Neurocrit Care
https://doi.org/10.1007/s12028-022-01616-x

NEUROCRITICAL CARE SOCIETY

NEUROCRITICAL CARE THROUGH HISTORY

Blow Smoke and Air: A Peculiar Story of Resuscitation in Near Drowning

Eelco F. M. Wijdicks*

Keywords: History of Medicine, Drowning, Resuscitation, Positioning, Tobacco insufflation

Defined by the World Health Organization as "the process of experiencing respiratory impairment from submersion or immersion in liquid," near drowning is a devastating environmental critical illness [1]. It is danger in plain sight and our innate emotional instincts kick in when we see someone drowning. Resuscitation must be early and in the field, but it is dependent on bystander's efforts.

When taken out of the water, patients can be limp and comatose, gasping for air, and seriously hypothermic. When the submersion time is less than one hour and there is no obvious physical evidence of departure from life, patients enter the emergency department, and outcome is then determined by a number of observations: apnea on admission, presence of fixed and dilated pupils, a severe metabolic acidosis, and whether coma persists days after resuscitation. Aspiration of contaminated water may become an outcome determinant.

After resuscitation, general measures focus on prevention of additional brain damage from hypoxia and hypoglycemia, both common accompanying conditions in near-drowning victims. Targeted temperature management (32–34 °C for 24 h) is standard in many institutions. Attempts to prolong the protective effect of hypothermia with high doses of barbiturates have been unsuccessful, but others have reported success with early institution of induced hypothermia [2]. Nevertheless, spectacular recoveries have been reported after hours of resuscitation and even after more than 1 h of submersion.

*Correspondence: wijde@mayo.edu
Neurocritical Care Services, Saint Marys Hospital, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA

Springer

Care of the nearly drowned patient has matured and over time has increasingly involved neurointensivists. But going back to the history of rescue of lifeless bodies after near drowning, we find that its methods were both bizarre and inexact. Decades passed before some rational method materialized.

The Miracle Smoke

Historically, bringing back the dead could only be found in fiction (e.g., Mary Shelley's *Frankenstein, or The Modern Prometheus*). Indeed, until the eighteenth century, medicine was far more concerned with correctly identifying signs of death (to avoid the greatest fear of all—premature burial) rather than attempting revival.

Often, a frightening encounter involved a person who had drowned but still showed some sign of life. Resuscitation was haphazard, with shaking, rewarming, and using spirits, and as a last resort, a surgeon might make a laryngotracheal incision to blow air directly into the lungs. The very first rescue society was founded in 1767 in Amsterdam, the Netherlands, and was known as the Amsterdam Rescue Society and later Society to Rescue People from Drowning (*Maatschappij tot Redding van Drenkelingen*). In Amsterdam, with its plethora of canals, drowning was frequent; for example, 90 people drowned on New Year's Eve in 1790, when dense fog made canals invisible, certainly for the inebriated [3]. The society developed a number of methods to treat drowning but without a predetermined protocol. Methods also changed over the years and included rubbing, warming, tobacco smoke clysters, oral ventilation techniques, bloodletting, and barrel rolling. Various other rescue societies were formed, and they installed "fumigation kits" along the Thames, Seine, Rhine, and Meuse Rivers and other major waterways and around Lake Geneva. Intestinal insufflation with tobacco smoke

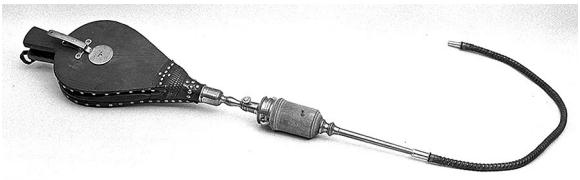

Fig. 1 Apparatus to blow tobacco smoke. Credit: Royal Humane Society Resuscitation apparatus. Wellcome Collection. Attribution 4.0 International (CC BY 4.0)

rapidly became a preferred method (Fig. 1). Although it was called "the Dutch Method," European settlers noted that Native Americans also practiced anal insufflation of tobacco as a rescue therapy.

Albrecht von Haller [4] from Berne (1708–1777) wrote that for him, the priority was to "create movement in the lungs and remove the foam that in most cases prevents the victim from breathing." For this purpose, he advised a bellows fitted to a hose inserted into the throat: "a curved hose like the kind used in anatomy… and through this hose air is forcefully blown into the drowned lung." He reported on 8 years of practice with this technique "to resuscitate a body that is already rigid." During this time, he found nothing more useful than tobacco smoke enemas. He advised blowing this smoke into the intestines for at least 2 h because the effect was often slow. The appearance of colic rumbling after auscultation was indicative of success, and the physiology behind it was gut expansion pushing against the diaphragm to facilitate emptying of the respiratory tracts and at the same time to "warm up" the patient. Furthermore, at low doses, nicotine stimulates the adrenergic receptors in the rectal submucosa and has a cardiotonic effect [5].

Several groups reported phenomenal numbers of revival. The Society for the Recovery of Persons Apparently Drowned (later named the Royal Humane Society) was particularly concerned with the Thames River, the site of many deaths by drowning at a time when few Londoners knew how to swim, and installed resuscitation kits at multiple points along the Thames (a booklet translated by Cogan in 1773 introduced in London the methods practiced by the Amsterdam Rescue Society [6]). But in 1811, Brodie reported that in his animal experiments, rectal smoke could kill, which was explained by nicotine's cardiac toxicity. His experiment was widely shared and alarmed drowning societies, who effectively abandoned this method despite claimed clinical success in hundreds of cases [7].

Body Positioning

After the drowned person was removed from the water, a number of body positions were suggested, and each had some physiological underpinning. The aim was to imitate the natural respiratory movements—expiration by compression and inspiration by the recoil of the chest wall. They included the Marshall Hall method expiration by turning the patient in the prone (face down) position and applying pressure to the back over the thorax and abdomen. Inspiration started when this pressure was released. The Silvester method adopted a supine posture, producing inspiration by expanding the chest wall and expiration by compressing it. Howard's method attempted to create the greatest possible degree of recoil and overextended the spine by placing a pillow or any convenient support under the patient to make the subcostal margin prominent. Finally, the barrel method became popular (See Fig. 2 for illustration of these methods).

Mouth to Mouth

Mouth-to-mouth resuscitation came into practice gradually over the course of the nineteenth century. Meanwhile, intestinal insufflation silently disappeared from the recommendations. The instructions provided by

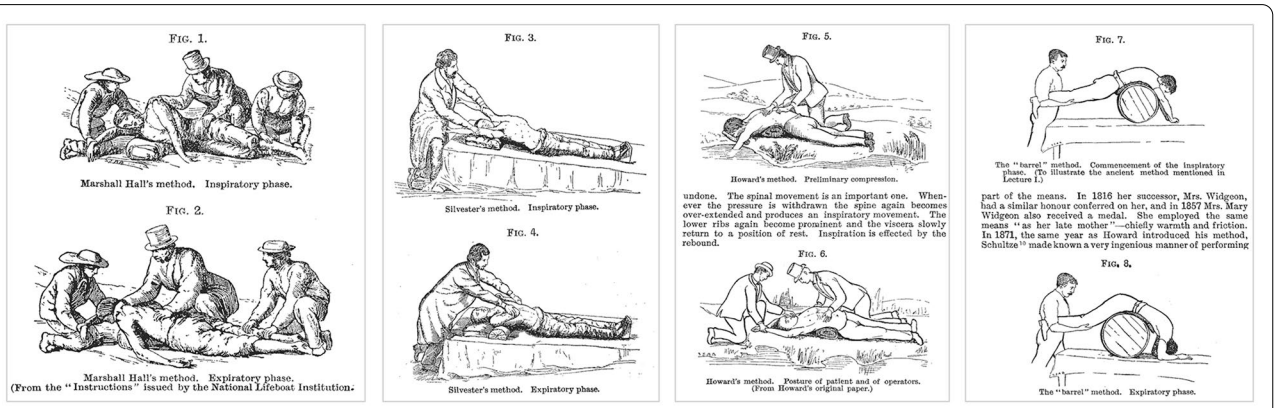

Fig. 2 Multiple methods of body positioning [6]

the English Humane Society in its first annual report in 1775 included the following:

> *Artificial respiration [was] carried out in the following manner. The operator closed the patient's nostrils and applied his mouth to his and thus inflated the lungs and expanded the belly and the chest. By compressing these parts with his free hand the operator brought about an expiratory movement.*

In 1744, John Fothergill published an essay in the *Philosophical Transactions of the Royal Society of Medicine* in which he discussed a previous publication by William Tossach. Tossach had helped resuscitate a coal miner who was apneic and pulseless.

> *Tossach had applied his mouth close to the patient's and by blowing strongly, holding the nostrils at the same time, raised his chest fully by his breath. The surgeon felt 6–7 quick beats of the heart…in one hour the patient began to come to himself, within four hours, he walked home, and in as many days returned to his work.*

Later on in the discussion, Fothergill wrote the following:

> *It has been suggested to me by some that a pair of bellows might possibly be applied with more advantage in these cases, than the blast of a man's mouth; but if any person can be got to try the charitable experiment by blowing, it would seem preferable to the other [because] the lungs of one man may bear, without injury, as great a force as those of another man can exert; which by the bellows cannot always be determined" [8].*

In 1829, d'Etioles demonstrated that using bellows for ventilation is potentially harmful because the lungs of a pulseless patient cannot tolerate positive pressure ventilation. Also, when the lungs are inflated, the main direction is to the epigastrium, and the water-logged parts of the lungs lying against the rigid apical and dorsal walls do not expand to the same extent. Indeed, in 1837, the Royal Humane Society removed the use of bellows, as well as mouth-to-mouth resuscitation, from its list of recommended treatments [9, 10].

We can only conclude that physicians grappled throughout history with resuscitation but understood that some external mechanical help could compress and recoil the lungs. But then the focus switched to the heart. In 1960, Kouwenhoven published his landmark article on cardiopulmonary resuscitation (CPR), and in his own words, "anyone, anywhere can initiate cardiac resuscitation procedures. All that is needed are two hands" [11, 12]. A new epoch of resuscitation started and continued to evolve, with guidelines released by the new American Heart Association, a world leader in CPR, emergency training, and education.

It is more difficult to know when to discontinue resuscitation after near drowning. No single factor accurately predicts good or poor survival with 100% certainty, although flaccidity or decorticate or decerebrate responses 6 h after rescue have some prognostic validity [13]. In many cases, resuscitation continues until there is unambiguous evidence of futility (e.g., patients who have sustained severe concomitant trauma). ECMO has become an option and includes the reinstitution of perfusion regardless of the cardiac rhythm, reduction of the high blood viscosity associated with severe hypothermia, and rapid restoration of normothermia [13, 14].The earlier drastic measures are now only of historical interest, but they illustrate that good ideas in their embryonic state eventually evolve into accepted practices with robust physiologic underpinnings. But that sifting takes centuries.

Source of support
None.

Conflict of interest
None.

Publisher's Note

Received: 16 September 2022 Accepted: 20 September 2022
Published online: 12 October 2022

References

1. van Beeck EF, Branche CM, Szpilman D, Modell JH, Bierens JJ. A new definition of drowning: towards documentation and prevention of a global public health problem. Bull World Health Organ. 2005;83(11):853–6.
2. Bohn DJ, Biggar WD, Smith CR, Conn AW, Barker GA. Influence of hypothermia, barbiturate therapy, and intracranial pressure monitoring on morbidity and mortality after near-drowning. Crit Care Med. 1986;14(6):529–34.
3. Bierens J. The Amsterdam-based Maatschappij tot Redding van Drenkelingen 1767–2017: guiding drowning resuscitation during 250 years. Resuscitation. 2017;120:A1–4.
4. von Haller A. Instruction pour conserver la vie aux personnes, qui ont eu le malheur de tomber dans l'eau; d'être suffoquées, ou de s'étrangler, & pour les guérir. Le tout composé & publié d'Ordre de l'Illustre Conseil de Santé de la Ville et République de Berne. Leurs Excellences: Berne, Switzerland; 1776.

5. Serdeczny A. Du tabac pour le mort. Une histoire de la reanimation. Ceyzérieu, France: Éditions Champ Vallon; 2018. p. 386.
6. Keith A. The mechanism underlying the various methods of artificial respiration. Lancet. 1909;1:745–9.
7. Brodie, B.C. Experiments and observations of the different modes in which death is produced by certain vegetable poisons. Philosophical Transactions of the Royal Society: London; 1832. p. 101.
8. Fothergill, J. Observations on a case published in the last volume of the medical essays, &c. of recovering a man dead in appearance, by distending the lungs with air. Coll Med Lond 1744;43(5):275–81.
9. Keith A. Various methods of artificial respiration practised since the foundation of the royal humane society. Lancet 1774;1909:825–8.
10. Keith A. The period of mechanical expansion and compression of the chest wall. Lancet 1856–1909;1909:895–9.
11. Kouwenhoven WB, Jude JR, Knickerbocker GG. Closed-chest cardiac massage. JAMA. 1960;173:1064–7.
12. Kouwenhoven, W.B.Langworthy, O.R. Cardiopulmonary resuscitation. An account of forty-five years of research. Johns Hopkins Med J 1973;132(3):186–93.
13. Szpilman D, Morgan PJ. Management for the drowning patient. Chest. 2021;159(4):1473–83.
14. Topjian AA, Berg RA, Bierens JJ, et al. Brain resuscitation in the drowning victim. Neurocrit Care. 2012;17(3):441–67.