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## Summary

News of anesthesia's discovery came via Great Britain and France, and ether was given by February 1847. Chloroform quickly followed, but its lethality caused a reversion to ether by 1900. During the last half of the nineteenth Century, surgeons directed delivery of anesthesia by nurses and non-medical persons. Operations were few in number, and infections remained the dominant surgical risk. Surgeons introduced local and regional anesthesia after Koller's 1884 demonstration of the anesthetic effects of cocaine.

Until the 1930s, nurse anesthetists, directed by surgeons, continued to provide most anesthesia. Surgeons persuaded a few colleagues like Gordh (Sweden) to pursue a career in anesthesia. Gordh returned home in 1940 after 2 years training in the US. World War II delayed the training of other Nordic pioneers. Swedish scientists synthesized lidocaine, and Gordh clinically tested it in 1943. In 1950, Thesleff, and von Dardel in Sweden studied succinylcholine in patients.

In 1949, the World Health Organization established a one-year anesthetics course in Copenhagen for European and third world countries physicians. The course was repeated 23 times. After 1950, Nordic doctors needed 3 years of anesthesia training to become specialists in anesthesia. Besides the course in Copenhagen, each country developed its own annual postgraduate course.

In 1950–1952, polio epidemics struck Denmark and Sweden, and Ibsen applied long-term ventilation to decrease mortality, leading to the development of intensive care units (ICUs). In December 1952, Bauer opened the first ICU in Sweden, and in 1953 Ibsen did the same in Denmark. In the 1950s, Norwegian toy manufacturer Laerdal developed "Resusci-Anne". He supported Safar's 1961 first-ever meeting on closed chest cardiac massage.

Nordic anesthesia associations were founded in the mid-twentieth century. The first congress took place in Oslo in 1950. In 1957, the Association launched *Acta Anaesthesiologica Scandinavica*, with Eric Nilsson as the first editor.

From the 1960s onwards, Nordic anesthetic practice paralleled that in other developed countries. For example, the Swedish Society of Anesthesiologists increased from 180 members in 1966, to 400 in 1974, and 1400 in 2011. Within a department of anesthesia, teams of anesthesiologists and nurse anesthetists delivered anesthesia. Nordic anesthetists also provided prehospital acute care, intensive and postoperative care, and support for interhospital transportation.

## Introduction

Anesthesia is a young Nordic specialty. The first position for an anesthesiologist in Scandinavia and mainland Europe was established in 1940, at the Karolinska Hospital in Stockholm, Sweden. Why did anesthesiology take longer to develop in Nordic countries than in Great Britain (GB) and the United States (US)? Until the 1930s, Nordic medical practice followed that on the European mainland. Nordic students and young doctors traveled to Germany and France to further their education, and anesthesiology in these countries lagged behind that in GB and the US. While European surgeons needed modern anesthesia as much as did their British and American counterparts, they regarded this new 'technology' as another "surgical method" for nurses or technicians. Every young physician wanted to be THE surgeon. Besides, there were no paid hospital jobs for anesthesiologists.

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## The Early Days

The political geography of Scandinavian countries in 1846 differed from today. Finland was a part of the Russian Empire, albeit with considerable independence. Its cultural bonds were to Sweden of which it had been part for 400 years. Sweden and Norway were united in an unpopular union, created in 1814 after the Napoleonic wars. Norway had its own constitution (created in 1814) and longed for independence. Norway was also the Scandinavian country most closely connected with GB. As part of the large European peninsula, Denmark had always been more influenced by the south. Denmark also ruled Iceland until World War II, and shaped its development.

Health care provided to Nordic inhabitants before 1850 was limited to urban areas. Operative reports indicate that all surgeries were performed without anesthesia or systematic use of analgesics [1]. Operations included treatment of skull fractures, removal of the mandible, gastrotomy, and repair of inguinal hernias and cleft lips.

## The Start in Scandinavia

News of ether anesthesia reached Scandinavia in February 1847. Swedish chemist Jöns Jacob Berzelius wrote a letter from France, describing the discovery, a letter read to the Swedish Society of Medicine on 2 February. One month later, Carl Ekströmer, head surgeon at the Karolinska Institute reported satisfactory anesthesia in young healthy colleagues who volunteered to receive ether [2].

The Finn, Carl von Haartman, had a son studying in Paris who heard of ether's effects. He wrote of these to his father who read the letter to the Finnish Medical Association on 13 February [3], leading to the first anesthetics in Finland at the beginning of March.

On 18 February, in Norway, a letter from the young physician Petter Winge describing anesthesia, was read to the Norwegian Medical Society. The first trials of ether anesthesia took place at the national hospital (Rikshospitalet) at the beginning of March [4].

How the news reached Denmark is uncertain, but the first anesthetic was given on 20 February, 1847 [5]. Medical practice in Iceland lagged behind that in Europe, the first hospital opening in 1866. A general practitioner, Jon Finsen, working in the small town of Akureyri on Iceland's north coast, gave the first anesthetic in 1855 [6].

## 1847–1900; Ether, Chloroform and Complications

As in mainland Europe, Nordic anesthetic practice developed slowly after 1847. Many surgeons, other doctors, and even

lay members of society maintained a continuing skepticism concerning anesthesia. Eventually, the use of ether became accepted throughout Europe, but these European anesthetic experiences were seldom documented and no "champion anesthesiologist" (like John Snow in England) advanced the specialty. Different methods for the administration of ether were 'imported' or invented. A Swedish surgeon, EG Palmgren, designed an apparatus for ether vaporization within one month of the news of the discovery reaching Sweden [7].

Chloroform became popular in Scandinavia, soon after Simpson described its anesthetic properties. In Finland, Carl von Hartmann (the man who reported Morton's discovery), visited Simpson and became an enthusiastic chloroform champion, persuading Finns to use chloroform instead of ether for 4 decades [8]. For a time, chloroform was the most common anesthetic in all Nordic countries, but it gradually decreased in popularity as complications with its use became obvious. After 1880, ether again became the primary anesthetic with chloroform's use eliminated by the beginning of the twentieth century.

Although the incidence of complications related to anesthetics indicated that the work demanded significant professional skill, nurses or technicians provided part-time anesthesia care throughout continental Europe. As noted, part of physician disinterest in anesthesia lay in low pay and status. In addition, there was a shortage of doctors and especially surgeons in all Nordic countries. Denmark, with 1.9 million inhabitants, had only 80 doctors in 1857, and surgery had become a medical specialty only 15 years earlier [9]. The total number of operations remained small for nearly two decades after the introduction of anesthesia. Concern about the risk of postoperative infections and associated morbidity and mortality may have limited surgery. Only when antiseptic, and then, aseptic surgery were introduced, could the surgeon's world expand.

The relationships between anesthetic depth, inadequate ventilation, hypoxia and hypercarbia were poorly appreciated during the first decades after the discovery of anesthesia. Few anesthetists considered the implications of carbon dioxide accumulation, inadequate oxygen transport and cyanosis. Patients might breathe (and even re-breathe) hypoxic mixtures of air and ether or chloroform gas, in inadequate volumes, with partly obstructed airways, without assistance.

Few reports described Nordic anesthesia during the nineteenth century. In Denmark, Berthelsen found 24 anesthesia-related papers published in the decade after 1847 [9]. Most articles discussed techniques, complications, and comparisons distinguishing ether and chloroform. Few dealt with pharmacology and physiology. None considered the question of who should administer anesthetics.

At its first meeting (in Gothenburg), the Scandinavian Society of Surgeons (Nordisk kirurgisk forening) launched

an inter-Nordic anesthetic survey for 1894–1895. In 11,047 open drop chloroform anesthetics, 5 patients died (one death per 2,209 cases), while no deaths occurred in 1,279 ether anesthetics. When chloroform was used only as the induction agent, preceding 2,122 ether anesthetics, no deaths occurred. The greater “chloroform mortality” was consistent with results from Germany, France and Great Britain [10].

## Anesthetic Delivery

Technical improvements focused on anesthetic administration. Though open drop anesthesia was preferred, many physicians constructed versions of Morton’s original ‘inhaler’. In Europe, the most common ‘ether inhaler’ became the French Charrière model.

In Denmark, around 1880, surgeon Oskar Wancher introduced a curious and potentially dangerous method for the administration of ether. Wancher’s bag was a rubber bag of unknown volume connected to a breathing mask. The anesthetist placed 50 ml of ether into the bag, forming a pool in the bottom of the bag which was then filled with the patient’s exhaled air. The ether evaporated into this air. The decreased oxygen and increased carbon dioxide in the rebreathed gases stimulated ventilation and thereby accelerated induction of anesthesia. “Fresh air” was added by letting the patient occasionally breathe room air [11]. The influential Danish surgeon, Professor Thorkild Rovsing strongly recommended this method in 1901, and it remained in frequent use for 30–40 years! The associated mortality remains unknown.

The use of nitrous oxide is mentioned around 1860. The slow development of nitrous oxide anesthesia is not surprising given the absence of a good method of storage, difficulty in manufacture, absence of an ability to easily add oxygen, and the limited potency of nitrous oxide. In 1894, the Gothenburg dentist Hjalmar Carlsson rediscovered ethyl chloride as a general anesthetic, reporting his accidental observation that ethyl chloride acted as a general anesthetic if used for local anesthesia in the mouth [12]. It became popular for rapidly inducing anesthesia before maintenance of anesthesia with ether.

Norwegian surgeon Jacob Heiberg (1843–1888) became an expert on treating anesthetic-associated complications in the 1870s. When respiration and circulation deteriorated, he taught: “*Throw away your surgical instruments. Stop the operation and open all windows and bathe the patient in masses of cold water* [13].” Heiberg soon realized that airway obstruction (and not warm rooms) was the major cause of complications stemming from inhalational anesthesia. He invented the “jaw thrust” to open the airway, and published this in 1873 [13]. The jaw thrust saved thousands of lives. Five years later, Johan von Esmarch (1823–1908) a German (who introduced the tourniquet), described a similar tech-

nique, for a time known as the Esmarch-Heiberg technique, but later attributed only to von Esmarch [14].

In 1898, Ingjald Reichborn-Kjennerud (1865–1949) published the first comprehensive description of anesthesia practice in Norway: “Anesthesia and local anesthesia” (Narkose og local anesthesi) [15]. In the introduction, he wrote: “The number of general anesthetics is so few that one can’t get much experience with its use. Hence one is at a disadvantage compared to larger towns in Europe, with hundreds of patients to evaluate one’s technique.”

The development of anesthesia as a clinical and scientific specialty, in Sweden before 1900, was similar to that in Norway. Fritjof Lennmalm (a neurologist) described that history in a review presented to the Swedish Society of Medicine in 1908 [16]. Except for mention of the 1847 demonstration of ether anesthesia, Lennmalm found no additional references describing progress in anesthesia before 1908 [16]. He stated that from 1838–1858 “*the great time for the surgeons had not yet come*” and when he summarized the years 1879–1904 he described surgical progress with scarcely a mention of anesthesia. He did note that chloroform was the most commonly used anesthetic.

In the second half of the nineteenth century, Swedish physiologists immobilized experimental animals with curare and gave them artificial ventilation. In Stockholm where only a narrow street separated laboratories and operating theatres, the famous Finnish/Swedish physiologist Robert Tigerstedt (who discovered and named renin in 1898) used this technique [17]. In Uppsala, his colleague Frithjof Holmgren, proposed the use of curare and intermittent positive pressure ventilation (IPPV) in a patient with tetanus, intending to evaluate whether curare had any analgesic effects [18].

The Nordic Medical Society recognized the importance of anesthesia at the end of the nineteenth century. At the 1898 meeting of the Swedish Society of Medicine, John Berg, professor of surgery, gave an honorary lecture entitled “*the start, development and current status of surgical anesthesia*”. His presentation seems to have produced no effect on anesthesia research or clinical development.

## Specialization in Anesthesia

Rovsing, the Dane who recommended Wancher’s bag, became professor of surgical techniques, including anesthesia, without facilitating the specialty’s development. It would perhaps have been better if his colleague, Fritz Levy, had been given the opportunity to take the lead. At a 1904 meeting, Levy stated:

*“To perform a good anesthetic is an art which has to be taught just as everything else in life. It is also a gift which not all have been given. Thus this task cannot be handed over at random to anyone in the surgical staff. On the contrary it is necessary to secure an adequate number of well trained anesthetists”* [19].

A Roth-Dräger's anesthesia machine came into use in Copenhagen in 1902–03. For the first time a Nordic anesthetist could administer chloroform in a controlled way and also give the patient "a surplus of oxygen".

## Local Anesthetics

News of Karl Koller's demonstration of the local anesthetic effects of cocaine, in Vienna in 1884, traveled quickly to Scandinavia. In 1885, the Swedish laryngologist, K Malmsten, vividly described the application of this breakthrough. After relating how earlier trials with local application of morphine/chloroform had been unsuccessful, he stated that "*in 6 months all earlier scientific quarrels stopped when cocaine came into use*" [20]. The Dane, Ernest Schmiegelow, used it in 1886 for topical administration [21]. Shortly thereafter another Dane, Christian Paulsen, performed the first trials with infiltration of cocaine for local anesthesia

In Norway's Tromsø hospital, still the most northern university hospital in Europe, a young surgeon, Kristian Igelsrud, performed a spinal anesthetic shortly after August Bier's 1898 report. He also gave cocaine for superficial and infiltration anesthesia. These techniques gave the lone surgeon a perceived safer method than general anesthesia, safer because the surgeon could establish a stable level of anesthesia before attending to the surgery [22]. In major centres, the spinal anesthetic was often placed by a junior doctor with little experience in anesthesia, and when it was seen to work, nurses or technicians took over observation of the ongoing effect of the anesthetic. Contemporaneous similar reports were published by H Munch-Pedersen in Denmark [23] and by G Nyström in Sweden [24].

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## 1900–1920

### Surgeons in Control

By the early 1900s, many doctors in England and the US had specialized in anesthesia, but in Nordic countries, surgeons were responsible for anesthetic delivery and remained so for another four decades. Nurses provided general anesthesia under the surgeon's supervision. Such approaches became increasingly used in all Nordic countries. No scientific reports refer to general anesthesia in Scandinavia in this period. In the weekly journal *Hospitaltidende*, the co-editor, Aage Kiaer, stated in 1904: "*As well as I don't want to be operated by anyone, I don't want to be anesthetized by anybody*" [25]. His warning went unheeded. In 1916, the need to control the supply of ether and oxygen by an anesthetic machine was questioned (*the equipment would be too expensive!*) by a Danish professor of internal medicine.

### Surgeons like Regional Anesthesia

Surgeons like Kristian Igelsrud in Norway, and Gunnar Nyström and his teacher KG Lennander in Sweden, brought regional anesthetic techniques to various hospitals. In 1904, Nyström, who later became professor of Surgery in Uppsala, published a comprehensive review of local anesthesia including the production of regional anesthesia by nerve blocks in the journal of the Swedish Society of Physicians [24]. In 1907, Lennander wrote a chapter about local and subarachnoid anesthesia in Keen's *Surgery* [26] in which he presented his results for spinal anesthetics, and described Cushing's method of anesthetizing the abdominal wall and the lower thoracic region with intercostal blocks, using cocaine.

Central Europe, rather than GB or the US, influenced anesthetic developments in Scandinavia during this period. A 1906 Swedish summary of a survey on spinal anesthesia, by the Austrian E Slajmer, recommended restricting the method to surgery below the umbilicus, using the thinnest needle possible, and applying pure alcohol for skin disinfection [27]. In 1909, Swedish surgeon G Bäärnhjelm, reported on 100 spinal anesthetics with procaine [28]. Three years later Gustaf Petrén described his use of intravenous regional anesthesia with 0.5% procaine, as advocated by Bier. Procaine remained the standard local anesthetic until the introduction of lidocaine in the 1940s.

Much knowledge of this period comes from the research of the Dane, Preben Berthelsen. He describes a 1904 report of a trial with "Scopolamine/Morphine anesthesia for otologic surgery" [29], and a report on "Subcutaneous nutrition with dextrose and peptone."

### Intermittent Positive Pressure Ventilation (IPPV)

In 1910, Holger Mollegaard, a young student working with Christian Bohr, constructed a ventilator providing continuous positive pressure [30]. A mixture of chloroform and air was used for ventilation in 17 operations involving the lung. The trial was stopped because the surgical technique was inadequate and severe postoperative infections ensued.

Swedish surgeon K Giertz used Sauerbruch's sustained negative pressure method, proving in dogs that IPPV was needed to guarantee carbon dioxide elimination. He unfortunately published his results only in Swedish [31]. Giertz' pupil Clarence Crafoord, used IPPV for thoracic surgery. In his thesis, "On pneumonectomies in Man", Crafoord describes anesthesia with cyclopropane, using tracheal intubation and mechanical IPPV [32]. The Swedish company AGA and Paul Frenckner (A Swedish ENT physician), had constructed the respirator (Spirapulssator). It was used in Sweden until the 1970s.

Except for Finland, Nordic countries were sheltered from the worst effects of World War I, suffering however from

isolation, leading to shortages of medical supplies, and to a lack of information. In Finland, the 1917 civil war did not make things better.

In 1916, Norwegian Nils Backer Groendahl, published the first Nordic anesthesia textbook for nurses entitled: *Anesthesia and Care of Surgical Patients* [33]. In this book he stresses the importance of skill and knowledge. By 1920, anesthetic practice had improved. Experienced nurses gave most of the anesthetics.

## 1920–45

### Anesthetic Practice

The Swedish pioneer in neurosurgery, Herbert Olivecrona, observed that

*‘usually the American neurosurgeons prefer ether anesthesia. This method is, however, very difficult and demands an anesthetist with long experience... For myself I have entirely changed to only use local anesthesia in brain surgery as long as the patient’s mental condition permits it’* [34].

This reflected the situation in all Nordic countries. Surgeons wanted to expand their practice but were constrained by a lack of experienced anesthetists. In part, this was a problem of their own making; they were “in charge” and unable/unwilling to relinquish this power.

In the 1930s, new ultra short acting barbiturates (in Scandinavia the German compound hexobarbital, Evipan was practically the only one) attracted interest, but their introduction in Sweden was marred by scientific quarrels about their use and dangers. New equipment like the McKesson apparatus increased interest in nitrous oxide anesthesia. These developments pointed to a need for specialists in anesthesia. Prominent surgeons like P Nylander in Finland, E Husfeldt in Denmark, J Holst and C Semb in Norway, and C Crafoord, J Strömbeck and G Söderlund in Sweden became convinced that anesthesia should be established as a medical specialty. Young surgeons were approached but their enthusiasm was limited for reasons previously discussed.

Wars usually bring improvements in surgical care. World War I advanced thoracic and neurosurgery, but did little to improve the performance of anesthesia. World War II varied in its effect on Nordic countries. Denmark was mostly spared. Norway was less fortunate, especially northern Norway where in late 1944, Russian troops fought the Germans, who burned everything as they retreated, leaving a desolate countryside. Medical development in both Denmark and Norway suffered from 5 years of isolation and restrictions. Nazi deportations of medical doctors (not only Jews) caused great hardship. JGBU’s father, a doctor, remembers the Germans taking a Dr. Bernstein while he was on ward rounds. He

never returned. The Allies occupied Iceland which was minimally affected by the war. In contrast, Finland fought two bitter wars against the Soviet Union, one in 1939, and the second in 1941–44. The Finns were obliged to pay a postwar indemnity to the Soviet Union, a huge financial burden for many years. Sweden remained neutral during the war, and thanks to Torsten Gordh’s pioneering work, anesthesiology began to develop as a specialty.

### Nordic Pioneers: Denmark

A Danish pharmacologist, Knud Moeller, believed that most surgeons had little interest in anesthesia. He began a campaign to develop anesthesiology as a specialty. In 1936, while participating as a member of a doctoral committee involving a candidate defending a doctoral thesis about lumbar anesthesia, he raised public awareness that the quality of Danish anesthesia was inferior to that in other countries [35].

The first Danish anesthetist for a patient undergoing pneumonectomy (1939) was Ole Lippmann, the young director of Simonsen & Weel (a Danish manufacturer of medical instruments). He was not a physician but had learned how to administer nitrous oxide anesthesia during a 3 month stay in Toledo, Ohio while attached to the McKesson factory [35]. Lippmann introduced the technique to Ernst Trier Mørch, who later became Denmark’s first anesthesiologist [36].

The thoracic surgeon, Erik Husfeldt, had recruited Mørch to help with his operations. Between 1941 and 1949, Mørch acted as a freelance anesthetist in Copenhagen. In 1943, the Germans permitted him to have a 3 week sabbatical stay with Torsten Gordh in Stockholm, an experience that committed him to anesthesia. During the rest of the war he also contributed to the Danish resistance and took an active part in the smuggling of Jews to Sweden.

Immediately after the war, Mørch spent two years studying anesthesia in London and Oxford. Returning to Denmark, he taught anesthesia and established anesthesiology as a specialty there. He published the first Danish textbook on anesthesia in 1949. In 1949, he abruptly emigrated to the US, perhaps protesting against the government’s failure to create a department of anesthesiology at the Rigshospitalet (the National Hospital). In the US he led departments of anesthesia at major hospitals in Kansas City and Chicago [36].

### Nordic Pioneers: Finland

After visiting Crafoord, Per Nylander, a Finnish surgeon, brought a ‘Spiropulsator’ back home. Another surgeon, Aare Järvinen, went to Sweden to study new anesthetic techniques. Nylander, and pharmacologist Armas Vartiainen, persuaded two resident surgeons, Eero Turpeinen and Lauri Aro, to become anesthetists. Before the war Turpeinen had studied the effects of anesthetic gases on animals, work for which he earned a PhD. Aro began work as an anesthesiologist after 1944.

In 1941, Turpeinen planned to travel to the US. The war delayed this until 1945, when he spent three months in the US and another three in the UK. On returning home he proposed the establishment of a position for an anesthetist at the Surgical Hospital in Helsinki. When this was rejected, he specialized in surgery, but in 1950 he was appointed as an anesthetist at Maria Hospital in Helsinki. After this, Turpeinen played a central role in the development of the specialty in Finland, and in founding both the Finnish and the Scandinavian Societies of Anesthesiologists.

Lauri Aro began surgical training in 1943 but, encouraged by Nylander, he converted to anesthesia. In 1948, he spent half a year in the UK, training at the Brompton Chest and Westminster Hospitals. Returning home he became a full time anesthesiologist with a special emphasis on anesthesia for thoracic surgery. He played a prominent role in the development of the specialty in Finland. In 1953, a new anesthetic position was created for him in Helsinki University Hospital [37].

### **Nordic Pioneers: Iceland**

Three of the first four anesthesiologists in Iceland trained in the US, reflecting the close contact with the ‘occupants’ during World War II. Although Elias Eyvindsson studied anesthesia at the Mayo Clinic from 1948 to 1950, he became a surgeon after working for a few years at Landspítalinn (Iceland’s National Hospital). Torbjörg Magnúsdóttir became the real pioneer, returning home in 1952 after training in Copenhagen and Lund (Sweden). The other two anesthesiologists trained in the US, were Alma Torarinsson and Valtýr Bjarnason [38].

### **Nordic Pioneers: Norway**

Otto Mollestad (1908–1973) became the first Norwegian anesthetist, having shown a special interest in anesthesia during his medical studies. He had become friends with the surgeon Semb, just before World War II. After the war, Semb, who had joined the Norwegian resistance in London, arranged a position for Mollestad as an assistant to Robert Macintosh in Oxford. In 1946, a position as an anesthesiologist was created for Mollestad in Rikshospitalet, in Oslo.

Another surgeon, Johan Holst, arranged a residency position for Ivar Lund (1911–1992), at the Massachusetts General Hospital, with Henry Beecher. Lund returned to fill the second position for anesthesia in Norway in 1947. By 1950, four Norwegian hospitals had salaried positions for anesthesiologists [39].

### **Nordic Pioneers: Sweden**

In Sweden, Gustaf Söderlund, professor of surgery in Stockholm, and the British anesthesiologist, Michael Nosworthy, persuaded a 29 year-old surgeon, Torsten Gordh (1907–2010), to train with Ralph Waters’ at the University of Wis-

consin in 1938. The start of World War II shortened Gordh’s stay with Waters to 18 months, but before returning home, Gordh made a ‘grand tour’ through the US, meeting American pioneers including Virginia Apgar and Emery Rovenstine, contacts that later proved valuable to the development of Nordic anesthesiology. Just before the German invasion of Denmark and Norway (April 1940), Gordh journeyed home to Sweden, bringing with him a Foregger anesthesia machine, laryngoscopes, tracheal tubes and two Waters soda lime canisters [40].

Gordh immediately (1940) took up the first anesthetist position created in Sweden (and mainland Europe), a position at the Karolinska university hospital in Stockholm, and worked independently from the start. In contrast to the evolution of anesthesia in other Nordic countries, Sweden’s neutrality allowed Gordh to develop anesthesiology in (relative) peace, albeit with an enormous clinical workload. Not only did he direct anesthesia at the Karolinska, he also provided anesthesia for the neurosurgical department at the Seraphimer hospital, the original university hospital in the city centre.

His biggest problem was a shortage of medicines and instruments. Gordh had his Foregger machine, but further imports proved impossible. However, the Swedish company AGA, an enterprise founded at the end of the nineteenth century by the Nobel laureate Gustaf Dahlén, soon met the demand for anesthetic machines. AGA, manufacturer of the ingenious equipment for lighthouses and also the ‘Spiropulsator’, also provided oxygen, nitrous oxide and cyclopropane. Swedish manufacturers of surgical equipment started making laryngoscopes, and the pharmaceutical company Astra synthesized a new ultra short acting barbiturate (Narkotal). Other drugs and items remained scarce.

A remarkable pharmacological breakthrough occurred in Sweden during the early part of the war. The local anesthetic lidocaine, was synthesized and tested by two chemists, Löfgren and Lundqvist [41] Initially they had difficulty interesting the Swedish Pharmaceutical Industry in lidocaine. They even considered travelling to London for negotiations with the British pharmaceutical industry, but German air attacks made any flight too dangerous. In 1943, Astra acquired the rights to lidocaine. It became Astra’s first ‘golden’ product. Sweden continued to play a major role in local anesthetic development. Pharmacologist Bo af Ekenstam, introduced mepivacaine and bupivacaine in the 1960s. Ropivacaine was introduced in 1995. All three drugs were tested in Swedish hospitals [42] (Table 32.1).

Doctors and nurses in Sweden and other Nordic countries recognized Gordh’s great ability as a teacher, and came to train with him. Three additional anesthesia positions in Sweden were established in the 1940s, and given to doctors trained in GB or the US. In Stockholm, Olle Friberg was employed in 1943 at the Sabbatsberg’s hospital, where Crafoord had his cardiothoracic center. In 1945, Eric Nilsson

**Table 32.1** Some Nordic contributions to anesthesiology

Country	Date	Contribution	Contributor/manufacturer
Denmark	1950s	Gas analysis	P Astrup; O Siggaard Anderson
	1955	Ruben valve; Ambu bag	H Ruben
Sweden	1940s	Gordh-Olovsson needle	T Olovsson; T Gordh
	1940s	Lidocaine	N Löfgren, B Lundqvist
	1957	Mepivacaine	Bo af Ekenstam
	1965	Bupivacaine	Bo af Ekenstam
	1996	Ropivacaine	Bo af Ekenstam
	1952	Engström ventilator	CG Engström
	1971	Servo ventilator	B Jonsson, L Nordstrom; Elema-Schönander
	1958	Implanted pacemakers	Å Senning, R Elmqvist; Elema-Schönander
	1948	<i>Inkjet ECG printers</i>	R Elmqvist; Mingograph-Elema-Schönander
Norway	1870	Jaw thrust	J Heiberg
	1901	First open CPR	K Igelsrud
	1961	Resuscitation simulators	B Lind; Asmund Laerdal Industries

was appointed in Lund, and is remembered for his contributions to intensive care. At the Bispebjergs Hospital in Copenhagen, Nilsson, together with the director Carl Clemmesen, adapted basic anesthesiological principles (open and clear airways, physiotherapy, frequent changes of body positions and careful positioning of the patient; and, if necessary, artificial ventilation and circulatory support) to treat patients with barbiturate intoxication, thereby decreasing the mortality rate from 20 to 1%. This ‘Scandinavian method’ continues as a cornerstone of the treatment of barbiturate intoxication and of intensive care [43].

In 1947, Olle Lundskog was appointed in Malmö, and in 1949, Karl-Gustav Dhuner received the first position for an anesthetist in Gothenburg—Sweden’s second largest city. Göran Haglund, the first pediatric anesthetist in Sweden and a pioneer in pediatric intensive care, was appointed in 1951. At Uppsala University, Martin Holmdahl, a PhD in physiology and trained in Great Britain, received an independent position in 1954. He developed a prominent research center and produced several academic scientists, including Ake Grenvik.

## A Nordic Society

In 1949, Gordh, Mollestad, Turpeinen and Henning Poulsen (Denmark) met in Helsinki to form a Nordic Society (Nordisk Anaesthesiologisk Forening, NAF) and create a Nordic Anesthesia journal. In 1950, the first congress was held in Oslo and the first bylaws were approved. Subsequently, these congresses have been held every second year, the venue rotating between countries. The president of the current congress also

serves as society chairman. A general secretary guarantees continuity.

*Acta Anaesthesiologica Scandinavica (AAS)* first appeared in 1957. Eric Nilsson in Lund, became the first editor-in-chief, and Poulsen played a pivotal role, acting as a member of the first Editorial board and taking responsibility for publishing the journal. For the first 15 years, the journal was printed in his home town in Denmark—Aarhus [44]. He also became the NAF’s first Secretary General.

## 1945–60

An expanding surgical work load forced the few existing anesthesiologists to focus on clinical demands. Such pressures precluded research or teaching, and recruitment of doctors into anesthesia. Although the specialty had become indispensable, financial constraints limited the number of new anesthesiologist positions. Despite these problems, Nordic anesthesiology developed rapidly.

While almost all of the first generation of Nordic anesthetists went to GB or the US for training, domestic centers slowly developed specialty training. Initially, importation of British and Irish colleagues was needed to fill new positions, and some of these doctors stayed and became valuable contributors to the specialty, particularly outside regional centers.

The initial creation of only one anesthesia position per hospital, required anesthesiologists to recruit anesthetic nursing staff to get the work done. But the nurses had worked under the surgeon’s supervision, and both surgeons and nurses sometimes found it difficult to accept physician anesthesia-led departments. Eventually harmonious anesthetic departments were created with teams of nurses (with post-graduate specialty training) directed by anesthesiologists.

This team approach continues to the present. Although the number of doctors progressively increased, a shortage existed early in the history of the specialty, partly because anesthesiologists earned less than most other doctors (they received the same hospital salary but lacked the opportunity to gain income from private outpatients). Mollestad’s successor, Jacob Stovner summarized the situation: *‘At the end of the working day we biked homewards in the exhausts from the surgeons’ limos!’*

Anesthesia from 1945–1960 paralleled that in the rest of the western world, a barbiturate induction and maintenance with nitrous oxide and ether. Cyclopropane was sometimes used for pediatric anesthetic induction. The introduction of muscle relaxants was enthusiastically accepted. Although Hunt and Traveau synthesized succinylcholine in Boston in 1906, the Swedes Thesleff, von Dardel, and Holmberg first tested it clinically in 1950 [45]. In the same year, the Swedish ENT surgeon Eric Carlens published experiences with the use of his invention, the double lumen tracheal-bronchial

tube for separation of the lungs [46], a prerequisite for pulmonary surgery.

## A Gradual Expansion

Denmark is more densely populated than Finland, Iceland, Norway or Sweden, but all have metropolitan areas where a majority of the inhabitants live. In Iceland and Norway, the population is concentrated in coastal areas. These conditions led to differences in the development of anesthesiology. Hence separate descriptions are necessary for each country. We rely on the book *Scandinavian Anaesthesia during 150 years*. (Nordisk anesthesiologisk forening), to describe these differences.

### Denmark [47]

In Denmark, development after Lippmann and Mørch was slow. Willy Dam (1914–1990) assumed the first position as an anesthetist, created in 1944 at Bisbebjergs Hospital in Copenhagen (within the department of surgery). In 1948, Erik Andersen was employed at Gentofte hospital, where he provided anesthesia services to three different surgical departments. He was later given the first independent anesthetic position.

Poulsen and Ole Secher started their careers after the end of World War II. Secher worked at the major state hospital—Rigshospitalet—where in 1953, he received an academic position as a lecturer. Poulsen initially worked in Copenhagen, soon moving to Aarhus where he created a university department. As noted, in 1949, he started the Danish Society for Anaesthesiologists and was a founder of the Nordic association.

Around 1950, the state recognized anesthesiology as an independent specialty and anesthesia development expanded throughout Denmark. The World Health Organization started a one-year international course in anesthesiology (the Anesthesiology Centre) in Copenhagen, with the initial faculty including Henry Beecher, Harry Churchill-Davidson, Stuart Cullen, Francis Foldes, Emmanuel Papper, John Severinghaus and Jackson Rees. The course was repeated 23 times in the ensuing two decades. In 1953, the first independent anesthetic departments were created under Secher and Henning Ruben (famous for the development of the Ruben valve and the self filling ventilating bag, Table 32.1).

In 1952, a lethal poliomyelitis epidemic in Copenhagen led to the development of Intensive Care Units (ICUs). The epidemic prompted professor HCA Lassen to form an expert group charged with finding a strategy for treatment of cases with severe respiratory insufficiency. The free-lancing anesthetist, Bjørn Ibsen, (who had earlier spent a year in Boston with Beecher) with physiologist Poul Astrup, convinced this group that the patients had to receive intermittent posi-

tive pressure ventilation (IPPV). Physiologist Poul Astrup helped guide the ventilation by pioneering a new method of blood:gas analysis. Volunteer doctors, nurses and students performed this radical treatment, manually squeezing reservoir bags attached to tracheotomy tubes. Mortality decreased from 87 to 37 per cent, a remarkable achievement. Ibsen established a permanent ICU in the city hospital (Kommunehospitalet), in April 1954. Two Danish anesthesiologists, Henrik Bendixen and Henning Pontoppidan, emigrated to the US in the 1950s, becoming pioneers of ICU medicine at the Massachusetts General Hospital.

### Finland [48]

Immediately after World War II, severe shortages of medical equipment, and the absence of positions for anesthesiologists, hindered development of anesthesia. Some conservative surgeons claimed that “*ether anesthesia administered by a nurse was quite sufficient*” (a well-known point of view). The first positions were created in the county hospital in Lahti in 1950, for Sakkari Pelttari and Jorma Airaksinen. As mentioned before, the pioneers Turpeinen and Aro had to wait until 1950 and 1953 before obtaining positions. Turpeinen, Aro and their colleagues worked diligently to establish the specialty. Turpeinen was one of the 1949 founding fathers of the Nordic Society. In 1952, he and three colleagues founded a national society, promoting the spread of the specialty in Finland. The Society focused on the need for education and training of doctors in anesthesia, and the creation of independent departments and positions for specialists.

The WHO anesthesiology centre in Copenhagen provided an important educational resource, attended by 22 Finnish anesthetists between 1950 and 1967. Others gained training in the UK. A domestic training program began in 1957–1958, requiring three years of anesthesiology, and one year of surgery, internal medicine, otology or basic sciences. The Society proposed establishment of university departments in Helsinki and Turku (Åbo), a dream realized in 1969–1970.

During this period, the Finnish Society of Anesthesiologists successfully negotiated for new positions and salaries. However, recruitment remained difficult and several measures were taken to improve the situation. A three-month compulsory training course in anesthesia for all surgical residents was implemented, and at their own request medical students were approached by the Society regarding careers in anesthesiology at several meetings. How much these measures affected recruitment is unclear, but the number of specialist members in the Finnish Society of Anesthesiologists steadily increased to reach 300 in 1980.

### Iceland [49]

Jon Sigurdson observed that

*“In Iceland as in all neighboring countries the development from 1950 was gigantic... When the specialty anesthesiology*



*took its first steps it was not highly valued by other specialists. Less experienced colleagues, medical students, nurses and even unqualified staff members were entrusted to perform anaesthetics. Anyone could do it!"*

After Magnúsdóttir, came Alma Torarínsson and Valtyr Barónason, both having studied in the US. Thereafter, most anaesthesiologists were educated in Nordic countries. The number of specialists increased from 11 in 1975 to 67 in 1999, for an Iceland population of 300,000 (i.e., by 1999 the same ratio as in the US). Several of these doctors pursued research in and outside Iceland.

### Norway [50]

The first anaesthesiologists worked in Oslo; Mollestad at the central State hospital (Rikshospitalet), and Ivar Lund at Ullevål's hospital (the major city hospital). Both faced a lack of support and understanding of what anaesthesia could provide. Upon retirement, Mollestad noted that he started without a chair to sit on. The challenges were a general lack of doctors and low salaries for anaesthesiologists, but an advantage that half of the specialists in Norway were women. The Norwegian pioneers worked to establish a professorship, finally succeeding in 1973, when Jakob Stovner was appointed at Rikshospitalet.

### Norway/Scandinavia Contributed to Cardiopulmonary Resuscitation (CPR)

In 1901, Igelsrud performed the world's first successful open CPR (i.e., where an incision is made in the chest to allow resuscitation by directly squeezing the heart in a rhythmic manner), at the Tromsø Amtsykehus (Hospital) where he was the only doctor. Igelsrud has not received proper acknowledgement for this crucial first step in CPR. The description of this first resuscitation was published in 1904 in *Therapia Gazette*, by an American doctor WW Keen from Philadelphia, who was visiting Igelsrud.

In the late 1950s, in cooperation with Peter Safar and Åsmund Lærdal of Laerdal Industries, Norwegian anaesthesiologists further contributed to the field of resuscitation. Bjørn Lind, at the hospital in Stavanger, pioneered the development of Resusci-Anne (Fig. 32.1). Lærdal's support facilitated the first meeting on the new management of cardiovascular collapse, "Symposium on Emergency Resuscitation-Rescue Breathing and Closed Chest Cardiac Massage" in Stavanger Norway from 21–25 August 1961 [51]. Since then Laerdal Industries have achieved international prominence, producing Resusci-Anne and her followers and also developing sophisticated equipment for simulators (Table 32.1).

In 2000, doctors at Tromsø Hospital were again in the news, saving a victim of severe accidental hypothermia (13.7°C), a world record [52]. While skiing, the victim fell head first through a hole in thick ice. Rushing water filled



**Fig. 32.1** Resusci Anne's face was supposedly based on "the death mask of an unidentified young woman reputedly drowned in the Seine River around the late 1880s." (Courtesy of Phil Parker, Leamington Spa, UK)

her clothes, wedging her in place. But she managed to turn her face sufficiently to breathe air beneath the ice. After 40 min, she ceased to move. When the rescue team arrived they declared her clinically dead. But they started Basic CPR because she was so cold. Within 2 hours cardiopulmonary bypass was initiated, and she was slowly warmed. She made a remarkable recovery, returning to work as a physician. What would Igelsrud have said about this achievement?

### Sweden [53]

From 1945 to 1960, hospitals outside the major cities recruited increasing numbers of anaesthetists. By 1960, almost all hospitals had anaesthetic departments. However, as stated before, usually only one doctor was initially appointed. The anaesthetist could not do all the cases and needed help from nurses who had previously performed anaesthesia. This reflected the typical development of doctor–nurse teams in operating wards in all Nordic countries.

Surgeons in the central hospital in Borås (a regional centre in Southwest Sweden), convinced the board of directors in 1951, that it was necessary to engage an anaesthesiologist. Eric Nilsson suggested Åke Bauer who accepted the offer

with three conditions. (1) He should finish his specialty training. (2) He should be allowed to travel to GB and Germany to visit the postoperative wards of some major military hospitals. (3) An ICU should be established in Borås. All proposals were accepted, and on 1 June 1952, a properly equipped ICU was opened. For a few months it was only open during the daytime, but from December 1952, it was open 24 hours a day, caring for both surgical and medical cases. Bauer created nursing routines and even ethical guidelines for intensive care. He is regarded as one of the world's pioneers in intensive care [54].

A few years earlier, using the van Slyke method for gas analysis, Carl-Gunnar Engström at the Stockholm Hospital for Infectious Diseases, found that the available external methods for artificial ventilation (e.g., iron lungs) did not adequately ventilate the lungs of patients with severe poliomyelitis. He had been working with Crafoord and the 'sipopulsator', and realized that the problem could be solved by IPPV via a tracheotomy. At first this was done manually, but soon Engström and the engineer Paul Herzog constructed the ventilator thereafter named for Engström. The ventilator soon came into use in Stockholm, and in the 1952 polio epidemic in Copenhagen [54, 55].

## 1960–1980

During this period, anesthetic developments in Nordic countries converged. All hospitals established departments as the specialty's importance to medical care became obvious. Domestic specialist training and the number of specialists increased, although the number of positions lagged. For example, the Swedish Society of Anesthesiologists in 1966 had around 180 members; in 1974, 400 members; and in 2011, 1400 members. 'Sub-specialization' arose early in pediatric, cardiothoracic and neurosurgical sectors, and in intensive care medicine.

ICUs were gradually established, mostly as the province of departments of anesthesiology. Separate units also arose in some departments of cardiothoracic and neurological surgery. In smaller hospitals, postanesthesia care units (PICUs) might care for trauma and septic cases, drug overdoses, and severe internal medical emergencies. Most of these smaller units evolved to include intensive care. Before the development of coronary care units, PICUs might care for medical patients with cardiac dysfunction. Demand for care in ICUs was greater in larger hospitals. The severity of illness was greater and the criteria for admission stricter. In these hospitals, doctors increasingly specialized in ICU medicine, leading to a new subspecialty.

After 1975, Nordic anesthesiology developed in line with the rest of the western world—with some stylistic differences. Kjell Eric Strömshag described these in the context of a

Specialty on Four Pillars—(1) Anesthesia, (2) Intensive Care Medicine, (3) Prehospital Emergency Care and Transportation and (4) Pain treatment [51].

*Regarding anesthesia*, the close cooperation between anesthesiologist and nurse anesthetists is a typical Scandinavian feature, without which early development would have been difficult. This cooperation has resulted in mature organizations with well-defined roles. Another feature is the small size of the private sector. The public sector runs most hospitals and is financed by taxation.

*ICU Medicine*. The early bonds created between anesthesia and ICU medicine remain close. Departments of anesthesiology run most ICUs, and the directors are anesthesiologists. Patients' primary care physicians and the director jointly decide treatment, but the director decides who is admitted.

*Prehospital acute care and transportation*. Scandinavian anesthetists have taken responsibility for prehospital acute care and interhospital transportation, particularly in Norway. Norway's long and jagged coastline hinders emergency access, and a good helicopter service is imperative. Anesthetists are responsible for the organization and medical protocols applied in this service. An anesthetist or ICU nurse usually accompanies the patient in the helicopter. Similarly, an anesthetic nurse is almost always in the crew of an ordinary ambulance service.

Another condition necessitating a special transportation organization is that patients in need of specialized care must often be transported to a tertiary hospital some 300 to 600 kilometers away. This has created a need for special expertise both in smaller and large hospitals. Some of the large centers have a special organization for these transports.

*Treatment of pain*. Nordic anesthesiologists have always participated in the development of pain treatment, beginning with consultations in terminal cases. Special pain units were formed in the 1970s, and the need for close cooperation with other specialties has resulted in the present multidisciplinary pain-clinics.

## Nordic Organizations

Since its inauguration in 1951, congresses of the Nordisk Anestesiologisk Forening have been held every other year, alternating among the five countries. Before 1999, the president of the coming congress also acted as the chairman of the Society during the 2 year interval. However, the elected Secretary General in reality guaranteed the continuity of the administration. As the activities grew, the way of working with alternating presidents became inadequate. In 1997, the NAF General Assembly agreed on a change. Now a board and an executive president are elected for four years. The Society acts as an umbrella organization for the 5 national

societies. This organization became the Scandinavian Society for Anesthesiology and Intensive Care (SSAI). The SSAI has assumed responsibility for education, quality of care, and research in anesthesiology in the original five countries and in the three Baltic countries. The national Societies continue their work both as unions and as organizations for education and research [56].

From its first issue, the journal *Acta Anaesthesiologica Scandinavica* (AAS) was published in English, intending to have an international presence. The first editor-in-chief was Eric Nilsson from Lund, Sweden, with Ibsen and Poulsen as Co-editors. Initially, four issues totaling approximately 250 printed pages were published each year. The number of pages increased progressively and several supplements were published.

In 1972, Olof Norlander succeeded Nilsson as Editor-in-Chief. Viggo Dyrberg from Gentofte, Denmark and Jan Eklund joined the board. Munksgaards became the publisher, and the characteristic red cover appeared. Under the editorship of Norlander and his successors Eklund and Sven E Gisvold (Trondheim, Norway), AAS has become a truly international, peer reviewed journal, which in 2010, published ten issues containing approximately 1300 printed pages [57].

## Conclusions

Outside influence prompted the initial development of anesthesia practices in Nordic countries. Subsequently, Nordic physicians have made key contributions to anesthesia, intensive care medicine, pain therapy, airway management, blood-gas analysis, ventilatory care, the development of PACUs and ICUs, resuscitation, and simulations (Resusc-Ann). They have played an important part in making anesthesia and perioperative care what it is today—safer.

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