based on the absence of five factors: OHCA witnessed by EMS personnel, shockable rhythm, return of spontaneous circulation (ROSC), OHCA witnessed by a bystander and bystander-administered CPR [14]. These TOR rules have been adapted to local conditions in different countries [15].
In Europe, and especially in the Franco-German EMS, prehospital EPs constitute the highest level of advanced life support providers, and they intervene with the ambulance team in the field [16 17]. In OHCA situations, these EPs provide advanced care to patients and make medical decisions (e.g., decision to stop CPR and declare death in the field) [18].
When in the field, the EPs may decide not to perform advanced resuscitation or to stop resuscitation early where an OHCA has occurred, especially when the initial rhythm is asystole. The factors that influence their decision to perform or not to perform advanced resuscitation in the field are not precisely known.
The objective of this study was to identify the key elements used by such EPs when deciding whether or not to attempt ALS manoeuvres in adult victims of OHCA whose initial rhythm was asystole.

2. Materials and Methods

This report follows the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) Statement guidelines for reporting cohort studies [19].

2.1. Study design and setting

This study was based on a retrospective analysis of the OHCA register in Geneva, Switzerland. It has been approved by the Geneva Cantonal Commission for Research and Ethics (identification no: 12-208-R). Patient consent was waived by this committee. Medical records were all computerized.
At the end of 2016, the permanent population residing in the Canton of Geneva was of almost 500'000 inhabitants; during daytime, this figure is increased by around 100'000 daily commuters from France and other Swiss cantons. The emergency medical communication centre (EMCC) centralizes all requests related to prehospital medical emergencies, including OHCA. In Geneva's EMCC, dispatchers have a paramedical or nursing background and coordinate emergency mobile units remotely by sending appropriate response teams.
In the canton of Geneva, the EMS is two-tiered (or three) with different medical levels and skill sets. The first level is made up of emergency ambulances, staffed by two ALS-trained paramedics. There are fifteen ambulance bases scattered throughout the Canton of Geneva that operate according to the proximity of the base to the scene of the emergency. The second level is made up of a Mobile Emergency and Resuscitation Service or SMUR *(Service Mobile d'Urgence et de Réanimation)*, a light vehicle that operates with a certified paramedic and an EP in training (junior or intermediate) whose background and level of expertise can vary, but who has at least 2 years of experience [20]. If necessary, specialist senior EPs are available 24 hours a day to intervene on site (third level), for example in the event of a difficult intubation, a refractory OHCA or if the junior EP is already busy with another emergency event [21]. To improve their skills and knowledge, these junior EPs follow a number of internal courses, including resuscitation simulation. Official training courses such as the Advanced Cardiovascular Life Support (ACLS) are not mandatory but highly recommended. Senior EPs review all EMS intervention reports daily for teaching and quality control purposes.

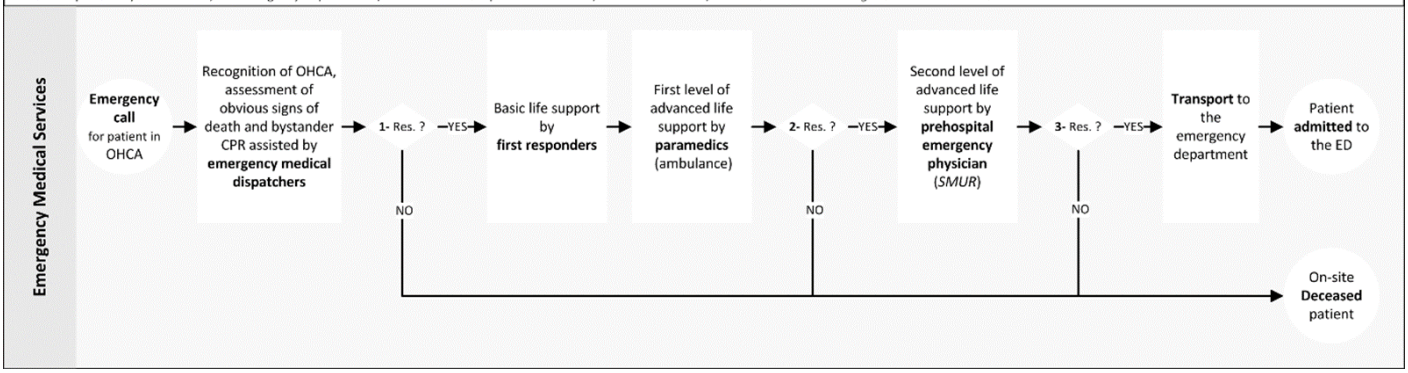
2.2. Prehospital management of OHCA and decisions

There are three decision points during the management of an OHCA in Geneva (Figure 1). Decisions at points 2 and 3 are made by the attending EP. The EP has no specific guidelines imposed on him/her when making decisions not to start or to withhold CPR. The TOR guidelines for ALS are not applied in Geneva regarding decision point number 3 (before transport)

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 July 2021 doi:10.20944/preprints202107.0447.v1

Figure 1: Geneva process for the management of out-of-hospital cardiac arrets and decision points

CPR: Cardio-pulmonary resuscitation; ED: Emergency Departement; OHCA : Out-of-hospital cardiac arrest; Res. : Resuscitation; *SMUR : Service mobile d'urgence et de réanimation*



2.3. Study population

The medical records, of all patients for whom an emergency call for OHCA was received by the EMCC between 01.01.2009 and 01.01.2017, were screened. Patients were eligible for inclusion if they presented a confirmed OHCA case in the Canton of Geneva and had been taken care of by the *SMUR*. Patients were then excluded if they were not in asystole, presented obvious signs of death (*post-mortem* lividity, rigor mortis or life-incompatible injury), had a DNAR order, or were younger than 16.

2.4. Variables

The outcome was the medical decision to perform an advanced resuscitation. Therefore, a patient in whom we decided not to start ALS or where we decided to stop very early (after receiving information regarding the patient's wishes, clinical condition and the circumstances of the OHCA) were considered not to have the outcome.

Indeed, early administration of adrenaline is recommended by the ACLS guidelines [6]. The medical decision not to resuscitate was defined as the mention in the intervention report, of abstention from CPR, or non-use of intravenous adrenaline in the absence of return of spontaneous circulation (ROSC). Therefore, we considered that the EP did not intend to provide advanced resuscitation if resuscitation was stopped prior to the administration of the first dose of adrenaline.

Factors that may influence the medical decision to perform advanced resuscitation have been identified on the basis of a conceptual framework. These factors were included only if they were known by the EP at the time the decision was made. For patients, the factors included were sex, age, co-morbidities and the presumed aetiology of OHCA. The presumed aetiologies were classified (according to Utstein 2015) as medical (cardiac and non-cardiac), traumatic, asphyxia and unknown [22]. Patient co-morbidities were defined by the Charlson Comorbidity Index (CCI) which was collected retrospectively in a pre-hospital chart review [23]. With regard to the circumstances of the OHCA, the presence (or absence) of witnesses at the time of the cardiac arrest and the CPR performed (or not) by bystanders was also considered. For ALS providers, we took into account the response time of the first team in the field, the gender and the experience of the lead pre-hospital physician. EP's experience was defined as "junior" (less than 5 years of medical residency), "intermediate" (specialist certification or more than 5 years medical residency, without a supervisory role) or "senior" (prehospital specialist EP with a supervisory role in the prehospital unit).

2.5. Statistical analysis

Statistical analysis was performed using STATA version 16 (Stata Corporation, College Station, TX, USA).

Patients' characteristics are expressed as means ± standard deviation for continuous variables and as frequency and relative percentage for categorical variables. Comparisons between groups were performed using Student *t*-test or chi-2 test, as appropriate. Bivariate logistic regression analysis was used to study the different associations. We then built a multivariable logistic regression model, including our pre-specified factors, and reporting the full model, even if some factors were not statistically significant. Continuous variables were categorized if the linearity of the log-odds was not respected, based on previously used categories. Collinear variables were excluded from the model. The "goodness of fit" to the model was checked globally using the Hosmer-Lemeshow test.

We performed three pre-specified sensitivity analyses. In the first case, the outcome was defined only based on the mention of "abstention of resuscitation", without taking into account adrenaline use. In the second case, the cut-off used to determine the "intermediate" level of experience was lowered from 5 to 3 years. Finally, we excluded patients with a presumed non-medical OHCA aetiology.

Missing values were reported as such and coded as "unknown"; no multiple imputations were performed. Based on the estimation that the decision not to perform resuscitation occurs in about 20% of OHCA, 500 patients would have

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 July 2021 doi:10.20944/preprints202107.0447.v1

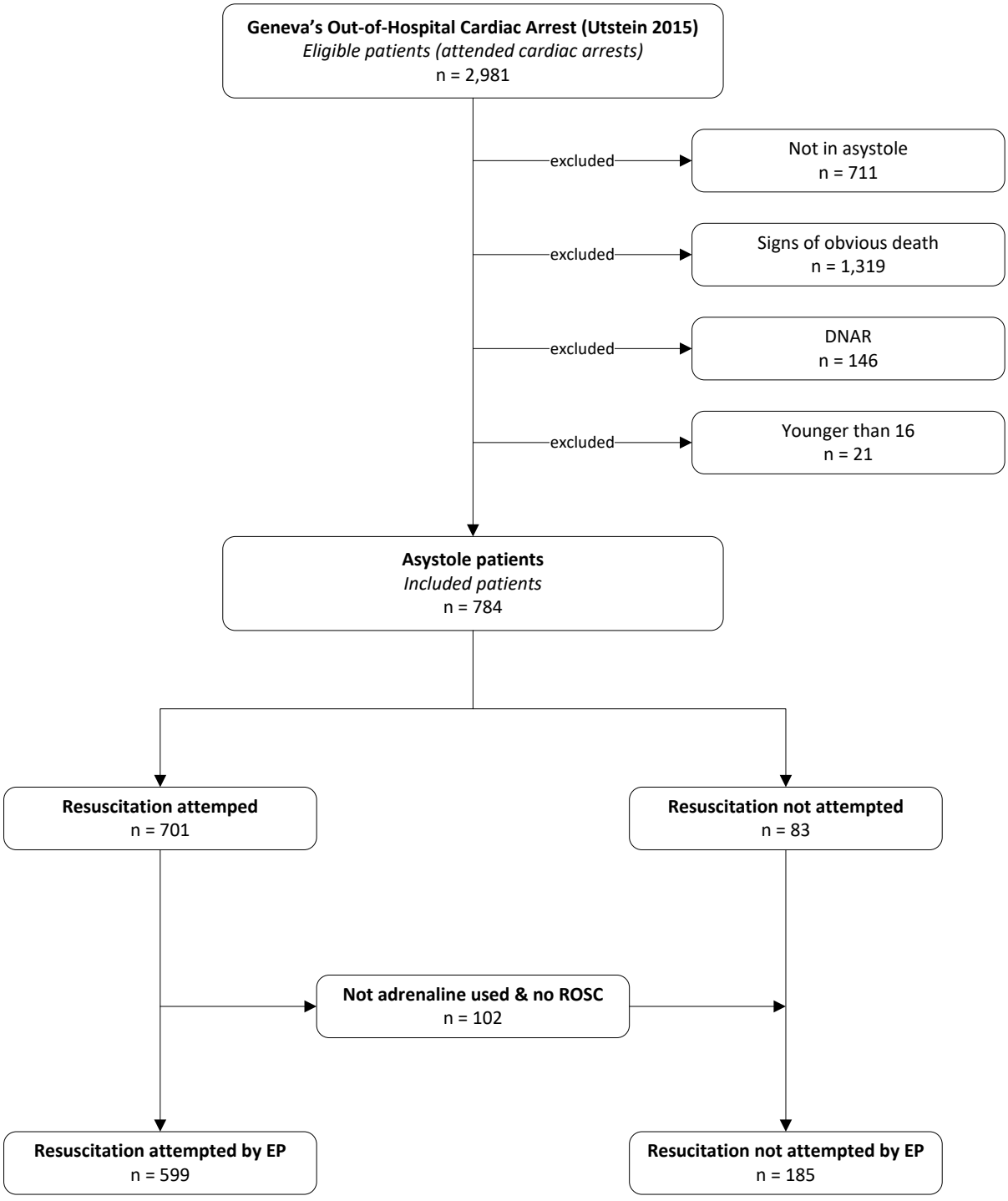
been needed to adjust for 10 potential predictors. Based on the estimated average of 80 potential patients a year, an 8 year-period was considered for this study. For all tests, a two-sided p-value below 0.05 was considered significant.

2.6. Patients and public involvementPatients and the public were not involved in the design or planning of the study.

3. Results

2'981 OHCA patients were considered for inclusion. The two most frequent exclusion criteria were the presence of obvious signs of death (n=1'319) and an initial rhythm other than asystole (n=711). Finally, 784 patients were included in the analysis (figure 2).

Figure 2: Flowchart of the study



Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 July 2021 doi:10.20944/preprints202107.0447.v1

The exact arrival times of the ambulance crew and the *SMUR* team on site were reported in 644 (82.1%) of the 784 OHCA cases included. The average response time of the EMS was 9'32'' (±4'00''). The first team on site was the ambulance crew in 527 (81.8%) OHCA cases, while it was the *SMUR* team in 74 (11.5%) OHCA cases. In 43 (6.7%) OHCA cases, both teams arrived on site at the same time. In the 74 situations where the SMUR team arrived on the scene before the ambulance crew, the SMUR team arrived on average 2'08" (±3'00") before the ambulance crew. The rate of patients resuscitated was the same regardless of which team arrived first on site (p = 0.225).

Table 1 presents the patients' characteristics. The patients were mostly men. The mean age was 66.9 (SD=18.1) years. More than half of the patients did not have any known comorbidity. Half of the OHCA were of an unknown presumed aetiology and an equivalent proportion occurred in the presence of witnesses. CPR manoeuvres were performed by bystanders in less than one out of four patients. Out of the 784 patients, a decision to not attempt advanced resuscitation was taken for 185 (23.6%) of them (figure 2). These patients were older than those in whom resuscitation was initiated, had more comorbidities, and their presumed OHCA aetiology was more frequently traumatic or unknown. Their OHCA was less likely to have been witnessed and CPR was provided less often prior to the arrival of the EMS team. There was no difference associated with either the sex or the experience of the lead physician.

Table 1: Patients characteristics

	Total	**Resuscitation attempted by EP**	**Resuscitation not attempted by EP**	**P-Value[2]**
	n = 784	**n = 599**	**n = 185**	
Patient's sex (male), n (%[1])	496 (63.3)	392 (65.4)	104 (56.2)	**0.023**
Patient's age (years), mean ±SD	66.9 (±18.1)	64.6 (±17.6)	74.4 (±17.8)	**< 0.001**
Charlson Comorbidity Index, n (%[1])				
0	427 (54.5)	341 (56.9)	86 (46.5)	**0.001**
1 - 2	277 (35.3)	210 (35.1)	67 (36.2)	
3 - 4	38 (4.9)	26 (4.3)	12 (6.5)	
5+	42 (5.4)	22 (3.7)	20 (10.8)	
Presumed aetiology, n (%[1])				
Medical (cardiac and non-cardiac)	256 (32.7)	218 (36.4)	38 (20.5)	**0.001**
Trauma	51 (6.5)	20 (3.3)	31 (16.8)	
Asphyxiation (external causes)	40 (5.1)	35 (5.8)	5 (2.7)	
Unknown	437 (55.8)	326 (54.4)	111 (60.0)	
Witnessed arrest (yes), n (%[1])	415 (52.9)	337 (56.3)	78 (42.2)	**0.001**
Bystander CPR (yes), n (%[1])	187 (23.9)	169 (28.2)	18 (9.7)	**< 0.001**
EMS response time (min), mean ±SD	9.2 (±4.3)	9.2 (±4.1)	9.3 (±4.8)	0.869
EMS response time, n (%[1])				
0-2 min	24 (3.1)	14 (2.3)	10 (5.4)	0.305
2-6 min	100 (12.8)	79 (76.4)	21 (11.4)	

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 July 2021 doi:10.20944/preprints202107.0447.v1

6-9 min	274 (35.0)	212 (35.4)	62 (33.5)	
9-12 min	200 (25.5)	149 (24.9)	51 (27.6)	
12-25 min	128 (16.3)	98 (16.4)	30 (16.2)	
> 25 min	9 (1.2)	6 (1.0)	3 (1.6)	
Missing	49 (6.4)	41 (6.8)	8 (4.3)	
Lead physician's sex (male), n (%[1])	488 (62.2)	373 (62.3)	115 (62.2)	0.979
Lead physician's experience, n (%[1])				
Junior	456 (58.2)	353 (58.9)	103 (55.7)	
Intermediate	220 (28.1)	160 (26.7)	60 (32.4)	0.282
Senior	108 (13.8)	86 (14.4)	22 (11.9)	

[1] *Percentages may not total 100 due to rounding. All variables given as numbers (column percentages in parenthesis)*

[2] *Based on Student T- test or chi-squared test as appropriate*

SD: Standard Deviation; CPR: Cardiopulmonary resuscitation; EMS: Emergency Medical System.

Table 2 presents the unadjusted and adjusted associations. In the univariate analysis, the factors associated with the decision to attempt advanced resuscitation were sex (male), younger age, few comorbidities, presumed medical aetiology, witnessed arrest and bystander CPR. In our multivariable model, factors favourably influencing the decision to provide ALS by the prehospital EP were young age, low CCI, presumed medical aetiology, witnessed out-of-hospital cardiac arrest and bystander CPR.

Table 2: Univariable and multivariable logistic regression

Variables	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Patient's sex (male)	**1.47 [1.05 - 2.06]**	1.15 [0.77-1.72]
Patient's age (years)		
18 - 64	Ref.	Ref.
65 - 79	0.69 [0.44 - 1.07]	**0.52 [0.32 - 0.89]**
≥ 80	**0.24 [0.16 - 0.36]**	**0.14 [0.09 - 0.24]**
Charlson Comorbidity Index		
0	Ref.	Ref.
1 - 2	0.79 [0.55 - 1.14]	**0.57 [0.36 - 0.89]**
3 - 4	0.55 [0.26 - 1.13]	**0.41 [0.17 - 0.95]**
5+	**0.28 [0.14 - 0.53]**	**0.12 [0.06 - 0.27]**
Presumed aetiology		
Medical (cardiac and non-cardiac)	Ref.	Ref.
Trauma	**0.11 [0.06 - 0.22]**	**0.04 [0.02 - 0.08]**
Asphyxiation (external causes)	1.22 [0.45 - 3.31]	0.75 [0.25 - 2.26]
Unknown	**0.51 [0.34 - 0.77]**	**0.55 [0.35 - 0.87]**

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 July 2021 doi:10.20944/preprints202107.0447.v1

Witnessed arrest (yes)		**1.76 [1.26 - 2.46]**	**2.14 [1.43 - 3.20]**
Bystander CPR (yes)		**3.65 [2.17 - 6.12]**	**4.10 [2.28 - 7.39]**
EMS response time			
	0-2 min	Ref.	Ref.
	2-6 min	**2.69 [1.05 - 6.90]**	2.00 [0.63-6.35]
	6-9 min	**2.44 [1.03 - 5.70]**	1.91 [0.65-5.56]
	9-12 min	2.09 [0.87 - 4.90]	1.48 [0.5-4.40]
	12-25 min	2.33 [0.94 - 5.70]	1.86 [0.6-5.78]
	> 25 min	1.43 [0.29 - 7.10]	1.14 [0.16-8.03]
	Missing	**3.66 [1.21 - 11.10]**	1.95 [0.51-7.51]
Lead physician's sex (male)		1.00 [0.72 - 1.41]	0.99 [0.67-1.47]
Lead physician's experience			
	Junior	Ref.	Ref.
	Intermediate	0.78 [0.54 - 1.13]	0.83 [0.54-1.28]
	Senior	1.14 [0.68 - 1.91]	1.31 [0.71-2.41]

Logistic regression: OR > 1 : In favour of performing advanced life support

OR: Odds Ratios; CI: Confidence Interval; CPR: Cardiopulmonary resuscitation; EMS: Emergency Medical System; EP: Emergency Physician.

The Hosmer Lemeshow test (Chi2=8.92, p= 0.349) validates the multivariate logistic regression model goodness of fit. Finally, the three pre-specified sensitivity analyses did not substantially affect the results.

4. Discussion

In OHCA cases with asystole as initial rhythm, we observed that age less than 65 years, absence of co-morbidities, presumed medical aetiology, witnessed OHCA and bystander CPR were independent predictors that favourably influenced the prehospital EP's decision to attempt advanced resuscitation.

These results are consistent in many respects with a recent Austrian study which showed that resuscitation is unlikely to be initiated by the EP if patients are in asystole, elderly, have significant comorbidities such as malignancy or have not received CPR prior to the EP's arrival [24]. In Geneva, there was no association with EMS response time, but this may be explained by the very short response times in Geneva, whose area is more limited than that of the Graz region in Austria. The variable "first on the scene" was not included in the multivariable model because the differences in response time between the *SMUR* team and the ambulance crew are extremely small and not significant. These differences in response times between the EP and the ambulance crew were not published in the Austrian study and it is therefore difficult to compare with them in this respect. The very short response time of the Geneva EMS may also explain why the Geneva EP attempts ALS in 76.4% of asystolic OHCAs, whereas the Austrian EP only attempts ALS in 62% of asystolic OHCAs.

Another study also showed that old age, previous poor health and lack of CPR initiation influenced the EP's decision not to initiate advanced resuscitation [25]. These results are also consistent with current knowledge about prognostic factors in OHCA. Advanced age [26], a high number of comorbidities [27], a non-witnessed OHCA, absence of bystander administered CPR [28] and traumatic aetiology are indeed well known to reduce survival rates after an OHCA [29]. These medical decisions not to attempt advanced resuscitation, made on the basis of knowledge of poor prognostic factors, are also consistent with decisions made when a physician believes that the prognosis is very poor and that further treatment would be futile [30]. In the emergency department, the main factors influencing the decision not to

provide resuscitative care are old age and previous severe functional limitations [31]. It is therefore reassuring that EPs are making decisions consistent with knowledge of the prognostic factors associated with OHCA.

In this study, we measured the CCI retrospectively for each patient, based on a systematic review of medical records. Although this may be considered a limitation, the influence of patients' comorbidities on the medical decision to attempt ALS has been reported infrequently in the literature. However, we found that the presence of comorbidities does seem to influence this decision. Ideally, comorbidities should be systematically documented, as well as their relationship to medical decision making. Another way to achieve this could be the prospective integration of a frailty score, such as the Clinical Frailty Scale (CFS) developed by Rockwood [32]. This tool, which has been shown to be relevant for the limitation of life-sustaining treatment in the ICU [33], could be included as a core variable in the Utstein resuscitation registry template [22].

We deliberately limited the scope of this study to asystole situations, as we assumed that advanced resuscitation was routinely provided when a shockable rhythm or pulseless electrical activity was noted on the EPs arrival at the emergency site. This may be debatable, especially in situations of pulseless electrical activity, which may not be resuscitated in real life. However, the recent Austrian study shows that when an electrical rhythm is present on the electrocardiogram, the EP tends to systematically provide advanced life support [24].

When the EP is confronted with an OHCA, a time delay is required to gather the information necessary to make a decision. When BLS is in progress, the EP will not interrupt it, and may even start ALS, whilst looking for futility criteria at the same time. This is rarely documented in the medical records and is not one of the variables to be collected in the Utstein resuscitation registry template [22]. For this reason, we chose the criterion of "non-use of intravenous epinephrine in asystole" to ascertain the lack of intent to provide ALS as it can easily and reliably be measured retrospectively. The intention to initiate ALS and the intention to transport under ongoing CPR, after ALS has been delivered at the emergency site, are two temporally successive decision points. Advanced TOR rules have been proposed to avoid patient transport whilst under continuous CPR, especially when there is no EP present who can intervene in the field and decide to stop ALS [14]. There are no rules on which advanced care providers can base a decision to withhold giving ALS, and recognition of early criteria for futility, such as post-mortem lividity, can be difficult.. Knowledge of the factors on which EPs make these decisions, and the relevance of these criteria, are therefore the first steps in developing decision support tools in this area. These tools could be very useful in helping EPs when taking a decision not to attempt ALS in futile situations [34].

The standardized description of the OHCA care process (figure 1) in business process model and notation (BPMN) [35] makes it possible to highlight the three successive decision points of the pre-hospital phase in Geneva. The second decision point (decision to attempt ALS) is very important because in general, the proportion of survivors at discharge (or at 30 days) are measured against this decision point, so the better the selection of patients for whom ALS is performed, the better the final survival rate. Although this variable is not reported in the Utstein resuscitation registry template, the rate of ALS is likely to be lower when an EP is dispatched to the field to make this decision. As a result, the patient survival rate at discharge who have received ALS is likely to be better in these systems than in systems where this decision cannot be made in the field. This has already been demonstrated with the implementation of the TOR rules for the third decision point [36].

In the pre-hospital setting, medical decisions to withhold and withdraw care are therefore common [37]. Unfortunately, these decisions are often made by emergency physicians alone in the field [25]. A previous study showed also that less trained clinicians tended to forego care in emergency departments more often than physicians with more years of training [38]. However, in our study, we did not observe any difference in the number of years of medical residency regarding decision making. This could be explained by our set-up, where senior physicians readily support EPs in training, either directly in the field or by phone. EPs in training can therefore always count on the support of a senior physician when making the decision as to whether or not advanced resuscitation should be attempted. Another explanation could be the ethics and decision-making training provided early-on during pre-graduate studies and medical residency in Switzerland.

This study has several limitations. Indeed, it is a retrospective and monocentric study, with all the limitations associated with its study design. Moreover, the canton of Geneva is small and essentially urban, so the generalisation is limited to similar territories, in particular with regard to response times. Finally, it is an emergency medical system where ALS is provided by paramedics and, in addition, where an EP can be dispatched to the field. Few emergency medical systems are comparable to Geneva's emergency medical systems. The observation period is eight years; it is possible that changes in decision making during this period are not taken into account. We should also note that the criterion of "no use of intravenous (or intraosseous) epinephrine in situations" as a definition of no intention to provide ALS may be questionable. A bias may have been created by the fact that EPs reported more comorbidities in the medical records when making the decision not to initiate ALS, in an attempt to justify it.

These results deserve to be confronted with a future study that would prospectively measure whether EPs who make these decisions do so both ethically and appropriately. Patient survival (at hospital discharge or at 30 days), based on the decision criteria identified here, and where ALS care was provided, should be measured, as has already been done for TOR rules in 2006 [14].

5. Conclusions

An EP attempts ALS in more than three quarters of OHCA cases with an initial rhythm of asystole. The factors that favourably influence the EP's decision to attempt ALS are Age under 65 years, absence of comorbidities, presumed medical aetiology, witnessed OHCA and bystander CPR. The factors most strongly associated with the medical decision not to attempt ALS are traumatic aetiology, aged over 80 years and a CCI greater than 5.
The medical decision whether or not to attempt ALS should be routinely reported in the Utstein resuscitation registry OHCA template, at least in emergency medical systems using a prehospital EP.
Future studies are needed to prospectively measure whether EPs who make these decisions in the field are doing so both ethically and appropriately.

Author Contributions: Conceptualization, C. Payot and R. Larribau; methodology, C. Payot, CA. Fehlmann, R. Larribau; validation, FP. Sarasin, R. Larribau; formal analysis, CA. Fehlmann, R. Larribau; investigation, C. Payot, Larribau; data curation, C. Payot, CA. Fehlmann, L. Suppan, M. Niquille, R. Larribau; ressources, R.Larribau, M. Niquille ; writing – original draft, C. Payot, CA. Fehlmann, R. Larribau; writing – review & editing, C. Payot, CA. Fehlmann, L. Suppan, M. Niquille, C. Lardi, FP. Sarasin, R. Larribau ; validation, FP. Sarasin, R. Larribau; project administration, R. Larribau; All authors have read and agreed to the published version of the manuscript

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Geneva Cantonal Research and Ethics Commission on 27.09.2012, amended on 12.05.2018 (identification number: PB-12-208-R).

Informed Consent Statement: The Geneva Cantonal Research and Ethics Commission considered that the patient's consent could not be obtained and was not necessary for the study

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: We would like to acknowledge assistance provided by Jane Schurtz-Taylor with the English translation.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Anderson NE, Gott M, Slark J. Commence, continue, withhold or terminate?: a systematic review of decision-making in out-of-hospital cardiac arrest. European journal of emergency medicine : official journal of the European Society for Emergency Medicine 2017;**24**(2):80-86 doi: 10.1097/mej.0000000000000407[published Online First: Epub Date]|.
2. Anderson NE, Slark J, Gott M. Prehospital Resuscitation Decision Making: A model of ambulance personnel experiences, preparation and support. Emergency medicine Australasia : EMA 2021 doi: 10.1111/1742-6723.13715[published Online First: Epub Date]|.
3. Mancini ME, Diekema DS, Hoadley TA, et al. Part 3: Ethical Issues. 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care 2015;**132**(18 suppl 2):S383-S96 doi: 10.1161/cir.0000000000000254[published Online First: Epub Date]|.
4. Bossaert LL, Perkins GD, Askitopoulou H, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 11. The ethics of resuscitation and end-of-life decisions. Resuscitation 2015;**95**:302-11 doi: http://dx.doi.org/10.1016/j.resuscitation.2015.07.033[published Online First: Epub Date]|.
5. Panchal AR, Bartos JA, Cabañas JG, et al. Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2020;**142**(16_suppl_2):S366-s468 doi: 10.1161/cir.0000000000000916[published Online First: Epub Date]|.

6. Soar J, Nolan JP, Böttiger BW, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult advanced life support. Resuscitation 2015;**95**:100-47 doi: http://dx.doi.org/10.1016/j.resuscitation.2015.07.016[published Online First: Epub Date]|.
7. Embong H, Md Isa SA, Harunarashid H, et al. Factors associated with prolonged cardiopulmonary resuscitation attempts in out-of-hospital cardiac arrest patients presenting to the emergency department. Australasian emergency care 2020 doi: 10.1016/j.auec.2020.08.001[published Online First: Epub Date]|.
8. Patel F. Recognition of life extinct (ROLE)--multidiscipline role of healthcare professionals. Journal of forensic and legal medicine 2008;**15**(6):359-62 doi: 10.1016/j.jflm.2008.01.006[published Online First: Epub Date]|.
9. Lockey AS. Recognition of death and termination of cardiac resuscitation attempts by UK ambulance personnel. Emergency medicine journal : EMJ 2002;**19**(4):345-7 doi: 10.1136/emj.19.4.345[published Online First: Epub Date]|.
10. Jones T, Woollard M. Paramedic accuracy in using a decision support algorithm when recognising adult death: a prospective cohort study. Emergency medicine journal : EMJ 2003;**20**(5):473-5 doi: 10.1136/emj.20.5.473[published Online First: Epub Date]|.
11. Rajagopal S, Kaye CR, Lall R, et al. Characteristics of patients who are not resuscitated in out of hospital cardiac arrests and opportunities to improve community response to cardiac arrest. Resuscitation 2016;**109**:110-15 doi: 10.1016/j.resuscitation.2016.09.014[published Online First: Epub Date]|.
12. Kämäräinen A, Virkkunen I, Yli-Hankala A, et al. Presumed futility in paramedic-treated out-of-hospital cardiac arrest: an Utstein style analysis in Tampere, Finland. Resuscitation 2007;**75**(2):235-43 doi: 10.1016/j.resuscitation.2007.04.011[published Online First: Epub Date]|.
13. Nickel D. Attitude face à la fin de vie et à la mort Académie Suisse des Sciences Médicales (ASSM) 2018
14. Morrison LJ, Visentin LM, Kiss A, et al. Validation of a rule for termination of resuscitation in out-of-hospital cardiac arrest. The New England journal of medicine 2006;**355**(5):478-87 doi: 10.1056/NEJMoa052620[published Online First: Epub Date]|.
15. Ebell MH, Vellinga A, Masterson S, et al. Meta-analysis of the accuracy of termination of resuscitation rules for out-of-hospital cardiac arrest. Emergency medicine journal : EMJ 2019;**36**(8):479-84 doi: 10.1136/emermed-2018-207833[published Online First: Epub Date]|.
16. Javaudin F, Penverne Y, Montassier E. Organisation of prehospital care: the French experience. European journal of emergency medicine : official journal of the European Society for Emergency Medicine 2020;**27**(6):404-05 doi: 10.1097/mej.0000000000000770[published Online First: Epub Date]|.
17. Larribau R, Deham H, Niquille M, et al. Improvement of out-of-hospital cardiac arrest survival rate after implementation of the 2010 resuscitation guidelines. PloS one 2018;**13**(9):e0204169 doi: 10.1371/journal.pone.0204169[published Online First: Epub Date]|.
18. Chappuis VN, Deham H, Cottet P, et al. Emergency physician's dispatch by a paramedic-staffed emergency medical communication centre: sensitivity, specificity and search for a reference standard. Scandinavian journal of trauma, resuscitation and emergency medicine 2021;**29**(1):31 doi: 10.1186/s13049-021-00844-y[published Online First: Epub Date]|.
19. Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Journal of clinical epidemiology 2008;**61**(4):344-9 doi: 10.1016/j.jclinepi.2007.11.008[published Online First: Epub Date]|.
20. Suppan L, Chan M, Gartner B, et al. Evaluation of a Prehospital Rotation by Senior Residents: A Web-Based Survey. Healthcare (Basel, Switzerland) 2020;**9**(1) doi: 10.3390/healthcare9010024[published Online First: Epub Date]|.
21. Chan M, Fehlmann CA, Pasquier M, et al. Endotracheal Intubation Success Rate in an Urban, Supervised, Resident-Staffed Emergency Mobile System: An 11-Year Retrospective Cohort Study. J Clin Med 2020;**9**(1):238 doi: 10.3390/jcm9010238[published Online First: Epub Date]|.

22. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Circulation 2015;**132**(13):1286-300 doi: 10.1161/cir.0000000000000144[published Online First: Epub Date]|.
23. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of chronic diseases 1987;**40**(5):373-83 doi: 10.1016/0021-9681(87)90171-8[published Online First: Epub Date]|.
24. Zajic P, Zoidl P, Deininger M, et al. Factors associated with physician decision making on withholding cardiopulmonary resuscitation in prehospital medicine. Scientific reports 2021;**11**(1):5120 doi: 10.1038/s41598-021-84718-4[published Online First: Epub Date]|.
25. Duchateau FX, Burnod A, Ricard-Hibon A, et al. Withholding advanced cardiac life support in out-of-hospital cardiac arrest: a prospective study. Resuscitation 2008;**76**(1):134-6 doi: 10.1016/j.resuscitation.2007.06.018[published Online First: Epub Date]|.
26. Huang JB, Lee KH, Ho YN, et al. Association between prehospital prognostic factors on out-of-hospital cardiac arrest in different age groups. BMC emergency medicine 2021;**21**(1):3 doi: 10.1186/s12873-020-00400-4[published Online First: Epub Date]|.
27. Andrew E, Nehme Z, Bernard S, et al. The influence of comorbidity on survival and long-term outcomes after out-of-hospital cardiac arrest. Resuscitation 2017;**110**:42-47 doi: 10.1016/j.resuscitation.2016.10.018[published Online First: Epub Date]|.
28. Ono Y, Hayakawa M, Iijima H, et al. The response time threshold for predicting favourable neurological outcomes in patients with bystander-witnessed out-of-hospital cardiac arrest. Resuscitation 2016;**107**:65-70 doi: 10.1016/j.resuscitation.2016.08.005[published Online First: Epub Date]|.
29. Evans CC, Petersen A, Meier EN, et al. Prehospital traumatic cardiac arrest: Management and outcomes from the resuscitation outcomes consortium epistry-trauma and PROPHET registries. The journal of trauma and acute care surgery 2016;**81**(2):285-93 doi: 10.1097/ta.0000000000001070[published Online First: Epub Date]|.
30. Ferrand E, Robert R, Ingrand P, et al. Withholding and withdrawal of life support in intensive-care units in France: a prospective survey. French LATAREA Group. Lancet (London, England) 2001;**357**(9249):9-14 doi: 10.1016/s0140-6736(00)03564-9[published Online First: Epub Date]|.
31. Le Conte P, Riochet D, Batard E, et al. Death in emergency departments: a multicenter cross-sectional survey with analysis of withholding and withdrawing life support. Intensive care medicine 2010;**36**(5):765-72 doi: 10.1007/s00134-010-1800-1[published Online First: Epub Date]|.
32. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne 2005;**173**(5):489-95 doi: 10.1503/cmaj.050051[published Online First: Epub Date]|.
33. Guidet B, Flaatten H, Boumendil A, et al. Withholding or withdrawing of life-sustaining therapy in older adults (≥80 years) admitted to the intensive care unit. Intensive care medicine 2018;**44**(7):1027-38 doi: 10.1007/s00134-018-5196-7[published Online First: Epub Date]|.
34. Druwé P, Monsieurs KG, Gagg J, et al. Impact of perceived inappropiate cardiopulmonary resuscitation on emergency clinicians' intention to leave the job: Results from a cross-sectional survey in 288 centres across 24 countries. Resuscitation 2021;**158**:41-48 doi: 10.1016/j.resuscitation.2020.10.043[published Online First: Epub Date]|.

35. Mincarone P, Leo CG, Trujillo-Martín MDM, et al. Standardized languages and notations for graphical modelling of patient care processes: a systematic review. International journal for quality in health care : journal of the International Society for Quality in Health Care 2018;**30**(3):169-77 doi: 10.1093/intqhc/mzx197[published Online First: Epub Date]|.

36. Clemency BM, Innes JC, Waldrop M, et al. Changes in Field Termination of Resuscitation and Survival Rates After an Educational Intervention to Promote on Scene Resuscitation for Out-of-Hospital Cardiac Arrest. The Journal of emergency medicine 2021;**60**(3):349-54 doi: 10.1016/j.jemermed.2020.10.003[published Online First: Epub Date]|.

37. Ferrand E, Marty J. Prehospital withholding and withdrawal of life-sustaining treatments. The French LATASAMU survey. Intensive care medicine 2006;**32**(10):1498-505 doi: 10.1007/s00134-006-0292-5[published Online First: Epub Date]|.

38. Richardson PG, Greenslade J, Isoardi J, et al. End-of-life issues: Withdrawal and withholding of life-sustaining healthcare in the emergency department: A comparison between emergency physicians and emergency registrars: A sub-study. Emergency medicine Australasia : EMA 2016;**28**(6):684-90 doi: 10.1111/1742-6723.12684[published Online First: Epub Date]|.