History of the Norwegian Society of Nuclear Medicine and Molecular Imaging

Origins of nuclear medicine in Norway

In 1947 Odvar E. Skaug obtained a fellowship for studies in Sweden, where there was already some radionuclide production. Radionuclides were made accessible to Norway, and in 1950 the first reports on the use of ^{131}I and ^{32}P in biochemical research, radioprotection and clinical medicine were presented:

Skaug OE. Some remarks on Geiger Müller equipment for biological works. *Scand J Clin Lab Invest* 1950:2:173–5.

Eldjarn L. The metabolism of tetraethyl thiuram disulphide (Antabus, aversan) in the rat, investigated by radioactive sulphur. *Scand J Clin Lab Invest* 1950;2:198–201.

Bull R. Engelstad: Radioactive iodine for diagnostic purposes. Report of two cases. *J Norw Med Assoc* 1950;7.

In the course of the 1950s, nuclear medicine laboratories were started at six hospitals in Norway. These included laboratories started by Odvar E. Skaug at the Psychiatric Clinic, Oslo in 1950, by Lorentz Eldjarn at the Norwegian Radium Hospital in 1951 and the Rikshospitalet in 1959, and by Herbert Palmer and Søren Chr. Sommerfelt at Drammen Hospital in 1952; all of the aforementioned were medical chemists. Laboratories were also started by Kåre Myhre (a radiotherapist) at Ullevål Hospital, Oslo in 1954 and by Olav Holta (a radiologist) at Gjøvik Hospital in 1956. Over the years, nuclear medicine in Norway has mainly been linked to medical chemistry. During the past decade, most nuclear medicine departments have been organised in imaging departments.

National milestones of nuclear medicine

1950: The first publications on the use of radionuclides (see above)

1952: Radionuclide production started at the Institute of Atomic Energy (IAT), Kjeller, Norway 1958: First rectilinear scanner installed 1966: First ^{99m}Tc generator produced at IAT

1967: Start of nuclear medicine at Haukeland University Hospital, Bergen 1969: First gamma camera installed 1972: Norwegian Society of Nuclear Medicine founded 1974: Start of nuclear medicine at Tromsø University Hospital

1974: Rikshospitalet purchased a cerebrograph for measuring regional cerebral blood flow 1976: Medical physicist Arne Skretting developed a data program for performing SPECT on a manually moved single-head gamma camera 1978: First SPECT camera installed at Rikshospitalet 1979: First annual seminar in nuclear medicine and radioprotection 1983: First nationwide quality control of nuclear medicine equipment for in vivo studies 1984: Rikshospitalet purchased an advanced SPECT camera specially designed for examination of the head

1987: First mobile camera installed 1993: Kjell Rootwelt appointed to the first professorship in nuclear medicine 1995: Kjell Rootwelt presented the first Norwegian textbook in nuclear medicine 1995: First dual-head camera with rectangular heads installed 1997: Nuclear medicine accepted by the health authorities as a separate medical specialty 1998: First coincidence camera installed 1999: First production of ^{18}F-FDG 2005: First PET/CT scanner installed 2006: Second PET/CT scanner installed 2007: Professorship in Nuclear Medicine at the University of Bergen 2008: Third PET/CT scanner installed (in Bergen) 2010: Fourth and fifth PET/CT scanners installed; mobile PET/CT service in Tromsø

The development of nuclear medicine in Norway

Radiopharmaceuticals

In 1951 the first nuclear reactor outside the superpowers was installed at the Institute of Atomic Energy (IAE), Kjeller [since 1980 known as the Institute of Energy Technology (IET)]. The first radionuclides (^{24}Na, ^{32}P and ^{131}I) were produced in 1952. In the following years the number of different radionuclides and the amounts increased rapidly. In 1957 the first pharmacist was employed. In 1963 28 different radionuclides in more than 50 different radioactive compounds could be delivered. From 1965 iodine-labelled compounds became a specialty, with eight different ^{125}I-labelled and 21 different ^{131}I-labelled compounds.

^{99m}Tc generators have been produced at Kjeller since 1966, and many ^{99m}Tc labelling kits have been developed. IAE (later IET) produced the majority of the radionuclides used for medical purposes in Norway and a considerable portion of those used in other Nordic countries.

In 1999 IET started production of ^{18}F-FDG with ^{18}F produced at a research cyclotron at the Institute of Physics, University of Oslo. This was used for performance of gamma camera coincidence PET studies.

In 2005 a PET centre including a new cyclotron was founded at Rikshospitalet, where GE-Health is responsible for ^{18}F-FDG production.

Imaging equipment

For a few years, hand-held Geiger-Müller counters were used to measure radioactivity, both for quantitation and for "manual" imaging. Odvar E. Skaug built his own Geiger-Müller counter in 1949 and a small series of these were sold in Sweden.

Scintillation detectors with higher sensitivity and resolution were introduced later and were used for different types of in vivo studies, mostly thyroid studies. A two-detector system was mainly used for renography.

The first scanner was obtained at Rikshospitalet in 1962 and the first gamma camera in 1970.

The introduction of nuclear imaging equipment from the late 1960s (rectilinear scanners, gamma cameras) started a quite rapid development of nuclear medicine in Norway.

By 1980 there were 25 nuclear medicine departments, and in course of the 1970s all had acquired gamma cameras. In the course of the 1990s most nuclear medicine departments obtained dual-head SPECT cameras.

In the early 1990s, efforts started to acquire PET scanners for Norway. The Norwegian health authorities have been reluctant to adopt this technology, and several proposals were turned down. The Norwegian Radium Hospital got a gamma camera for coincidence PET studies in 1999, as did the Rikshospitalet in 2000. After some years of successful activity with these gamma cameras and with private funding and additional money from Oslo University, a PET centre was started with a cyclotron at the Rikshospitalet and PET/CT scanners were installed at the Norwegian Radium Hospital (2005) and the Rikshospitalet (2006). PET/CT scanners were also installed at Haukeland Hospital in Bergen in 2008, at Ullevål Hospital, Oslo in 2010 and by a private company (Aleris).

Tromsø Hospital uses a commercial mobile PET with ^{18}F-FDG delivery from Finland.

Nuclear medicine examinations

From the outset, in vitro analyses were part of nuclear medicine; later these analyses were transferred to clinical chemistry.

During the early years of nuclear medicine examinations, thyroid studies with ^{131}I (iodine uptake measurements and scintigraphic demonstration of the thyroid gland performed by hand-held Geiger-Mûller counters) were the dominant examinations. Static scintillation detectors then took over, and later rectilinear scanners were used for thyroid, brain and liver scintigraphy. Liver and brain scintigraphy was subsequently replaced by ultrasound and CT, respectively.

Brain studies (measurement of cerebral blood flow and scintigraphy of the basal ganglia) are performed in many nuclear medicine departments.

Renal function studies and renography have been important over the years, first with ^{131}I-*ortho*-iodohippurate, then with ^{99m}Tc-EDTA and now most often with ^{99m}Tc-MAG3. ^{99m}Tc-DMSA is also in general use for studies of renal cortical processes (e.g. scars, pyelonephritis, horseshoe kidneys and multiple kidneys).

Since the 1970s, bone scintigraphy has been the most frequent nuclear medicine examination. This investigation is useful for detection not only of bone metastases, especially from breast and prostatic cancer, but also of bone inflammation, bone infections, bone injuries and prosthetic complications.

Myocardial scintigraphy started in the late 1970s with ^{201}Tl and later ^{99m}Tc-labelled hexamibi or tetrofosmin. This is still one of the most frequent nuclear medicine examinations.

Radionuclide ventriculography is in part in competition with echocardiography and is therefore not available at all nuclear medicine units. In many cancer chemotherapy programmes, radionuclide ventriculography is the method of choice for monitoring heart function.

Diagnosis of pulmonary embolism with perfusion and ventilation scintigraphy is done in all nuclear medicine units. During the past few years, however, multislice CT scanners have replaced scintigraphy for this purpose at several sites.

After the introduction of ^{99m}Tc-labelled compounds for parathyroid imaging, this became a popular procedure and led to increased frequency of surgical removal of hyperfunctioning parathyroid adenomas.

Sentinel node scintigraphy was introduced just before the end of the old millennium. It is now done in all hospitals where breast cancer surgery is performed. At the Norwegian Radium Hospital the method is also used in patients with colorectal cancer or cancer of the penis and vulva.

Radionuclide therapy

Radionuclide therapy has been an important part of nuclear medicine, especially at the Norwegian Radium Hospital, which is a cancer centre.

^{131}I has been used to treat hyperthyroidism and thyroid cancer since 1950, and ^{131}I treatment of hyperthyroidism is still the most frequently used radionuclide therapy.

In the 1950s, intravenous injections of ^{32}P-phosphate were used in the treatment of polycythaemia vera, and this treatment is still in use. Also starting in the 1950s, ^{198}Au-colloid was used to treat peritoneal metastases from ovarian cancer, but towards the end of the 1970s it was replaced by ^{32}P-colloid and in about 1990 chemotherapy came to be preferred because it produced the same survival rate with fewer side-effects.

In the 1980s, ^{89}Sr was widely used for the treatment of metastases. It was subsequently replaced by ^{153}Sm, and promising studies on the effect of ^{223}Ra are ongoing.

Since 1990, ^{131}I-MIBG has been used to treat neuroendocrine tumours. The use of radiolabelled somatostatin analogues has not yet become a routine procedure in Norway, though a few patients have been treated in Sweden and Denmark.

^{90}Y-Zevalin has entered use in Norway for the treatment of recurrent lymphoma, with good results.

Nuclear medicine organisations in Norway

The Norwegian Society of Nuclear Medicine (NSNM) was founded in 1972 with Kjell Rootwelt as the first chairman. Since 1979 the society has arranged annual week-end meetings (seminars in nuclear medicine and radiation protection) for educational purposes and scientific presentations; these meetings have been geared towards the needs of all types of personnel working in nuclear medicine. The meetings have had a great impact on the nuclear medicine milieu in Norway and have attracted interest from the other Nordic countries. Since 1992 they have been associated with the Congress of the Scandinavian Society of Clinical Physiology and Nuclear Medicine every third year.

In 1997 nuclear medicine became a medical specialty. In the same year the Nuclear Medicine Specialty Committee was appointed and in the following year the Norwegian Association of Nuclear Medicine was founded. These two organisations are both headed by the Norwegian Medical Association.

The total number of approved specialists in nuclear medicine in March 2011 was 88, and some 60 are involved in active work in Norway today.

The future for nuclear medicine in Norway

With the addition of PET and PET-CT, the future of nuclear medicine is very promising. The number of PET and PET-CT investigations is expected to increase, and this technology will be an important part of nuclear medicine in the future. At the same time we must further develop and maintain a high quality of traditional nuclear medicine in all the departments.

The late introduction of PET and PET-CT in Norway has been an obstacle to the development of nuclear medicine in Norway. The number of Norwegian nuclear medicine specialists who have achieved qualification for work with PET and PET-CT is quite low. We must work actively to increase the number of positions for specialisation.

There is more active research in nuclear medicine in Norway than in the past, but it still lags behind research in the other Nordic countries.

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