Chapter 1

The 10 Commandments of Resuscitation

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Additional information is available at the end of the chapter

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Abstract

Cardiopulmonary cerebral resuscitation is a part of the theoretical and practical activities that must be mastered by health professionals who care for patients with haemodynamic compromise or cardiac arrest. Since Peter Safar, the father of western reanimatology, introduced the ABC-DEF-GHI mnemonic to help rescuers remember the steps of basic and advanced life support and postarrest management in a rapid, effective, and safe way, various mnemonic resources have been utilised to encode this knowledge in the long-term memory and help with fast retrieval. The purpose of this reflection article, based on different resuscitation workshops that have been carried out since 2000 at Colombian Society of Anaesthesiology and Resuscitation (S.C.A.R.E) and Universidad Nacional de Colombia., is to share a simple and practical set of 10 rules that must be followed in order to achieve successful resuscitation.

Keywords: cardiopulmonary resuscitation, cardiac arrest, sudden death, shock

1. Introduction

Cardiopulmonary cerebral resuscitation is critical among the competencies of every healthcare practitioner providing care to critically ill patients or patients who present with sudden haemodynamic decompensation or cardiorespiratory arrest.

Peter Safar, Austrian anaesthetist, three times nominated to the Nobel Prize in Medicine [1–4] for the wide scope of his scientific work focused on ensuring that "hearts and brains too young to die were resuscitated effectively," is considered the father of western reanimatology. He made significant contributions to the development of basic and advanced resuscitation with simple and sequential manoeuvres [1] and taught that resuscitation, an activity that must be performed in the midst of great stress, can be learnt with the purpose of not forgetting it and ensuring that a step-by-step procedure is followed. Also, at the end of the 1980s, the American cardiologist Richard Cummins [5, 6] introduced the chain of survival: a set of sequential and

coordinated life-saving actions that have been validated by evidence over time. Convinced that success in any endeavour in life requires a good method, as well as a base of experience and favourable research outcomes like those obtained by defibrillation in the hands of the community [7], the authors wish to propose 10 simple, practical, and easy-to-remember rules to be considered during resuscitation.

2. The 10 commandments of resuscitation

2.1. First commandment: first the patient, then the monitor

Although technology has enabled great progress in refining control of the haemodynamic condition of the patients, there is no doubt about the importance of the semiology of the critically ill patient and the close surveillance on the part of the healthcare practitioner, considering that the patient is the original true source of information. Even in evidence-based medicine, the patient is one of the three fundamental pillars on which information is supported [8, 9].

It is not uncommon to find healthcare practitioners paying more attention to the parameters on the monitors than going to the patient as the primary source of information. This has given rise to medical errors in the diagnosis of "asystole" even before checking the patient (first 10 seconds in the first 10 minutes) [10, 11]; in the case of asystole, the worst possible diagnosis an individual can get, the protocol consists of confirming the effective placement of the electrodes, observing more than one lead, and increasing the amplitude of the electrocardiographic tracing.

2.2. Second commandment: check the pulse every 2 minutes

Consistent with the first commandment, cardiopulmonary resuscitation (CPR) cycles (compressions/ventilations) must occur at a constant rate of 30/2 (except in children, when two rescuers participate), and rescuers must switch and check pulse every 2 minutes [12]. However, in an editorial published in Resuscitation [13], Noordergraaf disagrees with the general algorithm of checking pulse every 2 minutes and attaches more importance to the type of arrest; if the aetiology is an H- or a T-like in pulseless electrical activity (PEA) and asystole, only 50% of patients have changed their condition to spontaneous circulation within 9 minutes, unlike what happens in shockable rhythms, which depend on electric therapy and require a discharge every 2 minutes. The objective of cardiopulmonary cerebral resuscitation is to help the heart resume circulation spontaneously with the least neurological compromise. If there is pulse there is life, hence the need to implement the 5th link in the chain of survival, which is the management of the "ischemia-reperfusion syndrome" or postcardiac arrest syndrome [14]. If there is a pulse, arterial pressure must be measured in order to determine the presence of vasodilation, characteristic of this syndrome. Hence, the need to be closely aware of these physiological changes is in order to initiate haemodynamic support infusions in a timely fashion.

2.3. Third commandment: if the rhythm changes, check the pulse!

The 2015 resuscitation guidelines emphasise prompt identification of the cardiac arrest as well as the quality of resuscitation. Chest compression frequency and depth are crucial for

perfusion of the key organ, namely the brain [15]. Rhythm change is of the greatest importance in resuscitation because it indicates that the patient has either exhausted mitochondrial and cellular ATP reserves (going from VF to continuous asystole) or has gone into a rhythm with good prognosis. How is this determination made? The only way is the pulse: finding a pulse in a patient who was previously in cardiac arrest is one of the greatest achievements in resuscitation. If the patient is in exit rhythm, the next step is to treat postarrest syndrome, and if the cause of the arrest is identified, prognosis and recovery will be assured. There is increasingly more certainty regarding the fact that wide and slow complexes are of coronary aetiology, secondary to severe hyperkalemia or severe sodium channel blocker toxicity (these are agonal rhythms or that require urgent coronary intervention), unlike narrow fast rhythms, which are due to mechanical causes (cardiac tamponade, tension pneumothorax, pulmonary embolism) or hypovolemia [16]. The current use of point of care ultrasound (POCUS) has an excellent indication in the case of rhythm change with a pulse in order to rule out mechanical causes or hypovolemia as the factors leading to cardiac arrest [17].

If rhythm changes but does not recover, it is important to consider eight Hs and eight Ts among the possibilities for pulseless electrical activity [18]:

The eight Hs: hypoxia; hypovolemia; hyper-/hypokalemia; hydrogen ion (acidemia); hypothermia; hypoglycaemia; hyperthermia, malignant hypervagal.

The eight Ts: toxic (anaphylaxis/anaesthesia); tension pneumothorax; thrombosis/pulmonary embolism; thrombosis, coronary; tamponade, cardiac; trauma (haemorrhage, shock, cardiovascular injury); qT prolongation; pulmonary hypertension.

2.4. Fourth commandment: do not apply the algorithm in reverse. Wait-and-see management of exit arrhythmias

It is a serious mistake to consider the "exit" rhythm as the final heart rhythm because when the heart resumes circulation, it is in postischemic ventricular dysfunction or myocardial stunning [19].

Myocardial dysfunction takes time to recover and that is the reason why the "metabolic" phase of resuscitation requires critical management in the intensive care unit [20]. The sarcolemma is under calcium overload because the "ischemia-reperfusion" process injures the sarcoplasmic reticulum and alters calcium homeostasis; and there is enzymatic inactivation, lipid peroxidation, and mechanical actin/myosin coupling derangement due to collagen matrix injury [20, 21].

Regional flow may recover abruptly as a result of spontaneous cardiac circulation; however, regional muscle function recovery is insidious. The typical example of "myocardial stunning" happens when the infarcted heart is reperfused. On the other hand, the "hibernating" heart produces ventricular dysfunction before angioplasty or revascularisation, and regional myocardial function becomes normalised as soon as there is reperfusion [22]. In conclusion, pulse needs to be checked if there is a change of rhythm; and if there is a pulse, this rhythm (regardless of whether it is normal or arrhythmic) is called exit rhythm, and arterial pressure needs to be measured.

2.5. Fifth commandment: do not defibrillate a PEA or asystole rhythm

Successful defibrillation occurs when it suppresses a chaotic, disorganised, or very accelerated rhythm [as is the case in ventricular fibrillation (VF) or in pulseless ventricular tachycardia (PVT)] and places the heart in transient asystole so that it can restart with an organised rhythm. This may be achieved when there is sufficient ATP or else the heart goes into asystole and remains there because, without energy (prolonged arrest), it will not respond to electric discharge [23]. Regarding PEA, the arrest results from a special situation, which is not related to electrical instability leading to abnormal cardiac rhythm. Hs and Ts are good mnemonics to rule out probable causes of PEA/asystole, and management is not based on electric therapy but rather on solving the underlying cause of the arrest [24].

2.6. Sixth commandment: do not break the chain of survival

Across the years, the chain of survival has proven to be the key for the success of resuscitation, if all its steps are carried out carefully and in strict order. If there is a weak link, the chain will break. When Cummins et al. first published it [5], it consisted of four links: early access, early CPR, early defibrillation, early advanced care.

In 2010, the American Heart Association (AHA) added the fifth link that was missing in the chain, wherein lies the science and art of managing the "ischemia-reperfusion syndrome". Changes to the 2015 Guidelines included two distinct chains: the chain of survival for the patient who goes into cardiac arrest outside the hospital, which depends on the ability of the witnesses of the arrest to respond (first responders), and the chain for the inpatient whose survival will depend on an appropriate surveillance system for unstable patients (early diagnosis and warning/rapid response) and an organised advanced resuscitation system (Code Blue/Megacode) and teamwork [25].

2.7. Seventh commandment: in cardiac arrest, always apply three therapeutic options supported by level A evidence

Give compressions if there is cardiac arrest; give ventilations if there is respiratory arrest; defibrillate in case of ventricular fibrillation or PVT (**Figure 1**).

Of the 315 recommendations for changes to the 2015 Guidelines, only three had level A evidence (1%), which means that they were supported by controlled clinical trials or high quality meta-analyses, and only 78 (25%) were class I recommendations, meaning that the benefit is much higher than the risk (strong recommendation) [26].

2.8. Eighth commandment: do not give amiodarone in cases of tachycardia with *torsade de pointes* (twisting of the points)

Amiodarone is the versatile antiarrhythmic in resuscitation [27] because it acts on different cell channels. It is considered class I, II, III, and IV antiarrhythmic according to the Vaughan-Williams classification [28]. However, despite being an excellent antiarrhythmic in resuscitation, it also has arrhythmogenic effects, especially since it prolongs the QT interval and predisposes to helical polymorphic ventricular tachycardia or torsade. This form of arrhythmia produces haemodynamic instability that leads to cardiac arrest if it goes unrecognised and is

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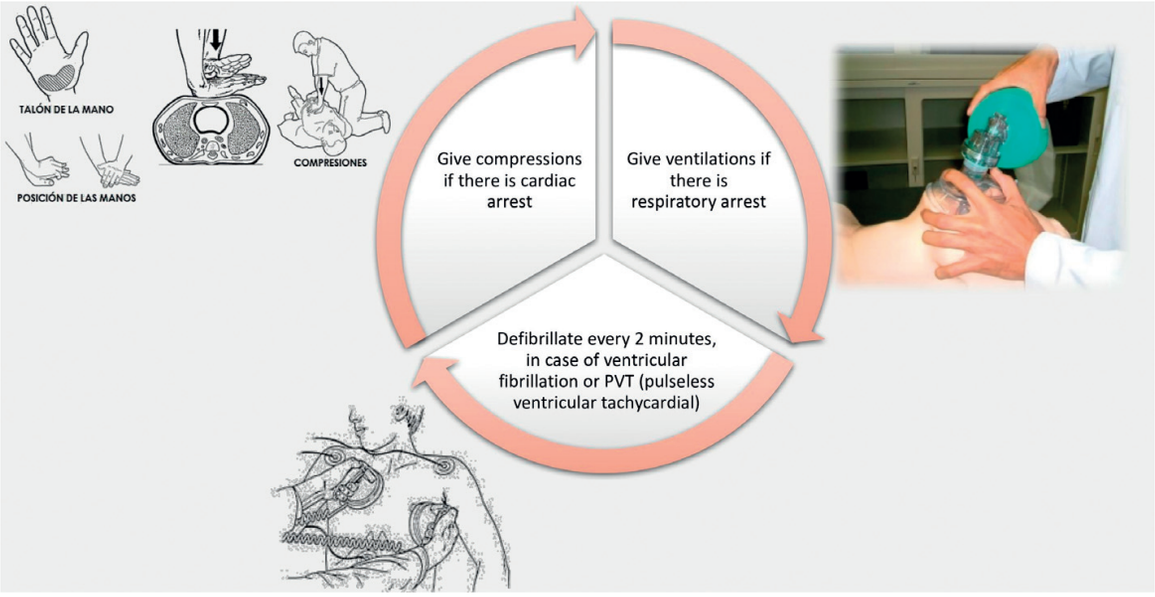

Figure 1. Therapeutic options with level A evidence. Note: PVT: pulseless ventricular tachycardia. Source: Author.

not treated on time, and among QT causes can be [29]: hypokalemia (normal levels: 3.5–5.3 mEq/L), hypomagnesemia (normal levels: 1.7–2.2 mg%), and antiarrhythmic toxicity.

2.9. Ninth commandment: give atropine only in case of symptomatic bradycardia

Severe bradyarrhythmias (produced by vagal responses during anaesthesia) respond to the use of atropine, an excellent parasympatholytic-anticholinergic agent that reduces vagal tone and increases sinus node frequency [25]. Atropine is a liposoluble tertiary amine of wide distribution in the body, which blocks muscarinic receptors. In cases of wide complex bradycardia, as is the case in high infra-His grade blocks, it has no effect because the block is below the AV node and it is actually contraindicated because atrial pacing may lead to cardiac arrest. Of these patients, 33% respond to transcutaneous pacemaker while waiting for assessment by the specialist and a definitive transvenous pacemaker [30, 31].

Atropine was excluded from cardiac arrest management (PEA-ASYSTOLE) already in the 2010 Guidelines; however, it must be kept in the crash cart because one of the Hs in the perioperative environment is "hypervagal response" [32].

2.10. Tenth commandment: assertive communication and clear messages

It has been estimated that 400,000 patients die every year because of medical errors, and 80% of these are attributed to communication errors and failures in nontechnical skills [33].

There is still a failure on the part of residents to adhere to the use of checklists, which have resulted in great progress in the control of adverse events [34].

Advanced life support teams (Code Blue/Megacode) must be characterised by excellent communication and leadership, which among nontechnical skills, are key to resuscitation success.

3. Conclusion

Cardiopulmonary cerebral resuscitation is a healthcare activity that requires an orderly step-by-step use of manoeuvres, and technical and nontechnical skills, where adherence to 10 rules described here reinforces the strength of all the links in the chain of survival and ensures a responsible, judicious, and effective job.

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