



## The Resuscitation Greats

# Franz Kuhn, his contribution to anaesthesia and emergency medicine.

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### Abstract

Franz Kuhn (1866–1929), a German surgeon, made a significant practical and scientific contribution towards the development of modern anaesthesia and emergency medicine. He developed modern, scientifically based concepts in close correlation to practical inventions for every day use. All of his studies and developments were patient orientated and led to remarkable improvements in patient safety. Kuhn was a major protagonist of endotracheal intubation, perfected his flexo-metallic endotracheal tubes, worked on different techniques of intubating the trachea, applied positive pressure to the lungs during thoracic surgery and developed anaesthesia machines. In the early 20th century, he wrote several papers on this topic including a remarkable monograph, dealing with the techniques, indications in anaesthesia and emergency medicine and his experiences of endotracheal intubation. Due to a dispute with Sauerbruch on the methods of avoiding a pneumothorax during thoracic surgery and the development of local and regional anaesthesia techniques, the value of his work and his revolutionary ideas were not appreciated until 40 years later. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

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### 1. Medical training

Franz Kuhn (Fig. 1), fifth child of a wealthy landowner, was born on 12. October 1866 in Aschaffenburg, a small town close to Frankfurt.

He began his medical studies in Würzburg and continued in Berlin and Munich. Kuhn obtained the doctorate in Würzburg in 1891 with a dissertation entitled ‘Morphologische Beiträge zur Leichenfäulnis’ (The Morphology of Cadaveric Decomposition).

His medical training and career began at the Department of Surgery at the University Hospital in Giessen, Germany, in 1895, where he was assistant to Heinrich Bose and Peter Poppert. Bose had been working on various problems associated with tracheostomy, Poppert was known to be an expert in anaesthesia due to his publications on the risks

of ether. Presumably, these teachers raised Kuhn’s interest in the issue of asphyxia due to anaesthesia [1].

Very early, he was working on techniques of examining the gastro-intestinal tract using flexo-metallic bougies [2].

Slightly resembling the modern flexible non-occlusive endotracheal tube, strengthened by a metal wire in its wall, Kuhn’s flexo-metallic tubes consisted of a spiral of thin metal with overlapping edges. Kuhn had proposed and published this principle for different purposes in medicine since 1896 [3]. After experience in examining the gastro-intestinal-tract he started studying its use for intubating the trachea in corpses, presumably influenced by his impressions from the United States.

In 1897, a scholarship enabled Kuhn to undertake an extensive study tour to the United States of America. His journey took him to New York

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Fig. 1. Franz Kuhn (1866–1929).

City, Philadelphia, and Baltimore. There, he came first into contact with digital intubation techniques of the trachea and the Trendelenburg cone for administering volatile anaesthetics.

## 2. Endotracheal intubation

The newly built Elisabeth Hospital in Kassel, Germany, appointed Kuhn in 1899 director and specialist in surgery.

During the time at Kassel, Kuhn undertook his most important anaesthetic investigations. He published more than 90 papers, one third of which were concerned with orotracheal intubation of the trachea and the technique of positive pressure ventilation.

In 1900, Kuhn was confronted with a patient who died from a sudden haemorrhage in the throat. This incident is thought to have motivated him to develop a technique of securing the airway with his flexo-metallic bougies. In 1900, he had developed a metallic endotracheal tube [4]. The first detailed description of the technique of orotracheal intubation followed in 1901 [5]. He commenced this publication with his intention for his work: "I describe the tubage of the trachea to ensure an uncompromised airway without tracheostomy" (Author's translation).

Kuhn stated that 'the perioral tubage (intubation) keeps the airway open, even without traction of the tongue or protrusion of the mandible'. Another remarkable statement was that 'even the direct ventilation of air into the trachea with a rubber balloon would be workable and is the most appropriate measure in case of asphyxia'. Very early, he had noticed the importance of a secure airway during anaesthesia and surgery and he never stopped promoting this conviction [6]. 'If, during anaesthesia, respiration may become insufficient or even stops, and there is the need for artificial ventilation, what is the first measure to perform? Clear and secure the airway! How could this goal be achieved faster and safer than performing perioral tubage?' [7]

Kuhn's first tubes measured between 12 and 15 cm in length with a cylindrical shoulder close to the distal end, which helped to prevent the tube from being inserted too far into the trachea. At the proximal end of the tube, a shield was fixed to prevent damaging the tube by the teeth. He recommended using tubes with a diameter of 6–7 mm for children, 9 mm for women and up to 10 mm for men.

Although Kuhn mentioned the use of the Kirstein autoscope, a forerunner of the laryngoscope, he usually inserted the tube with a metal introducer by the help of digital palpation of the epiglottis and the arytenoid cartilages. The tube was fixed after insertion into the trachea with a rubber band to a metal hook. The proximal end of the tube could be connected with a Trendelenburg cone filled with gauze to administer chloroform and perform anaesthesia. A stethoscope attached to the cone was used to monitor the patient's breath sounds.

Some years later, Kuhn explained his favour of the flexo-metallic bougie as endotracheal tube in comparison with a rubber tube [8]. He wanted to obtain a drainage of the airway, comparable to surgical principles, to guarantee an open airway from the teeth down to the trachea. Therefore he was looking for a flexible, but non-compressible tube, similar to the natural cartilages of the trachea.

Kuhn performed tracheal intubation using this technique in the awake patient, using local anaesthesia — with cocaine and sometimes added epinephrine — of the upper airways, or under

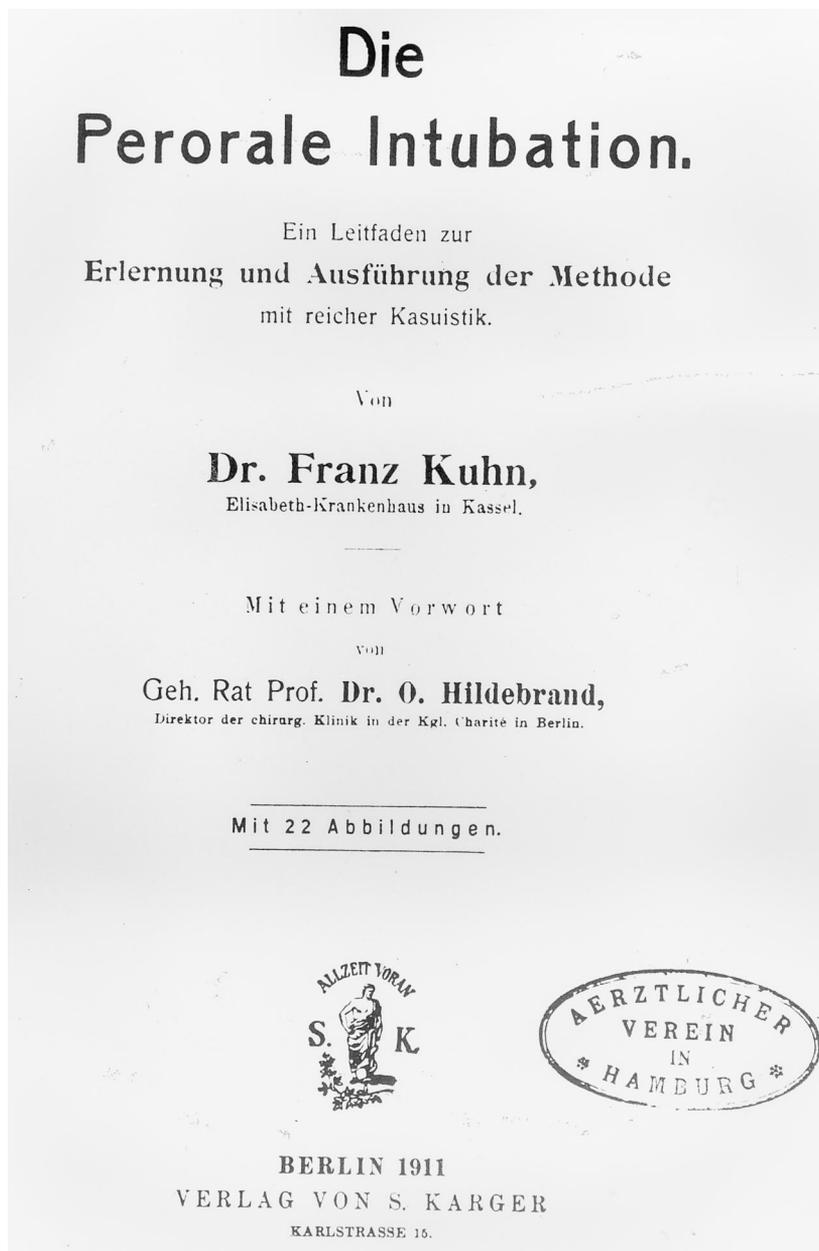


Fig. 2. First textbook on intubation.

general anaesthesia. For premedication, he used a mixture of atropine and morphine, administered subcutaneously.

He recommended tracheal intubation in patients suffering from asphyxia, to perform resuscitation and, most important of all, during anaesthesia using chloroform. In a wide range of applications, he described the use of this technique in patients undergoing surgery of the gall bladder, resections of tongue and mandible tumors, neurosurgery and others. Kuhn published his findings and studies on intubating the trachea in 1911, presenting the first textbook covering this issue [9] (Fig. 2).

### 3. Emergency medicine

Franz Kuhn also published very modern and, in 1910, revolutionary ideas on resuscitation and airway management in asphyxiated patients by performing endotracheal intubation [10]. According to his findings from animal research, he recommended immediate artificial ventilation after intubation using an air pump, the application of oxygen, the infusion of warmed fluids and cardiac massage performed by rhythmic thoracic compressions in asphyxiated patients. These resuscitative efforts should be continued for several hours [11].

Kuhn was also aware of another problem that existed, the individual qualification of doctors to perform emergency measures [12]. He demanded to reform the mechanical–technical part of resuscitation according to scientific knowledge, a very early reference to the now popular ‘evidenced based medicine’ principle.

In Kassel, Kuhn also worked on the problem of tracheal secretions. Beside premedication with atropine, he used a manually operated suction pump and flexible suction catheters to remove secretions and blood through his tubes.

Beside these anaesthetic studies, he also worked on surgical problems and introduced, to mention just one of the most important, sterile catgut into surgical practice [13].

#### 4. The controversy with Sauerbruch

Before Ferdinand Sauerbruch invented the revolutionary concept of a negative pressure operating chamber for thoracic surgery in 1904, surgical interventions on the thoracic organs were extremely uncommon, except for emergency cases. The patient breathed spontaneously while the his thorax was placed in a large negative pressure chamber where the surgeons could operate on the thorax avoiding a pneumothorax due to underpressure.

Franz Kuhn, in opposition to the generally accepted opinion, proposed using his endotracheal tube — after tamponade of the hypopharynx — to perform positive pressure directly to the lungs so avoiding a pneumothorax during thoracotomy. He also made experiments with a rubber coating of his metallic tubes to assure its airtightness. Rubber balloons, similar to a tube cuff, were placed in the pharynx, larynx or trachea to seal the airway and enable positive pressure ventilation.

Together with Dräger, an anaesthesia machine manufacturer, he developed the Kuhn–Dräger anaesthesia machine for positive pressure ventilation (Fig. 3) [14].

Unfortunately, Sauerbruch had become such an influential figure, especially in Germany, that Kuhn’s novel ideas were met with hostility and — due to Sauerbruch’s opposition and Kuhn’s intubation difficulties during clinical demonstrations — further development of the routine use of tra-

cheal intubation was considerably delayed [15,16]. Another reason for the very slow spread of this technique of securing the airway was the introduction of local anaesthetics into clinical practise at this time. Some surgeons performed up to 80% of operations under local anaesthesia, because the use of chloroform was thought to be dangerous, even by federal authority and jurisdiction [1].

#### 5. Anaesthesia machines

Franz Kuhn also worked on more effective and safe ways of administering volatile anaesthetics, mainly chloroform. Until this time, the liquid chloroform had to be dripped on a Schimmelbusch mask held over the patients face.

Kuhn’s very practical and modern solution was an injector system, using the Venturi principle. The Dräger company used this type of injector in many of their anaesthesia machines until the first World War.

The absorption of carbon dioxide in closed anaesthesia systems was also investigated by Kuhn. He developed a closed system anaesthesia machine with two soda lime canisters and valves to direct the gas flow [14]. Due to a large deadspace in the system and the fear of possible

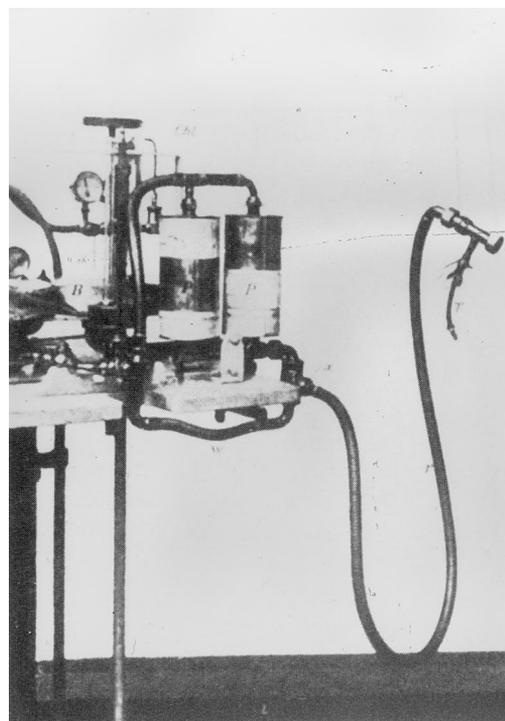


Fig. 3. The Kuhn–Dräger anaesthesia machine.

interaction between the soda lime and the chloroform, he did not finish his investigations on this issue.

## 6. Kuhn's work in Berlin

In 1913, Kuhn became Director of the newly built St. Norbert Hospital in Berlin Schöneberg. During 1912 and 1913, Kuhn developed with the Braun company a dextrose based isotonic infusion, which should be applied to prevent, among other indications, venous thrombosis.

Beside studies on a high pressure applicator for local anaesthetics, Kuhn worked mainly on surgical questions at the St. Norbert Hospital [17].

On 28 March 1929, Franz Kuhn died of lung carcinoma in Berlin.

To modern anaesthesiologists, it seems puzzling that Franz Kuhn with his enormous technical and scientific contribution to anaesthesia was not properly recognised until the second half of the 20th century [18].

In 1974, Zinganell [19] unveiled a plaque at the Elisabeth Hospital in Kassel, where Kuhn performed his major works:

*Here worked from 1899 until 1913*

*Dr Franz Kuhn.*

*His orotracheal intubation was a pioneer work for the anaesthesia today.*

*German Society of Anaesthesia and Resuscitation  
Society of German Anaesthesiologists.*

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