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History of cardiopulmonary resuscitation

The history and practice of cardiopulmonary resuscitation (CPR) brings together developments in three main fields. The first to develop was basic life support, followed by advanced life support, and later prolonged life support.

These three processes have evolved over many centuries, with the first accounts dating back to biblical times. However, consistently recorded medical success of CPR methods only appeared in the early nineteenth century. Advances in this area have progressed rapidly from the middle of the twentieth century up to the modern era.

Ancient Hebrew scripture and the Old Testament both describe the resuscitation of a young boy by the prophet Elijah. This is possibly the first documented account of life support. In the King James Bible, II Kings 4:34 reads: "And he went up, and lay upon the child, and put his mouth upon his mouth, and his eyes upon his eyes, and his hands upon his hands: and he stretched himself upon the child; and the flesh of the child waxed warm." [1]. Although it is obviously uncertain that this is an actual account of artificial respiration, it is possible. However, speculation aside, the earliest accounts of resuscitative events are primitive by today's standards and associate life with observed physical characteristics such as breathing, warmth, and motion. The ancient Chinese would immerse their dying in hot oil baths to restore life. Native Americans placed fresh animal dung (thought to contain life) on the dying person's abdomen [2]. Other common futile practices before the eighteenth century included vigorous stretching of the tongue or anus, hanging the victim upside down and alternately raising and lowering them, and placing them on a trotting horse to induce animation [2]. More effective methods of basic life support were not proposed until around the mid-eighteenth century

Basic life support encompasses the development of three major practices: airway control, artificial respiration, and cardiac massage.

Vesalius is credited with the earliest account of artificial respiration and airway control in 1555 when he used a reed placed in the trachea of animals to keep them alive while studying their anatomy [3]. In 1732, Tossach performed the first documented resuscitation of a coal miner overcome by fumes, using mouth-to-mouth [2–4]. Some years after Tossach received public attention for his work, the Paris Academy of Sciences recommended mouth-to-mouth resuscitation for the newly drowned [3]. Mouth-to-mouth resuscitation was not popular for hygienic reasons and the belief that the carbon dioxide in exhaled air was harmful if carried into the lungs of the victim [2]. Soon thereafter, manual methods of artificial respiration were introduced. The progress of each new manual method, such as the bellows method (initiated by Phillippus Aureolus Paracelsus [2]) and the mouth-to-mask technique, prompted the Royal Humane Society to recommend the bellows technique over the mouth-to-mouth technique in 1782 [2]. In the early 1800s, Leroy d'Etiolles was the first to manipulate the position of the body to induce ventilation. In 1829 he introduced a procedure of resuscitation that involved alternating compression of the victim's chest and abdomen [2]. The most popular methods of manual (postural) resuscitation from the 1850s to the 1950s included Hall's rolling method, Howard's thoracic compression method, Sylvester's chest pressure/arm lift method, Schaefer's prone pressure method, and the Holger-Nielsen prone back pressure/arm lift method [2, 5, 6]. Eventually some publications began to favor mouth-to-mouth resuscitation once again. However, it wasn't until 1958 when Safar, Escarraga, and Elam published the first definitive study that established the superiority of mouth-to-mouth resuscitation over manual methods. This led the National Research Council of the National Academy of Sciences to recommend mouth-to-mouth resuscitation as the emergency technique of choice that same year [2, 3].

The late 1800s also witnessed the developing practice of cardiac massage. The first successful use of closed chest cardiac massage in living cats is attributed to Bohem of Germany and his associates [3, 5]. In 1880 Niehaus performed the first unsuccessful attempt at closed chest cardiac massage in a man [3]. Five years later, Koenig reported eight successful cases of human closed chest cardiac massage [3]. Although experimental and in-hospital trials of closed cardiac massage continued, it was soon replaced by the assumedly superior and more invasive method of open chest cardiac massage.

In 1898 Tuffier and Hallion reported the first temporary success of open cardiac massage in man, and Igelsrud performed the second successful open chest cardiac massage three years later [3].

Eventually researchers, scientists, and physicians began to combine the known techniques of resuscitation in the hope of producing even more effective procedures. Early in the twentieth century, George Washington Crile wrote an extraordinary report about an experimental method of animal resuscitation combining the use of thoracic compression, artificial respiration, and parenteral epinephrine infusion [3, 6]. In this report he described open and closed cardiac massage and anticipated the 'thoracic pump theory' by stating: "Pressure upon the thorax alone is capable of producing an artificial circulation. This is by no means accomplished by its action upon the heart solely, but by its action upon all the large vessels: arteries, veins and capillaries together." [6].

The article also contained documented cases of successful closed chest cardiac massage in dogs and man, and the first 'MAST' suit description and use [3]. In 1960 Kouwenhoven, Jude and Knickerbocker reported the successful use of closed chest cardiac massage in 20 patients ranging in age from 20 months to 80 years, with a 70% survival rate [2]. Their article's well-documented successes in closed chest cardiac massage reinforced its efficiency. Eventually, closed chest compressions and artificial ventilatory techniques were combined to produce the method of cardiopulmonary resuscitation most commonly used today. The success of Crile's, Kouwenhoven's and many other scientist's work led to an improvement in basic life support, and opened the door to the progression of advanced and prolonged life support.

Experimental developments in the field of electrical resuscitation began in the mid to late 1700s but did not flourish until the early to mid 1800s. Around 1775, reports of experimental tests using crude, homemade batteries to induce electrical defibrillation began to emerge. Danish veterinarian and physician Peter Abildgaard conducted experiments with the effects of electrical shock and countershock in animals, and the 'Squires of London' reported a cardiac arrest and resuscitation using electrical defibrillation [2, 3]. Experimentation continued though out the 1800s by scientists such as Dr. Allan Burns of Glasgow who suggested inflation of the lungs and shock to the chest for resuscitation (1809), and Prevost and Battelli, who in 1899 thoroughly studied the effects of electrical shock on the mammalian heart [2, 3].

In 1947, Claude Beck performed the first successful internal defibrillation of a human heart in the operating room, and in 1956 Zoll et al. performed the first human external defibrillation [2, 7].

Without a doubt, the history of cardiopulmonary resuscitation portrays the advances in resuscitative medicine through the application of scientific method and an undeviating resolve to question accepted common practice. Although the field of CPR has seen much growth already, as health care providers we can only expect that the road ahead will lead to numerous discoveries and changes that will further shape resuscitative practice.

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