Orthopedic research and education in Scandinavia

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Based upon an enquiry conducted in 1988 and 1989, data on the resources for orthopedic research in Scandinavia are presented, supplemented with a survey of the number of scientific papers published from Scandinavia in major orthopedic journals. The postgraduate training programs for orthopedic surgeons in the Scandinavian countries are outlined.

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Orthopedic surgery and orthopedic research have a long tradition in Scandinavia. A few pioneering contributions are mentioned below. In Copenhagen, Peter August Lorentzen wrote a thesis on the treatment of congenital talipes in 1887. In Oslo, Julius Nicolaysen performed his first nailings of femoral neck fractures in 1895, before radiography was available. In Helsinki, Maximus Widekind af Schultén developed a myoplasty for chronic osteomyelitis, and published his results in 1896. Patrik Haglund became the first Scandinavian professor in orthopedic surgery in Stockholm in 1913. Together with Hermann Christian Slomann of Copenhagen and Poul Viktor Bülow-Hansen of Oslo, he initiated the founding of the Scandinavian Orthopedic Association in 1919. Patrik Haglund also started *Acta Orthopædica Scandinavica* in 1929.

At present, Scandinavia has a population of 23 million inhabitants, with 24 orthopedic departments in university hospitals. These institutions serve also as regional orthopedic centers.

To survey the present state of orthopedic research and education in Scandinavia, a regional enquiry was conducted in 1988 and 1989. The data were supplemented with a survey of orthopedic publications in major orthopedic journals published in English and with data from medical authorities and associations.

Goals of orthopedic research in Scandinavia

The main interest areas of orthopedic research in Scandinavia, as expressed by academic orthopedic surgeons, are clinical. The research includes the major disease and therapeutic areas, including the prophylaxis of orthopedic diseases and trauma. A major emphasis has been placed on prospective randomized studies to scrutinize the contemporary therapeutic modalities. Increasingly, endeavors are also being made to analyze cost/benefit aspects of diagnostics and therapy.

Experimental research also has a high priority, as expressed by the increasing number of orthopedic research laboratories for biomechanical studies and animal experiments.

The importance of basic research is recognized as team work together with pathologists, biochemists, geneticists, physicists, metallurgists, statisticians, and the like. Most of the university professors of orthopedics in Scandinavia have a solid background in experimental research.

The need by researchers of systematic education in general methodology and statistics is appreciated. Most universities arrange courses in experimental design and statistical methods, and methodologic training forms a part of the training of younger scientists.

Resources for orthopedic research

Orthopedic research is mostly done in university departments. Simultaneously, clinical orthopedic research exists, to a considerable extent, outside university departments. One fourth of the original Scandinavian contributions published in the *Acta Orthopædica Scandinavica* come from other sources than university or university-affiliated departments.

The time share of the academic manpower between research, education and teaching, and administrative, clinical, and other duties is the central factor in the perpetuation of orthopedic research. The contents of the working day of academic orthopedic surgeons seem to vary considerably from country to country and from university to university. Too much time is often devoted to routine tasks that do not necessarily require the highly qualified background of an academic orthopedic surgeon.

A resource that obviously is correlated with the experimental orthopedic research production is the number of research laboratories and their technical

Table 1. Orthopedic laboratories and associated technical personnel in Scandinavia

	Denmark	Finland	Norway	Sweden
Laboratories	9	4	4	10
Personnel	6	6	3	24

Table 2. Scandinavian original papers published in *Acta Orthopaedica Scandinavica* between 1983 and 1990. Icelandic papers are mostly published in cooperation with other Scandinavian authors

	1983	1984	1985	1986	1987	1988	1989	1990	Total
D	34	23	32	26	38	31	25	26	235
SF	10	19	23	15	5	10	11	8	101
N	21	16	10	12	9	4	21	8	101
S	60	56	35	41	43	55	70	55	415
Total	125	114	100	94	95	100	127	97	852

Table 3. Scandinavian original papers published in the *Journal of Bone and Joint Surgery* (American and British editions) and *Clinical Orthopædics and Related Research* between 1983 and 1989

	1983	1984	1985	1986	1987	1988	1989	Total
D	1	2	4	12	11	13	6	49
SF	2	1	3	10	7	11	10	44
N	–	1	2	2	1	4	6	16
S	15	21	10	17	28	24	28	143
Total	18	25	19	41	47	52	50	252

Table 4. Scandinavian original papers published in the four most cited orthopedic periodicals

	1983	1984	1985	1986	1987	1988	1989
JBJS[a] A	6	4	4	7	9	8	6
JBJS[a] B	5	5	4	13	11	17	19
Clin Orthop	7	16	11	21	27	27	25
AOS[a]	129	93	93	91	92	87	119
Total	147	118	112	132	139	139	167

[a]JBJS *J Bone Joint Surg*; AOS *Acta Orthop Scand*.

personnel. The figures in Table 1 do not claim to be quite exact, but they reveal a general tendency.

Sixty-six academic dissertations in orthopedic topics were presented in the Scandinavian universities from 1985 to 1987 inclusive: 7 in Denmark, 10 in Finland, 7 in Norway, and 42 in Sweden. Interestingly, the number of theses correlates significantly with the numbers of technical personnel in the laboratories, and probably with the number of the scientific personnel in orthopedics in general.

Orthopedic research productivity in Scandinavia

According to the journal-impact factor of *Science Citation Index*, the *Journal of Bone and Joint Surgery* A, *Journal of Bone and Joint Surgery* B, *Orthopædic Clinics of North America*, *Acta Orthopaedica Scandinavica*, and *Clinical Orthopædics and Related Research* are the five most cited orthopedic journals. The *Orthopædic Clinics of North America*, where free submitting of papers is not practised, was excluded from the following analysis. Excluded were also invited papers, that is, to the extent these could be determined.

An analysis was made concerning the years from 1983 through 1989 of the submitted full scientific papers coming from Scandinavia. The natural major forum for their own publication activity is *Acta Orthopaedica Scandinavica*, which published 852 papers from Scandinavia during those 8 years (Table 2). An increasing tendency to publish in other than Scandinavian fora is obvious (Table 3). However, no major changes occurred in the total publishing volume (Table 4). The preponderance of the number of Swedish papers is obvious. However, the numbers are more than doubled when the total Scandinavian production is taken into account. The orthopedic research productivity per capita is high according to these figures, and is higher than in any other part of the world.

Specialist education in Scandinavia

In spite of years of cooperation between the medical associations in the Scandinavian countries and in spite of a common Scandinavian market for doctors, specialist education differs considerable from country to country. The length of specialization time is shortest in Sweden, 4.5 years, and longest in Norway, 8 years (Table 5). In Iceland, 2.5 years of the training has to be done abroad. In Finland and in Norway, orthopedic surgery is a subspecialty of general surgery. In the other three countries, Iceland, Denmark, and Sweden, orthopedics is an independent specialty. Tendencies exist in Finland and Norway to increase the share of orthopedics at the expense of the time now devoted to general surgery education, and to make orthopedics a main specialty.

The control of cognitive and psychomotor skills acquired during the specialization period differs also.

An examination at the end of the specialization period in general surgery and orthopedics (orthopedics and traumatology) exists in Finland, and since 1988 in Sweden. In Norway, the residents build up a repertoire of specified orthopedic operations during their specialization period, with the latter serving as a gauge or measure of their psychomotor skills.

In every country, the residents have to take a certain number of courses. The course hours vary from 30 in Finland to 120 in Denmark and Norway, and to 180 in Sweden. In addition, weekly hours of continuous education are expected in the institutions in Finland (3 hours) and in Norway (2 hours).

In each country, the specialization is allotted a certain number of residencies, and the duration of service in these positions is regulated (Table 6). In Denmark and Sweden the allotment is not strict, and more specialists are educated than the number of positions would indicate. In the other three countries, the numbers of specialists are regulated more closely by the number of residencies.

In each country, the number of specialists in orthopedics will increase during the coming years. Assuming that the time in specialist service for an orthopedic surgeon is 30 years, the turnover and annual number of specialists can be calculated. Assuming that the specialist production remains unchanged until the year 2000, considerable increases will occur (Table 7). Considerable differences still will remain between the countries. The figures will still be lowest in Finland and Norway and highest in Iceland and Sweden. This will affect the work load and the work content of the orthopedic surgeons in the different Scandinavian countries.

Even if large differences are not assumed in the orthopedic morbidity in Scandinavia, with hip fracture as a notable exception, major changes may still be forecasted in the demand for orthopedic surgery. Waiting lists are still a reality in all the countries. In countries with high relative numbers of orthopedic surgeons, they can participate in outpatient consultation work, which may have a prophylactic importance. This type of work will increase.

The population of Scandinavia is not growing considerably (Table 7). The projected increase from 1986 to the year 2000 is from 22.8 million to 23.3 million inhabitants. However, the percentage of the elderly population is increasing, which is resulting in an increasing orthopedic work load.

Closing remarks

Several partly heterogeneous sources were used to collect the data. The methods used obviously influence the exactitude of the figures, and no claim is made that every detail is precise. However, this study reflects the general features of Scandinavian orthopedic research and education. In research, it appears that the Scandinavian countries are, on a per capita basis, very active, although differences exist between the countries. In orthopedic education, the Scandinavian countries are self-sufficient.

Table 5. Duration of orthopedic specialist training (years)

	Denmark	Finland	Iceland	Norway	Sweden
General surgery	1	4	1	6	2
Orthopedics	4	2	3.5	3	2
Other	1	–	1	0.5	0.5
Total	6	6	5.5	8	4.5

Table 6. Specialist training in Scandinavia. Positions, appointment times, and new specialists per year (average of last 5 years—1986–1900)

	Denmark	Finland	Iceland	Norway	Sweden
Positions	22	30	5	27	26+
Duration, years	2.5	2	1.5	3	2
New specialists per year	14	10	2	9	30

Table 7. Specialists in orthopedics in 1988 and 2000

	Denmark	Finland	Iceland	Norway	Sweden
Specialists in 1988	244	188	16	131	532
Population (mills.)[1]	5.2	4.9	0.24	4.2	8.4
Specialists per mill.	47	38	67	31	63
Specialists in 2000	302	232	24	187	679
Population (mills.)[1]	5.2	5.0	0.26	4.3	8.5
Specialists per mill.	58	46	92	43	80

[1] *Yearbook of Nordic Statistics* 1987, Nordic Statistical Secretariat, Copenhagen 1988

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