Facts, Legends and Myths on the Evolution of Resuscitation

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Abstract

This study aimed to overview in chronological order a number of "facts" and "myths" that have been reported in the literature on the history of resuscitation. In particular, this review presents remarkable resuscitation attempts, innovative techniques and landmarked events that enhanced resuscitation in terms of science, history and intervention from ancient times until today. The resuscitation methods were designed for victims needing help in various locations of three-dimensional space, with emphasis on those occurring on, or brought to, land. These methods required single or double rescues to be carried out. Some of them were either empirically or scientifically designed. In some techniques, the stimuli used to revive the victim were rather painful and dangerous or at least disturbing. In some techniques, respiration was attempted with various more or less sophisticated devices. Finally, a small number of cases have been mistakenly reported by previous scholars as resuscitation attempts.

Keywords: drowning, cardio-pulmonary resuscitation, emergency, history, art, medical history, first aid.

Scholarly work about resuscitation is extensive on most aspects, but limited in historical references. More precisely, a related search in the data base, Medline, using as key words "resuscitation", "cardio-pulmonary resuscitation" and other related terms, revealed several thousand published works that deal exclusively with this subject in terms of prevention, rescue and treatment. However, limited scholarly attention has been given to the historical route followed since the first reported resuscitation attempt. A similar search identified only a few publications that dealt with how resuscitation has evolved through the centuries.

Consideration of this lack of published evidence on the history of resuscitation raises several questions. Was the resuscitation of an apparently dead person always the same? Were resuscitation methods always scientifically established? How was resuscitation performed through the centuries? Was any equipment used during resuscitation attempts? Are there any facts and myths associated with the evolution of resuscitation internationally?

Answering these questions may be meaningful for a number of reasons. First of all, we will be able to overview the evolution of resuscitation and, therefore, know how techniques were developed through the centuries. Second, we will be able to identify whether any progress has been made in the thinking on medical and emergency response. Third, we will discover whether the development of resuscitation methods that aimed to save lives was an issue that has concerned scientists (e.g., doctors and researchers) and emergency professionals (e.g., lifeguards, rescuers etc) locally or internationally. Finally, such an overview will be interesting from a historical point of view, as we will be able to synthesize into a single study, and therefore witness the evolution of the most important aspects in first aid and emergency care. Therefore, the aim of the present study was to review the literature identifying various resuscitation methods that have been suggested and used from the past to the present, as well as to evaluate their content.

Resuscitation Attempts, Techniques and Landmark Events

In Biblical times, there is a myth about the Puah midwife applying external air ventilation (EAV). The Midrash Rabbah explained the origin of the name Puah. Rabbah, was a Biblical commentary written by a rabbi between 1900 and 1100 BC. Puah was a midwife mentioned in the book of Exodus. According to the text, she was given this name because she used to revive the newly born with her own breath (Exodus 1: 15–17). Some authors have reported this as evidence of the application of EAV on humans (e.g., Safar, 1989; Dworkin, 1999). However, a careful check of the verses in Exodus reveals that they were not about her applying EAV for newborn resuscitation (Trubuhovich, 2005). Therefore Puah could not be credited with knowledge of resuscitation.

In the year 896 BC, the myth arose about the first resuscitation attempt by the prophet Elisha. Some authors mistakenly attributed the first description of a successful resuscitation attempt to an episode reported in the Old Testament (see Safar, 1989; Vervaecke, 1995; Dworkin, 1999; Avramidis, 2010). According to the Bible (Genesis 2: 7, Kings 17: 17−22 and 4: 32−35), a child of a Shunemite couple had a headache and then died. The prophet Elisha prayed and then "*... placed himself over the child. He put his mouth on his mouth, his eyes on his eyes, and his hands on his hands, as he bent over him. And the body of the child became warm. He stepped down, walked once up and down the room, then mounted and bent over him. Thereupon the boy sneezed seven times, and the boy opened his eyes*" (Figure 1). However, this incident should be perceived only as a "miracle" because nothing in the text suggests that Elisha blew air into the child's mouth. Moreover, the time taken for the prophet to save the child was far too long for EAV to be considered the cause of his recovery (Clayton-Jones, 1913; Trubuhovich, 2005). Therefore, the first resuscitation attempt has been mistakenly credited to the prophet Elisha.

In ancient times, the treatment of the King of Chyryba took place. The treatment of King Aleppo is one of the preserved ancient resuscitation stories (see Vervaecke, 1997; Avramidis, 2010). The King was thrown into the Orontes River by the furious Egyptian Pharaoh Ramses II and almost drowned. In the Rameseum at Thebe the gravures of the rescue treatment given to the King by his soldiers are depicted. They lifted their King by his feet, probably to drain the water out of his lungs (Bierens, 1996; Meursing, 2006; Figure 2).

During ancient times, in China an effort to revive drowning victims was made. In particular, a method was used in which the victim was positioned on his stomach on the back of an ox. Both of his arms hung down on one side, and both of his legs on the other. The rescuer held the victim in this position while he brought the ox to a gallop (Bierens, 1996; Meursing, 2006).

In 700 BC, the theory of Pneuma dominated medical thinking in Greece. The Pneuma theory was postulated by some Greek philosophers: during their last breath, a casualty's Pneuma left their body, thereby achieving immortality. Based on this theory, drowning was considered to be particularly bad, since Galen postulated that during submersion, water obstructed the airway, preventing the Pneuma from leaving the body. Because of this, efforts were made to free the Pneuma after the victim was rescued (Meursing, 2006). Specifically, Hippocrates (460−370 BC) suggested in his work, Prognosticon, that a priest could blow the Pneuma back into the casualty's body by inserting a tube into the trachea (Bierens, 1996; Meursing, 2006).

In about 200–500 AD, there is a myth that the Babylonian Talmud refers to human EAV. The Babylonian Talmud Shabbat 128b describes the EAV method. According to this "*one should hold the newly born in a way that it cannot fall and one blows one's own exhaled air in the nose of the child*". Some authors have reported this as evidence of the application of EAV on humans (e.g., Meursing, 2006). However, the newborn, which

here is referred to as a human (Rosen & Davidson, 1972), was actually a calf or a lamb (Trubuhovich, 2005).

In 1000 AD, the heat resuscitation method was suggested. Every time a casualty's respiratory and circulatory systems fail and metabolism stops, the temperature of the body cools. The rationale behind this method was that if hot ashes and coals were placed on the chest, this would re-start breathing and the heartbeat, and re-warm the casualty. When the casualty was asleep, resuscitation was successful. When the casualty's breathing and heartbeat had actually stopped, the resuscitation attempt was apparently futile (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 3).

In 1530 AD, the bellows resuscitation method was introduced. Although not many rescuers carried fireplace bellows while on duty, the success of this technique motivated first-aid manufacturers to design the bag-valve-mask resuscitators (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 4).

In 1555 AD, the experiments of Vesalius dominated the field. Andreas Vesalius (1514−1564) was the first person to describe mechanical ventilation (Wikipedia, 2011). In his animal experiments, he showed that ventilation was necessary for the heart to function adequately. He reported his experiments in his book, *De Fabrica Humana Corporis*, published in 1555. Since then several scientists have repeatedly proved that his findings were correct (see Vallejo-Manzur, Perkins, Varon & Baskett, 2003; Meursing, 2006; Wikipedia, 2011).

In 1670 AD, Albinus promotes resuscitation for those who are drowning. The Swiss priest, Sebastian Albinus, has been credited for probably being the first who actively promoted resuscitative techniques for drowning victims. He published a booklet in which he described several techniques for resuscitating the drowning victim. He learned some of these techniques from his parents who owned a watermill (Bierens, 1996; Meursing, 2006).

In 1711 AD, the fumigation resuscitation method was introduced. Smoke was blown into the casualty's rectum via an animal bladder. North American Indians and American colonists used it successfully for some time. In 1767, this "resuscitation" technique was introduced in England (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 5).

In 1732 AD, the application of EAV was suggested. Tossach, a Scottish surgeon, wrote about a rescue he performed: "*There was not the least pulse in either heart or arteries, and not the least breathing could be observed: so that he was in all appearance dead. I applied my mouth close to his, and exhaled as strong as I could: but having neglected to close his nostrils all the air came out of them. Wherefore taking hold of them with one hand, and holding my other on his breast, I blew again my breath as strong as I could, raising his chest fully with it; and immediately I felt six or seven quick beats of the heart*" (Meursing, 2006, p. 16).

In 1740 AD, the first law for drowning victims by King Louis XV of France was established. He first recognised the significance of the government and law in the rescue process and the treatment of drowning victims. He ordered Reaumor to circulate in France a publication that explained how to save a drowning victim. At the same time, the law was changed. As a result, the rescue of a drowning victim was no longer a punishable action (Meursing, 2006).

In 1744 AD, the first article on mouth-to-mouth resuscitation in an adult victim was published by William Tossach. Twenty three years later, in 1767 AD, the Society to Rescue People from Drowning was established in Amsterdam with three objectives. The first was to reduce the fear associated with dealing with a drowning casualty. The second was to conduct scientific research. The third was to train the public in the best way possible, so that they were able to rescue drowning casualties. In addition, for

preventative reasons, billboards were placed in the harbour cities of the Netherlands describing the most helpful techniques (Meursing, 2006).

In 1770 AD, the inversion resuscitation method was introduced. Stanchions were placed on beaches. When a casualty was pulled out of the water, the rescuer would tie the casualty's ankles together and attach the victim to the stanchion where he would be alternately raised and lowered in an effort to push air in and out of his chest cavity (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 6).

In 1773 AD, the barrel-roll method was established. With this method, in use in Europe in the Middle Ages, the victim was put on his stomach on the barrel. The rescuer grabbed both feet and rolled the victim to and fro using the barrel. With our current knowledge, it seems likely that the changes in intrathoracic and intra-abdominal pressures that occurred caused the circulation to be re-established (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 7).

In 1774 AD, William Cullen made an important statement. During this period, scientists started realising that signs of death were not always irreversible. In particular, William Cullen (1712−1790), professor at Edinburgh and Glasgow, said that "*death is only irreversible after the neurons have died*" (Meursing, 2006).

1787–8 AD saw the "Ancestor" of the defibrillator. Charles Kite (1768−1811) developed an instrument that was similar to the modern defibrillator. He used a so-called bottle of Leiden which he charged with an electrification machine. He connected the capacitor to two copper poles with two cables. The poles were placed across the thorax of the patient with two wooden handles, in such a way that the capacitor would give an electrical charge to the thorax (Meursing, 2006).

In 1775 AD, Squires made the first recorded defibrillation. Evidence of this is recorded in the Annals of the Royal Humane Society that describes the first use of this machine during the resuscitation of Sophia Greenhill. Mr Squires, who worked as a surgeon at the Middlesex Hospital, London, administered several successful shocks to her (Meursing, 2006).

In 1780 AD, the first endotracheal intubation was introduced. Based on this, bellows were used to ventilate the patient via the endotracheal route. Although the role of oxygen in human metabolism was clarified by Priestly, Scheele and Lavoisier, these remarkable ventilation techniques were, unfortunately, neglected for several decades because of the complications involved in their application (Meursing, 2006).

In 1803 AD, the Russian resuscitation method of cooling was established. This method could be initiated easiest in cold climates. Its aim was to reduce the body's metabolism by cooling it under an icy layer of snow. However, the body part that needed to be frozen was the brain that was left outside the ice (Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 8).

In 1812 AD, the trotting horse resuscitation method was introduced. When a casualty was rescued and taken out of the sea, the rescuer would hoist the casualty onto the horse and run the horse up and down the beach. This led to an alternate compression and relaxation of the chest cavity because of the bouncing of the casualty on the horse. This procedure was banned in the USA because there were complaints by citizens who cared about the "cleanliness" of beaches (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 9).

In 1829 AD, d'Etioles triggered changes in resuscitation methods. Jean Jacques Leroy d'Etioles (1798−1860) published an article that demonstrated the potential hazards of positive pressure ventilation. He demonstrated that forceful ventilation with bellows could lead to pneumothorax and that if this was continued, to death. This particular work made physicians believe that the lungs of a victim of sudden death could not bear positive pressure ventilation. Eight years later, in 1837, the Royal Humane Society

removed bellows and mouth-to-mouth ventilation from the list of recommended techniques. Alternatively, as a result, various others techniques for artificial ventilation were established based on the same principle: the use of normal ventilation. Having about 100 push-and-pull techniques were too many, and this made the Royal Humane Society allocate a task force to evaluate them to find out which ones were positively tested and should eventually be used (Meursing, 2006).

In 1831 AD, the Dalrymple resuscitation method was suggested. Two rescuers placed fabric under a casualty's armpits and pulled the fabric towards themselves (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 10).

In 1847 AD, Van Hasselt introduced a new method. This method was called "Costal Elevation Method". The casualty was placed in the prone position. The rescuer placed his fingertips behind the false ribs and forcefully lifted the ribcage, to stimulate inspiration. Then, by releasing the ribcage, expiration was forced (see Bierens, 1996).

In 1856 AD, the Marshall Hall resuscitation method was applied to those in need. The chest is elevated and the casualty is immediately pulled up on his side. Then he is rolled back. The applied pressure on the back generates exhalation. The pressure is released when the person is on his side, for inhalation (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 11).

In 1858 AD, the Sylvester resuscitation method was used. This method consisted of two moves. The rescuer holds the wrists of the casualty who is placed in a supine position and presses his chest to cause passive exhalation of air from the lungs. Then, he pulls the wrists out and up to stretch the hands, to inflate the lungs with the entry of new air (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 12).

In 1871 AD, Van Howard introduced a resuscitation method that was named after him. The casualty was positioned on his back and a pillow was placed under his shoulders. The back was pushed to force out the gastric content and water from the lungs. The casualty's back was hyper-extended because of the pillow. His wrists were placed on the ground (inhalation). His thorax was compressed progressively on the six lower ribs by the rescuer's body weight (exhalation). Inhalation was achieved with the sudden release of the pressure of the body weight. The tongue was pulled back (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 13).

In 1886 AD, the Van Francis resuscitation method was established. The casualty was placed in a supine position along the middle of a piece of wood and his arms were extended upwards. The two sides of the wood were raised alternately to stimulate inhalation and then lowered to stimulate exhalation (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 14).

In 1892 AD, the Van Lamborde resuscitation method was introduced. The rescuer pulls the casualty's tongue rhythmically to trigger the pharynx, the glossopharyngeal nerve and the upper pharynx that activate the respiratory centre and the medulla oblongata (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 15).

In 1894 AD, the Prochownick resuscitation method was introduced. The newborn infant is inverted. The squeezing of the chest by the rescuer and the pull of gravity cause exhalation. The release of the chest lets the lungs fill (Vervaecke, 1995; Avramidis, 2010; Figure 16).

In 1896 AD, the Van Brosse resuscitation method was applied to apparently dead people. The casualty is placed in a supine position with his back on a low footstool. The rescuer approaches the casualty from the rear, holds and raises the casualty's hands, thus achieving extension of the thorax (inhalation). Then he pushes the casualty's bent elbows onto the diaphragm (exhalation) (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 17).

In 1903 AD, the Schaffer resuscitation method was used. The casualty is placed in a supine position with his arms folded beneath his head. The head is turned to the side. The rescuer applies all his body weight onto the lower ribs of the victim by pushing downwards and inwards through his arms to force the diaphragm to move down (inhalation). Then the rescuer removes his arms from the thorax, so the thorax returns to its initial position (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 18).

In 1910 AD, the Boland resuscitation method was used. This method required the victim to be in a prone position. The rescuer knelt on the victim and pulled him upwards from his shoulders, by hyperextending his spine. This move stimulated the phase of inspiration. Then, the victim was dropped on the abdomen, supported by the head to stimulate expiration. This method was not without its disadvantages though; due to the increased risk of aspiration of the stomach contents it was only applied to young casualties. However, the advantage of the method was that the tongue could not block the airway (see Bierens, 1996).

In 1910 AD, the Flagellation resuscitation method was used. National resuscitation organisations used this method for determining the response of an unconscious casualty. The rescuers whipped the casualty in order to stimulate a response (Vervaecke, 1995; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 19).

In 1918 AD, the Steward resuscitation method was used. This is the first air-tide cabinet method. A chamber is connected to bellows and creates positive and negative pressure on the casualty's abdomen to inflate and then deflate the lungs (Dworkin, 1999; Avramidis, 2010; Figure 20).

In 1926 AD, the Eisenmenger resuscitation method was used. Air from an electrically-driven pump goes into pressure and suction vessels in a dome on the casualty's body and triggers breathing (Dworkin, 1999; Avramidis, 2010; Figure 21).

In 1931 AD, the Oesterreich resuscitation method was introduced. When a lineman suffers an electrical shock his abdomen is compressed inwards and upwards for exhalation. The release of this compression generates inhalation (Dworkin, 1999; Avramidis, 2010; Figure 22).

In 1932 AD, the Van Eve resuscitation method was suggested. The casualty is placed on a board with a stone as a fulcrum. This board acts like a seesaw, moving the casualty's head up and down and requiring minimum effort from the rescuer. The vital organs push the diaphragm causing inhalation or exhalation, depending on the position of the head (high or low) (Vervaecke, 1995; Avramidis, 2010; Figure 23).

In 1932 AD, the Holger-Nielsen resuscitation method was established. The victim is laid in a prone position. The rescuer places his palms on the casualty's shoulders. He moves until his hands are placed vertically above the casualty's body. He pushes the casualty to enable exhalation. Then, he moves back, reducing the pressure to assist exhalation (Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 24).

In 1937 AD, the cardio-pulmonary resuscitation method was established. The American Red Cross and the American Heart Association started a campaign aiming to educate the national public in basic life support and resuscitation procedures. The primary objective was to train public safety and rescue personnel. Once this training was achieved, it was then taken out to the general population. Later, it was made clear that cardio-pulmonary resuscitation would be effective if it was followed by Advanced Life Support attempts (e.g., intubation, drug administration and defibrillation) (Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 25).

In 1947 AD, the first defibrillator and the rediscovery of external cardiac massage were made. That year the first defibrillator for internal use was used successfully by Claude Beck, who has been known since then, as the "father of defibrillation" (Tsakiris,

2008). Twelve years later the external defibrillator was developed and used successfully by other scientists. As a result, mouth-to-mouth ventilation, chest compression and shocks were once again brought together, as in 1829 (Meursing, 2006). In the early 1960s, the idea of administering cardio-pulmonary resuscitation was brilliant and perceived as one of the biggest achievements of humanity. Characteristically, the US President, John F. Kennedy, in a speech, said that "*within the next 10 years, United States would send a person to the moon and also cardio-pulmonary resuscitation would save thousands of lives*" (Tsakiris, 2008, p. 24). In due course, the use of automatic external defibrillators became so simple that even non-medical emergency personnel could operate them.

In 1950 AD, the Emerson resuscitation method was established. The lifeguard places the casualty in a supine position on the ground. He applies pressure on the casualty's waist with his hand (exhalation). Then he grabs and lifts the casualty up until the casualty's body is lifted from the ground (Vervaecke, 1995; Avramidis, 2010; Figure 26).

In 1950 AD, the mouth-to-mouth resuscitation method was introduced. A number of organisations started a promotional effort to raise awareness in the USA public of this procedure that had been advocated within the United States army during World War II. A decade later, this training was adopted by lifeguard organisations that taught mouth-to-mouth resuscitation in the water during a drowning rescue, using various types of lifeguard equipment (e.g., rescue buoys, rescue boards, boats, canoes, etc.; Dworkin, 1999; Avramidis, 2006a; 2006b; 2010; Figure 27).

In 1958 AD, the "push-and-pull" was replaced by the "mouth-to-mouth" technique. The push-and-pull technique had a profound influence in the evolution of resuscitation. Patients with respiratory insufficiency due to a poliomyelitis virus infection were ventilated by a so-called iron lung. Around their neck a rubber seal guaranteed air-tight closure of the iron lung and only their head was sticking out of the iron lung. Air was squeezed out or sucked into them by varying the air pressure inside the "lung". However, during the polio epidemic of 1949, many iron lungs underperformed; when they broke down, because the head was the only accessible part of the patient's body, the hospital staff had to administer either mouth-to-mouth ventilation or bag-mask ventilation. Three years later, J.O. Elam, an anaesthesiologist, discovered that these alternative techniques were effective in maintaining adequate blood gases. However, this was only published several years later. In 1958, the American National Red Cross, the National Academy of Sciences and the National Research Council, jointly advised that the mouth-to-mouth technique should replace the push-and-pull technique (Meursing, 2006).

In 1990 AD, the chain of survival is suggested as a teaching and intervention tool for lifesaving and first aid organisations. The American Heart Association developed the concept of the chain of survival in an effort to educate health care and rescue professionals and the general public, in the related procedures. This chain comprised four steps: early access to the emergency medical system by telephone, upon recognition of a patient's cardiac arrest; early basic life support through cardio-pulmonary resuscitation; early defibrillation by first responders; and, finally, early advanced life support by advanced trained emergency responders (Dworkin, 1999; Avramidis, 2001; Lee & Avramidis, 2008; Figure 28).

In 1996 AD, emphasis was given to early defibrillation. Guidelines from the American Heart Association stated that "all emergency personnel (like lifesavers and lifeguards) should be trained and permitted to operate an appropriately maintained defibrillator if their professional activities require that they respond to persons experiencing cardiac arrest" (Dworkin, 1995).

From 2000 AD until today, systematic resuscitation updates take place. Every four years the International Liaison Committee on Resuscitation produces revised guidelines and resuscitation protocols taking into account the results of scientific research (e.g., Handley, Monsieurs & Bossaert, 2001; Handley, Monsieurs, Perkins, Davies & Bossaert, 2005; Nolan et al, 2010). This initiative, together with the rapid development of the media has resulted in the spread of existing knowledge and the sharing of information about resuscitation techniques. Consequently, this allowed organisations to adopt the new techniques, significantly decreasing the number of drowning deaths by reviving those needing resuscitation.

Figures 1-28: Pictorial depiction of the evolution of resuscitation. Note. Images drawn by Nikos Kouremenos. Copyrighted and reproduced with permission from Avramidis, 1998; 2001; 2010.

Discussion

This review of the literature aimed to locate those resuscitation methods that have been suggested and used for reviving apparently dead people, as well as remarkable landmark events, and to clarify myths related to the history of resuscitation. As a result, several methods were found. A careful study of them reveals several findings that are discussed below.

The first finding was that resuscitation methods were designed for victims needing help in various locations of three-dimensional space, with emphasis on those occurring on, or brought to, land. Specifically, some techniques were applied to those in need of resuscitation in the air, or took place off the ground (e.g., the inversion method, the Prochownick method and the Oesterrreich method). One was applied to those needing resuscitation in the water (e.g., ventilation in the water). Finally, the majority of the suggested and used techniques were applied to victims on land (e.g., cardio-pulmonary resuscitation, the Sylvester method, the Holger Nielsen method, the Van Eve method, etc.). The message that we get from this observation is that although the emergency situations occurring on land were the subject of extensive effort, for those situations occurring in the air or in water, the attention of organisations dealing with them and possible solutions were limited.

A second finding was that all the resuscitation methods described required either one or two rescuers for their administration. More specifically, only a few methods required the intervention of two rescuers (e.g., the rummage and shaking method, the Van Francis, Van Lamborde method, the Dalrymple method). On the other hand, most methods needed a single rescuer (e.g., Holger Nielsen, Silvester, Van Howard, etc.). This observation gives the impression that in most cases, regardless of the time frame in human history (i.e., ancient, medieval or contemporary) or the nature of techniques (i.e., empirically or scientifically designed), their application was not difficult. It only needed the presence of a trained rescuer with limited "equipment".

In addition to the above, this review discovered that resuscitation methods were either empirically or scientifically designed. Those developed in the past were characterised by the imagination of their "inventors" (e.g., fumigation, bellows, barrel method, inversion, etc.). On the other hand, resuscitation methods that were used in the most recent decades were established as a result of scientific evidence (e.g., Holger Nielsen, Silvester, mouth-to-mouth, cardio-pulmonary resuscitation and defibrillation). This demonstrates a movement away from pure empiricism towards a more scientific way of approaching the issues of emergencies and the treatment of those in need of first aid. More importantly, the dramatic higher survival rates that are reported in the contemporary injury epidemiology statistics, compared with the high mortality rates of the past, demonstrate the success of science to produce (even after a long delay over the centuries) a valid and successful way of treating unconscious and non-breathing victims.

Fourth, in some methods the stimuli needed to revive the victim were rather painful and dangerous, or at least disturbing. While most methods required a gentle intervention by the rescuer, there were several other methods that included, as part of the process, pain to trigger revival (e.g., the heat method, fumigation method, inversion method, barrel method, cooling method, trotting horse method and flagellation method). Consideration of these techniques gives the impression that when they were successful (either because they worked on actually non-breathing victims or because the victims seemed, but were not actually, dead), they must have been very painful or annoying. Moreover, one may wonder what may have happened in those cases where a person seemed to be lifeless and was treated by an inexperienced rescuer with the heat or the cooling method; those victims may have ended up with several burns or frost bite.

Fifth, in some techniques, respiration was attempted with various more or less sophisticated devices. Among the less sophisticated devices we noted the ones that were used in the early years of resuscitation history (e.g., barrels, bellows, horses, ropes, stool, woods, whip, etc.). However, during more recent years, a number of more sophisticated devices were also used (e.g., a first aid-tide cabinet in the Steward method, an electrically-driven pump in the Eisenmenger method and the automatic external defibrillation). This use of specific devices demonstrates a turn from an empirical approach, mainly based on

the imagination of the technique's founder, to a more intelligent design that was the result of scientific research.

Finally, it was found that a small number of reported cases have been mistakenly reported by previous scholars as resuscitation attempts. This was evident in the incident where the prophet Elisha revived an apparently dead child possibly by a miracle. Also, the Puah midwife was not intending to revive non-breathing infants. Finally, a careful observation of the text in the Babylonian Talmud revealed that the presumed attempt to resuscitate a human child, actually referred to a calf or a lamb. From all the above, it is concluded that often, some events occurring throughout history are mistakenly interpreted by scholars and credited to people who did something different from what was reported. This also underlines the importance of using multidisciplinary research approaches when drawing conclusions, especially in periods of history where insufficient information and evidence are available.

Summary

Probably since prehistory, human beings have been helping and rescuing each other in times of danger and threat. Later, in Biblical periods, "miraculous" attempts, that were mistakenly labeled as artificial exhaled air ventilation, were made to save apparently dead human and non-human victims. In ancient times, because death was considered to be a special form of sleep, early rescuers used painful stimuli to wake up the victim. Since then, several other empirical and more scientific methods have been implemented for establishing standardised protocols and to revive those seeking emergency help. Several different resuscitation methods have been used in the past. These techniques were designed to be administered either by one or two rescuers to those in need of help in various locations of three-dimensional space, with emphasis on those occurring on, or brought to, land. Some of them were characterised by their intelligent design and sophisticated instrumentation, while others appear amusing or brutal. In any case, they represent medical knowledge, or the current thinking of their period. Overall, it seems that while in the early years methods were based on experience and coincidence, later techniques and their protocols were developed based on valid and reliable scientific research.

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