



Takuo Aoyagi—a Tribute to the Brain Behind Pulse Oximetry

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Abstract

A tribute is being paid to the Dr. Takuo Aoyagi who invented pulse oximetry to measure the oxygen saturation in the blood in 1974. The importance of pulse oximetry is felt more in this coronavirus pandemic. Takuo Aoyagi expired at Tokyo on 18 April 2020.

Keywords Oxygen · Pulse oximetry · Blood gas

“Oxygen lack not only stops the machine but wrecks the machinery” – JS Haldane



Dr. Takuo Aoyagi, a Japanese Bioengineer, whose pioneering work in 1974 led to the invention of modern first commercially available pulse oximeter, a life-saving device that clips on a finger and shows the level of oxygen in blood, died on April 18, 2020, at Tokyo, at the age of 84. Hanning

and Alexander William described the monitoring of the oxygen saturation as the “the greatest advance in patient monitoring since echocardiography” [1]. Introduction of pulse oximetry coincided with a 90% reduction in anesthesia-related fatalities. According to Dr. V Courtney Broaddus, Professor Emeritus of Medicine at the University of California, San Francisco, apart from the 4 vital signs—temperature, blood pressure, pulse rate, and respiratory rate, pulse oximeter has become the “fifth” vital sign for oxygen saturation monitoring. The discovery of pulse oximeter by Takuo Aoyagi culminated a century of efforts to prevent the 1885 euphoric high-altitude hypoxic death of Zenith balloonists and fighter pilots in World War 1. In an essay about Dr. Aoyagi, John W Severinghaus, Professor Emeritus of Anesthesia at the University of California, San Francisco commented in 2007 that Dr. Aoyagi’s “dream” has been to detect oxygen saturation levels without having to draw blood.

Takuo Aoyagi was born on February 14, 1936, in Niigata Prefecture, Japan, and graduated in 1958 from the Faculty of Engineering at Niigata University with a degree of Electrical Engineering. He joined the research division of Nihon Kohden Corporation in 1971. The inspiration behind Takuo Aoyagi’s discovery in his own words was “I read a report on an interview with Dr Yashio Ogino, Founder of Nihon Kohden Corporation in a newspaper. I was deeply impressed by his words. ‘A skilled physician can treat a limited number of patients, but an excellent medical instrument can treat countless patient in the world.’”

Takuo Aoyagi is often recognized for putting the “pulse” in pulse oximetry by using the waveform produced by the arterial pulse to measure and calculate SpO₂. He concluded that the variation of the tissue arterial blood volume may be useful

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for obtaining a signal depending only on pulse characteristics of arterial blood, which may be used for measuring arterial oxygen saturation [2]. While many companies sell oximeter today, “all of today’s oximeter are based on Mr. Aoyagi ‘s original principles of pulse oximetry” according to the Institute of Electrical and Electronics Engineers (IEEE), which awarded Dr. Aoyagi its IEEE medal for innovation in health care technology in 2015. He was the first Japanese person to receive the award and IEEE declared that his research had led to “a fortyfold reduction in death rates in anesthesia.” Nihon Kohden applied for a Japanese patent for its pulse oximeter in 1974 and it was granted in 1979. Aoyagi was awarded with the 2013 Gravenstein award from the Society of Technology in Anesthesia. The University of Tokyo gave Aoyagi a doctorate in Engineering in 1993. In 2002, he received a Medal with Purple Ribbon from the Emperor of Japan, given in recognition of achievements in the arts and academics.

Dr. Takuo Aoyagi’s contribution to the discovery of the principles and the development of the pulse oximeter was introduced to the world by Dr. John Severinghaus, but Aoyagi was himself quite reserved and even in Japan, he was relatively unknown in the early 1980s. Severinghaus concluded that Takuo Aoyagi’s invention was serendipitous [3]. Unfortunately, the business Dr. Aoyagi worked for did not recognize the potential of his invention and other companies eventually produced the pulse oximeter. By then, however, Dr. Aoyagi had been transferred to another project. The concept behind pulse oximetry had been “denied” by a skeptical supervisor at Nihon Kohden, Dr. Aoyagi recalled, and he was kept from working on the device until 1985. Competitors such as Minolta had made refinements that helped make the pulse

oximeter popular. Without their work, he wrote in a personal essay, “the idea might be buried.” In 2007, World Health Organization included pulse oximetry as an essential component of its surgical safety checklist for reducing complications. The Chairman of Board, Nihon Kohden Corporation Kazuo Ogino finally concluded “Dr Aoyagi invented one of the most important technologies for patient safety.” The role of pulse oximeter in the current coronavirus pandemic has been undoubtedly on the top. “Greatness in science often, as here, comes from the well-prepared mind turning a chance observation into a major discovery,” Severinghaus wrote about Aoyagi. In his obituary, Nihon Kohden Corporation present President H. Ogino mentions “The invention of the pulse oximeter is a feat that will go down in the history of the world.”

Compliance with Ethical Standards

Conflict of Interest The author declares no conflict of interest.

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