A Trip Down the Memory Lane of Dr. Frank Gollan, an Achilles of Extracorporeal Oxygenation

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Abstract

Every health care professional does his best for mankind, but handling a patient on extracorporeal circulation places cardiac surgeons, cardiac anesthetists, and perfusionists in a separate class of health professional altogether. This is a humble effort to reminisce the research work done by Dr. Frank Gollan since his instrumental time to the current day practice, without whom it is impossible to imagine open heart surgery and circulatory arrest.

Keywords

- Dr. Frank Gollan
- extracorporeal circulation (ECC)
- cardiac surgery

Introduction

Before the invention of the cardiopulmonary bypass machine by Dr. John Gibbon, surgeons like Dr. Clarence Walton Lillehei had performed open heart surgery with the aid of cross-circulation, where the patient's father's lung acted as the human oxygenator. In the author's opinion, the secret behind the success of Dr. John Gibbon was the incorporation of artificial oxygenator into the bypass circuit and his persistent effort which were the limiting factors till the date. Hence, it is prudent to recollect the efforts made by legend, Dr. Gollan, to the world of extracorporeal oxygenation (ECO) along with Dr. Leland Charles Clark (►**Fig. 1**).

The basic principle in Dr. Clark Jr. and Dr. Gollan's equipment was "Oxygenation of Blood by Gas Dispersion."[1] Till date, various routes of oxygen administration were attempted and rendered fruitless as minute amounts of oxygen was supplied to the body, as compared with the requirements of the body via nonrespiratory routes. They eventually developed as oxygen delivery system that would allow the introduction of sufficient quantity of oxygen into the blood by exposing a large surface area of blood to oxygen. This system was experimented upon in an anesthetized dog at a temperature of 40°C, and the blood was drawn from the inferior vena cava through a cannula (the position of the

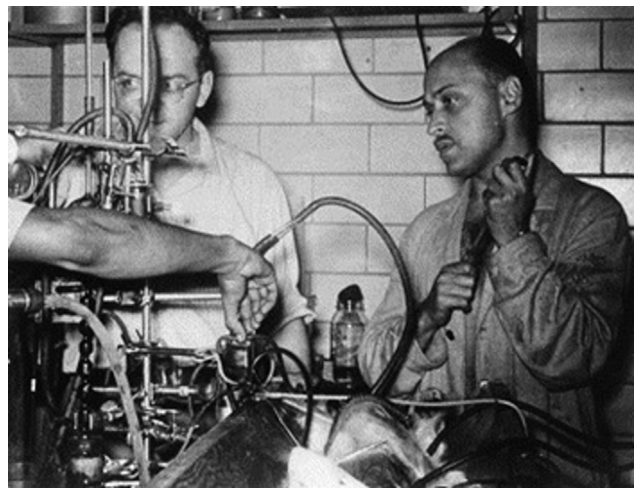

Fig. 1 Dr. Frank Gollan (on right) and Dr. Clark L.C., Jr. (on left) experimenting with bubble oxygenator.

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Table 1 Contributions of Dr. Frank Gollan

Serial No.	Year	Contribution
1	1948	Purification of MM Poliomyelitis virus
2	1950	Experiments on oxygenation of blood gas by dispersion
3	1955	Experiments on hypothermia in canine models
4	1959	Authored the first edition of the book "Physiology of Cardiac Surgery"
5	1966	Experiments on survival of mammals breathing organic liquids equilibrated with oxygen

cannula was confirmed by percussion). They made venous blood pass through a humidified oxygen chamber which consisted of a sintered glass plate with a pressure of 10 lb. Achieving ECO is certainly a big achievement, but the next level problem they had to deal with was bubbles in the oxygenated blood. Now, to overcome this problem, they made the oxygenated blood, pass through glass beads coated with DC Antifoam A, a silicone-based compound. Oxygenation was confirmed by change in blood color from dark to bright red and by measuring and comparing the pH. Oxygenated blood was infused back into animal via the external jugular vein into the superior vena cava.

With this they determined the minimum blood flow for survival, which was 40 mL/kg/min.[2]

They checked the efficacy of the oxygenation, by administration of 100% nitrogen through a tight-fitting transparent mask 5 to 10 minutes prior to pumping of oxygenated blood. All the oximeter readings showed oxygenation more than 95% when the dog was breathing 100% nitrogen. When this experiment was conducted in 15 dogs, they could manage a hypoxic state due to nitrogen inhalation by ECO for maximum of 99 minutes.[1]

Dr. Gollan had extended the experiment at various hypothermic temperatures on 33 dogs and documented his important findings.[1] It was those contemporary times when Bigelow was also conducting similar kinds of experiments with hypothermia. Dr. Gollan had manipulated the temperature by inserting a silver coil into the venous circuit which facilitated temperature adjustment. This experiment showed a path to understand the rate of cooling and rewarming, changes of temperature on blood pressure, respiration, electrocardiogram, and the mortality of animals.[1] When the animals were cooled to 29°C, all survived. Mortality was seen to be rising as soon as the temperature was decreased from 29°C to 27°C and all animals died when cooled below 27°C.

Along with contributions of Gollan in the territory of oxygenation, his experiments on differential hypothermia levels are phenomenal.[3,4] This experiment paved a way to circulatory arrest in the near future. These experiments demonstrated that hypothermia of 14°C without ECC can aid in the circulatory arrest for an estimated 12 minutes.

Their experiments on the survival of mammals breathing organic liquids with oxygen had ignited the minds of future generation researchers in the development of artificial oxygen carrying substances in the place of blood, which is among the most expensive substances in health care.[5]

Dr. Frank Gollan has also contributed in the purification of the MM poliomyelitis virus and electron microscopic studies in 1939.[6] Dr. Gollan has also attempted a total hypothermic blood exchange in acute endotoxin shock by infusing endotoxin. Although the results were immediately promising, all the animals suffered a delayed death as endotoxin particles were already engulfed by the reticuloendothelial system.[7]

Dr. Frank Gollan has authored the textbook "Physiology of Cardiac Surgery" in 1959, which gives details about hypothermia and ECC (►**Table 1**).

Conclusion

Dr. Gollan had poliomyelitis as a child and had dedicated himself to finding a solution, ultimately, he succeeded in isolating the virus which paved the way for scientists to effectively develop vaccines against this terrible disease. He was born in Czechoslovakia on July 1, 1907, escaped the Nazis and settled in Cleveland and became professor at Antioch College. He then moved to Florida and became a research scientist and professor at the University of Miami. He had to undergo two major surgeries in the last 4 years of his life, had a tumor of the brain excised, and had a heart attack. His wife Mrs. Alice Gollan was visually impaired and had Alzheimer's disease. Dr. Frank Gollan, at the age of 78, and his wife Mrs. Alice Gollan, at the age of 81, both committed suicide by taking several pills leaving a note stating that they were despondent about their deterring health at their home in Miami on October 6, 1988. He is survived by his son Mr. Andy Gollan.[8,9]

Dr. Walton C. Lillehei, the pioneer of cardiac surgery had written a letter to Dr. Gollan in 1951, appreciating his work on oxygenators.

We want to conclude with Dr. Gollan's statement which tells of his endless efforts to elevate perfusion and hypothermia to another level.

> "BE ASHAMED TO DIE UNTIL YOU HAVE WON SOME VICTORY FOR HUMANITY"[10]

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Conflict of Interest
None declared.

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