

# History of the Swedish Society of Nuclear Medicine



## The origins of nuclear medicine in Sweden

In Sweden, nuclear medicine started in the early 1940s, when Erik Lindgren treated five patients with leukaemia and one with polycythaemia vera using  $^{24}\text{Na}$  and  $^{32}\text{P}$ . The radionuclides were produced by Professor Manne Siegbahn using the cyclotron in the Research Institute for Experimental Physics.

During World War II, Prof. Jan Waldenström visited the United States and Prof. Robley D. Evans and received an introduction to tracer techniques. Later his colleague Bengt Skanse was sent to Boston and started research with radioactive iodine. His thesis, "Radioactive iodine in the diagnosis of thyroid disease", was published 1949. Bengt Skanse is the pioneer of nuclear medicine diagnosis in Sweden. During the 1950s isotope laboratories were started in Malmö, Stockholm, Gothenburg, Lund and Umeå and the use of scintigraphs was introduced, both for thyroid scanning and for whole-body scanning.

## National milestones of nuclear medicine

- 1944 Erik Lindgren: Versuche mit Radioaktiven< Isotopen bei Leukämibehandlung. *Acta Radiol* 25:614
- 1949 Bengt Skanse: Radioactive iodine in the diagnosis of thyroid disease. *Acta Med Scand Suppl* 235
- 1951 Licence issued for use of radionuclides at Malmö General Hospital
- 1953 Sven Johansson and Bengt Skanse. A photographic method of determining the distribution of radioactive material in vivo. *Acta Radiol* 39:317 (Figs. 1, 2)
- 1954 A scintigraph for thyroid imaging was constructed by Agnar Egmark
- 1956 A whole-body scanner was constructed by Lars Jonsson and Inger Ragnhult
- 1961 Erik Berne and Sven-Erik Lindell presented a method for gated acquisition of a first-pass study
- 1961 National regulations issued on the use of radioactive isotopes
- 1963 Production of radioisotopes started at the research reactor in Studsvik
- 1967 First gamma camera in Sweden installed in Lund
- 1969 Swedish Society of Nuclear Medicine founded
- 1977 A commercial SPECT system was developed by Stig A. Larsson and Anders Israelsson in cooperation with Nuclear Diagnostics



- 1979 A method of whole-body scanning with moving table and dual-head camera was introduced by K-J. Vikterlöf
- 1980 Recommendations on quality control of gamma cameras were issued by the Swedish Society for Radiation Physics
- 1981 First PET camera produced and installed in Uppsala
- 1982 National regulations issued on the use of radiopharmaceuticals 1996 Medical specialisation in nuclear medicine introduced
- 2003 A national PET group was started to promote PET and PET-CT in the country
- 2004 First PET-CT investigation performed in Uppsala (Imanet) 2006 Introduction of a new medical speciality, “Imaging and functional medicine”, where nuclear medicine is a sub-specialty

### **Establishment of the Swedish Society of Nuclear Medicine**

The rapid introduction and development of nuclear medicine in Swedish hospitals during the 1960s created a need for education and a national forum for the presentation and discussion of scientific matters as well as the promotion of nuclear medicine. National meetings were started in 1963 and the Swedish Society of Nuclear Medicine was finally founded in on 28 November 1969. The members of the board represented different specialties with interests in nuclear medicine and this is still the case. The society became a section of the Swedish Medical Society in 1970. In 2001 the Swedish Society of Nuclear Medicine and the Swedish Nuclear Medicine Union were combined. The present chairman of the society is Peter Gjertsson and the number of members is about 300 persons and 13 companies.

### **Development of nuclear medicine in Sweden**

#### ***Radiopharmaceuticals***

The company AB Atomenergi had two research reactors and started to produce radionuclides for medical use in January 1963. Due to the limited number of radionuclides produced and the increased use of radionuclides produced in cyclotrons, production ended in 1982. Since then all radiopharmaceuticals, except for those used in PET, have been imported from abroad.

#### ***Imaging equipment***

In the late 1950s the Swedish company NUKAB made a rectilinear scanner which was sold all over the world. Inger Ragnhult and Lars Jonsson constructed the first whole-body scintigraph in 1956. The equipment was then further developed by the company LKB. These types of imaging device were the standard instrumentation in Swedish hospitals until the introduction of the gamma camera.

The physicists Agne Larsson and John Svedberg made significant contributions in collimator design and pulse arithmetic in the further development of the Anger camera.

As mentioned above, Stig A. Larsson and Anders Israelsson, in cooperation with the company Nuclear Diagnostics (now Hermes Medical Solutions), made the first commercial SPECT system, which was further developed and sold by General Electric as 400T.

The Swedish company Scanditronix successfully developed a PET camera during the 1980s. The company's PET business was acquired by GE in 1996.

The use of computers in nuclear medicine was introduced early in Sweden. In 1960 the physicist Erik Berne gave a talk on the use of computer analysis in nuclear medicine. He later designed a computer system for use with both scanners and gamma cameras, The software was based on a PDP computer; this later became the Gamma11 system, which in the 1980s was further developed by Hermes Medical Solutions. This company is still one of the leaders in nuclear medicine application software.

### ***Nuclear medicine methods***

As mentioned above, the first radionuclide therapies in Sweden were performed in the early 1940s. Iodine therapies were introduced in the late 1940s and scientific work to improve the method was done in Stockholm and Malmö. It is still the most common radionuclide therapy method in Sweden.

Arvid Carlsson (Nobel Prize 2000) and his students Bertil Lindquist and Göran Bauer undertook pioneering work in bone metabolism using  $^{45}\text{Ca}$ . Arvid Carlsson's thesis in this area was published in 1951. Göran Bauer and B. Wendeborg already used  $^{85}\text{Sr}$  in 1959 in their studies of bone destruction. Inge Gynning, Per Langeland and Sture Lindberg continued with  $^{85}\text{Sr}$  and external measurements on patients with bone metastases from breast cancer. With the introduction of  $^{99\text{m}}\text{Tc}$  and diphosphonates in the 1970s, bone scintigraphy became the most frequent nuclear medicine examination in Sweden.

The first bone marrow scintigraphy in the world with colloidal  $^{198}\text{Au}$  was done at Radiumhemmet in Stockholm by Lars-Gunnar Larsson and co-workers (1956). Also the lymph drainage from the breast to axillary and parasternal lymph nodes was studied.  $^{198}\text{Au}$  was replaced by  $^{99\text{m}}\text{Tc}$  colloid, which was extensively studied in the early 1980s by S.-E. Strand and co-workers in Lund. The use of colloids is now very frequent when applying the sentinel node technique in patients with breast cancer or malignant melanoma.

Kidney function was studied using  $^{131}\text{I}$ -*ortho*-iodohippurate by Gösta Magnusson in Stockholm for his thesis in 1962. Bertil Nosslin in Malmö made theoretical calculations of clearance estimations with the single injection technique and without urine collection. This method was further developed in Denmark using  $^{51}\text{Cr}$ -EDTA and is still in quite frequent use. Today, more than 90% of kidney function studies are performed with  $^{99\text{m}}\text{Tc}$ -MAG3.

Research on the diagnosis of pulmonary embolism with perfusion and ventilation scintigraphy using  $^{99\text{m}}\text{Tc}$ -macroaggregated serum albumin and aerosols of carbon particles



has been performed by several people in Sweden: Alf Holmgren in Stockholm and Sven Erik Lindell, Måns Arborelius and Per Wollmer in Malmö. Marika Bajc and co-workers in Lund have now introduced V/P SPECT as a method for the diagnosis of pulmonary embolism and have also written an EANM guideline for the method.

David Ingvar in Lund, together with his Danish colleague Nils Lassen, developed a method to measure the regional cerebral blood flow using radioactive noble gases. The method has long been used as a gold standard but is now being replaced by PET methods.

Examinations of the heart have a long tradition in Sweden. This started with first-pass studies. Erik Berne and Sven-Erik Lindell in Malmö used ECG to trigger the collection of data as early as 1961. Software for analysis of gated equilibrium studies was developed in Stockholm and Uddevalla. Early studies of myocardial blood flow were performed in Lund using  $^{86}\text{Rb}$  and  $^{131}\text{Cs}$  (Håkan Westling and Sven-Eric Svensson). After the introduction of  $^{201}\text{Tl}$ , which was the breakthrough for the method, and after the introduction of  $^{99\text{m}}\text{Tc}$  substances, myocardial scintigraphy and bone scintigraphy have become the most common nuclear medicine examinations in Sweden.

### **Nuclear medicine in Sweden today**

Nuclear medicine is practised in 34 hospitals in Sweden. At the beginning of 2009 there were 126 registered specialists including 33 women. About 80 full-time medical physicists are working in the field, together with radiopharmacists and technologists. There are close to 100 gamma cameras in Sweden and about 140 work stations. PET-CT equipment is installed in Uppsala with two systems, Stockholm, Linköping, Lund, Malmö, Gothenburg, Örebro and Umeå. Cyclotrons for isotope production are found in Uppsala, Stockholm, Lund and Umeå.

In 2008 about 84,000 examinations using  $^{99\text{m}}\text{Tc}$  were performed together with about 7,000 PET examinations using  $^{15}\text{O}$ ,  $^{11}\text{C}$  or  $^{18}\text{F}$ . In 2009 more than 2,800 therapies were carried out. About 65% of these were for treatment of benign thyroid diseases. Other therapies are performed with  $^{153}\text{Sm}$ ,  $^{32}\text{P}$  and  $^{90}\text{Y}$ , and nearly 300 with  $^{177}\text{Lu}$ -octreotate for treatment of neuroendocrine tumours. In total, about 106,000 nuclear medicine examinations and radionuclide therapies are performed annually in Sweden today, giving a frequency of 11.8 per 1,000 people.

National courses in nuclear medicine are regularly arranged by different departments in cooperation with the national society. Together with EANM courses and congresses, these give continuous education and training for the different categories of staff.

### **The future of nuclear medicine in Sweden**

Based on a long tradition, nuclear medicine is now a well-established diagnostic and therapeutic tool in Swedish health care. The standard of the equipment is up to date and a programme for continuous replacement is running. For instance, conventional gamma cameras are now being replaced by SPECT-CT systems. The growing demand for PET-

CT is challenging in a country with large distances and a fairly low population density, especially regarding production and distribution of the short-lived radiopharmaceuticals and bearing in mind the need to keep financial costs under control. Research activities in the country are quite intensive and of a high standard. Together with well-educated personnel, this will secure the future of the specialty.

*Sven-Åke Starck*

*EANM National Delegate*

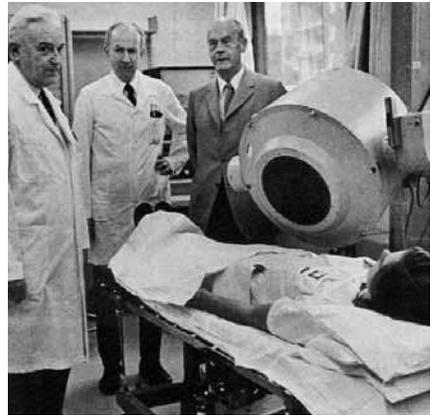
*Sten Carlsson*

*Honorary Member of the Swedish Society of Nuclear Medicine*

*Courtesy of the Swedish Society for Radiation  
Physics (image archive)*



*Fig. 1 The first scintillation camera with collimator developed by Sven Johansson and Bengt Skanse. A photographic film was placed directly on the sodium iodide crystal.*



*Courtesy of the Swedish Society for Radiation  
Physics (image archive)*

*Fig. 2 The first scintillation camera in the Nordic countries. From left: Martin Lindgren, Kurt Lidén and representative from John and Augusta Persson Foundation.*

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