From the Pages of History

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Ralph Waters

Yandell Henderson

Anaesthesia has been called as physiology in action. The development of anaesthetic agents and apparatus has dominated the discussion of development of anaesthesia. Yandell Henderson and Ralph Waters were the early proponents of the importance of physiology in anaesthesia[1]. Ralph Waters, who created the first academic department of anesthesiology in Wisconsin in 1927, was of the opinion that understanding the science was necessary for competency in the field of medicine. John Snow, called the first and greatest anaesthetist by Waters, was the first to do preoperative examination to understand the physiology of his patient. Yandell Henderson who was called the father of applied physiology had quoted that "Physiologists now and in the next few years will find their richest and most fruitful problems in the field of clinical, rather than in that of purely abstract, physiology... development of clinical physiology might well be the greatest event in the progress of medicine during the second de-cade of the twentieth century[1]."

The physiology in the early days was philosophical-physiology as found in the ancient Indian texts where multiple references to the importance of air (vayuh), respiration (pranah) and sleep (svapnah and svapnantah) are found. Chinese texts mention about Lien Chi (breath into the soul). At a time when man was seen as a special creation, Jean Fernel (1497 -1558) stated that nature's laws applied to physiology of man[2].

Progression of respiratory physiology[2]

In the era when human dissection was prohibited, Galen had pointed out that air is inhaled because of expansion of the chest and lung follows passively. The progression in the mechanics of respiration had to wait till GA Borelli who in 1680 measured the inspired volume and residual volume. In 1799, in his book, which mainly focused on Nitrous oxide, Humphry Davy describes the direct measurements of lung volumes. John Hutchinson (1846), a surgeon, described various subdivisions of lung volume after his experiments on 2130 individuals. He gave the first pressure - volume curves for the lungs in the year 1849 and coined the term vital capacity and described timed vital capacity. In 1864, Nester Grehant determined the functional residual capacity and coefficient of ventilation (inspired volume/FRC). Pulmonary dead space was described by Haldane and Priestly in 1882. Fritz Rohrer, in his doctoral thesis, calculated the pressures required to overcome laminar and turbulent airflows in 1915, which was the first description of the physics of the flow in the airway.

Richard Lower's Tractatus de corde (1669) mentions lung as the site where the blood changes its color when it comes in contact with air. The idea of respiratory system as a site where exchange of gases take place, was utilized by Stephen Hales (1677-1761), when he invented the trough for collecting gases with closed circuit respiratory apparatus. Haldane and Priestly used India rubber tube to sample alveolar gas. The identification of gases was a long journey, which culminated in the discovery of oxygen by Wilhelm Scheele (who was unlucky not to be credited for his various contributions) and Joseph Priestly. Joseph Priestly in 1774 gave the name "dephlogisticated air" after the "phlogiston theory" by George Ernst Stahl (1734). Joseph Black (1728-1799) observed that CO_2 produced during expiration turns limewater to $CaCO_3$. Antoine Laurent Lavoisier's (1743- 1794) statement that respiration is uptake of oxygine and production of carbonic acid gas put an end to various theories prevalent at that time. This was further established by the observation of Heinrich Gustav Magnus (1802- 1870) that venous oxygen content is less than that of arterial and venous content of carbondioxide is more than the arterial carbondioxide content.

The factors controlling the respiratory movements made progress only after the progress in chemistry. Ewald Hering and J Breuer theory of "self regulation" showed that inflation stopped respiration in expiration, known as the Hering-Breuer reflex. Marshall Hall gave the role of CO_2 in the rhythmicity of breathing in 1850. E Pfluger in 1868 suggested that hypoxia stimulates breathing. John Scott Haldane (1860 – 1936) in an article inferred that though all the mechanisms governing the respiration are yet to be elicited, the resting ventilation is controlled by CO_2. F Miescher Rusch in 1885 had suggested that resting ventilation is controlled by CO_2.

The transport of gases to the tissues was postulated by the Greeks, who thought that venous system carried blood and arterial system carried air. Empedocles of Sicily (495 – 435 BC) put forward the theory of ebbing

and flowing of blood from and to the heart. Diagenes of Apollonia (430 BC) suggested that blood vessels carried air through the body. The complete description of the systemic circulation had to wait till William Harvey's De Mortu Cordis in 1628.

Felix Hoppe Seyler isolated the iron containing hemoglobin and gave the oxygen carrying power to hemoglobin. He also determined absorption spectra for oxyhemoglobin and reduced Hemoglobin. Paul Bert (1833- 1886) , in 1872 provided data for oxygen dissociation curve (ODC). In 1904,Christian Bohr along with Hasselbach and Krogh gave the curve for ODC. Hasselbach and Krogh observed that adding carbon dioxide drives oxygen out. The relationship between hemoglobin saturation and the partial pressure of oxygen was given as an equation by J. W. Severinghaus in 1979, calculating a table of values for a standard human blood O2 dissociation curve at 37°C and pH 7.40.

Airway physiology[2]

Marshal Hall (1856), gave the first documented importance to freeing the respiratory airway for resuscitation. He was the first to describe pharyngeal obstruction and suffocation by the tongue falling back during deep chloroform anesthesia, an explanation that Snow had previously rejected. Hall advised turning the patient to the prone position to relieve the obstruction. Also mentioned about vocal cord closure to noxious stimuli. John Thomas Clover (1868), Jacob Heiberg (1874), and Friedrich von Esmarch (1877) have claimed the invention of the "jaw thrust" (pulling the jaw, and thus the tongue, forward) to remove airway obstruction. Benjamin Howard in 1880, suggested an alternative, head tilt and extension, something that might be done with one hand, a technique still used to relieve obstruction by the tongue.

Cardiac physiology[3]

Cyon and Ludwig in 1866 were the early observers of neural reflexes for cardiovascular regulation. Stimulation of depressor nerve resulted in decrease in heart rate and blood pressure. Variations in heart rate with emotions made Aristotle to consider the heart as the seat of the emotions, a phenomenon suggesting the early observation of the autonomic nervous system. Koester and Tschermark, 1902, put forward the theory of pressure sensitive region in arteries. Heinrich Ewald Hering, inspired by Johann Czermark's self experiments, described the carotid sinus reflex in 1905. In 1928, De Castro mentioned that carotid body is sensitive to the composition of the blood supplying it.

In 1867, Von Bezold and Hirt detected a decrease in heart rate and blood pressure after injection of intravenous veratrum alkaloids in animals. This observation was furthered by Jarisch in 1930s and led to the description of the now famous vagal chemoreflexes. Bainbridge reflex was described in the year 1915.

In 1864, Goltz mentions about the need for integrity of spinal cord is to maintain vascular tone. In 1870 Dittmar and Owsjannikow attributed the lower brainstem for resting blood pressure and reflexes. Sherrington put forward the theory of spinal autonomic apparatus for resting blood pressure. Brown Sequard's elixir followed his demonstration in 1856 that removal of the adrenal gland resulted in death. In 1899, Hunt described the medullary cardio accelerator and inhibitory fibres. Sir William Bayliss theorized about the constrictor and dilator centres in the brain. In 1902, the famous Bayliss effect was published about the arterial muscle contraction when pressure increases.

These are but a few of the important physiological advances, which helped in the progress of anaesthesia. The ability to understand physiology and the control of it helped in the progress of surgical sciences, critical care and resuscitation.

References

1) Yandell Henderson (1873 - 1944). A biographical memoir by John B West National Academies Press Washington D.C. 1998.

2) The Wondrous story of Aneasthesia. Eger EI II, Saidman LJ, Westhorpe RN (Eds). Springer Publication. 2014: 944.

3) Handbook of physiology, Wallace O Fenn, American Physiological society. 1965.

Anti-hypertensives in diabetic patients –to give or not to give?

Global prevalence of diabetes mellitus is 8.3% - roughly 382 million people worldwide. Many diabetics are at the risk of developing hypertension and cardiovascular disease. Antihypertensive treatment is often recommended to treat and prevent the complications. But this may not always be good idea. In a recent meta-analysis of 49 random controlled trials involving 73738 type 2 diabetes patients, the researchers found that treating diabetic patients with anti-hypertensives was beneficial only when the systolic blood pressure was more than 140, as it caused discernible reduction in cardiovascular complications and all-cause mortality. But when the systolic blood pressure was less than 140, there was no perceptible benefit from anti-hypertensives. In fact, the risk of cardiovascular death increased by 15%. The study is published in the BMJ (Brunström M, Carlberg B. Effect of antihypertensive treatment at different blood pressure levels in patients with diabetes mellitus: systematic review and meta-analyses. BMJ. 2016; 352:i717)

- Dr. K. Ramesh Rao