

# DEVELOPING EXCELLENCE IN MEDICAL TECHNOLOGIES

## Benchmark Report for Denmark/Sweden

A report prepared for  
Advantage West Midlands

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# 1. Introduction

The purpose of the benchmarking report is to provide a commentary on how the medical technologies industry has developed in The Copenhagen/Skåne region of Scandinavia, Known as the Medicon Valley. The report seeks to identify the stimulants and catalysts to growth; and the extent to which the existing industrial development and skills supply infrastructures, at national and local level, have contributed to or inhibited the growth of the industry. All details have not been collected for both Danish and Swedish part of the Medicon Valley. In some cases, the focus will mainly be on the Danish part.

The benchmarking report will provide:

- The size and characteristics of the medical technologies sector in each country;
- An account of national institutional arrangements for the development of the medical technologies sector;
- The supply of skills to the medical technologies sector;
- An account of a region where the medical technologies sector is concentrated and the factors behind the location of the industry in that region;
- The characteristics of the medical technologies industry in that locality.

In this study, the medical device industry is defined within the International Standard Industrial Classification of All Economic Activities (ISIC, Rev. 3), as follows:

## **Applied definition of medical device industry**

*Section D: Manufacturing*

*Division 33: Manufacture of medical, precision and optical instruments*

*Group 331: Manufacture of medical appliances and instruments and instruments for measuring, checking, testing, and navigating and other purposes...*

*Class 3311: Manufacture of medical and surgical equipment and orthopaedic appliances*

The definition excludes the manufacture of surgical dressings (2423); the manufacture of thermometers (3312); and the manufacture of corrective spectacle lenses (3320). There are a number of linkages that will be addressed, such as the link to human health activities (851).

The definition of the sector may vary between countries depending upon the extent of linkages between the various parts of the industrial cluster. The purpose of the study is to address the industry concerned with the manufacture of medical devices. This will lead to overlaps with:

- The health service (i.e. hospitals; medical teaching centres/universities);
- Pharmaceuticals (where they concerned with devices for the administration of medicines);
- Bio-technology;
- Information and communication technologies (ICT) where the development of products or services is concerned with the provision of medical treatments (e.g. telemedicine).

The Medicon Valley contains an impressive number of biotechnological, pharmaceutical and medical device and service companies, and holds a strong scientific position within this sector in Europe.

The benchmark study addresses the medical device industry but in many cases it has been necessary to describe the development on the basis of data and information on a broader group of industries.



## 2. *National overview of Denmark*

### 2.1. **National overview of economy**

#### 2.1.1. **Overall macroeconomic performance**

With a population of about 5.4 million citizens, of which about 3 million are of working age, Denmark is one of the smallest countries in the EU. However, given high productivity and continuous economic growth, GNP amounted to € 183 billion in 2002. This was equivalent to a per capita GDP of € 34.493, which places Denmark among the highest performing countries in the world.

Economic performance in relation to foreign trade has been fairly good during the past decade. In an international context, the Danish economy is very small but also very open, and has a great dependence on foreign trade.

In 2002, Danish exports totaled almost €54.8 billion, corresponding to 32 per cent of GDP. During the same year, imports totaled €51.5 billion, corresponding to 28 per cent of GDP. Sixty-five per cent of Danish exports are to EU-countries, while 72 per cent of imports are from EU-countries. The most important trading partner is Germany, which accounts for more than 22 per cent of Danish imports and 19 per cent of Danish exports. Other important trading partners are Sweden and the United Kingdom. In 2002, the national surplus on foreign trade was about €5.1 billion.

Due to previous deficits on the foreign trade balance, Denmark had a national debt ratio of €33.6 billion in 2002, corresponding to about 18 per cent of the annual GNP. However, the Danish debt ratio is gradually being reduced.

The strong performance of the Danish economy has been in contrast to the current global economic downfall in most EU countries, in the US and in Asia<sup>1</sup>.

The unemployment rate in Denmark is fairly low compared with EU standards. Thus, the unemployment rate in 2001 was reported to be equal to 5.2 per cent of the working population<sup>2</sup>.

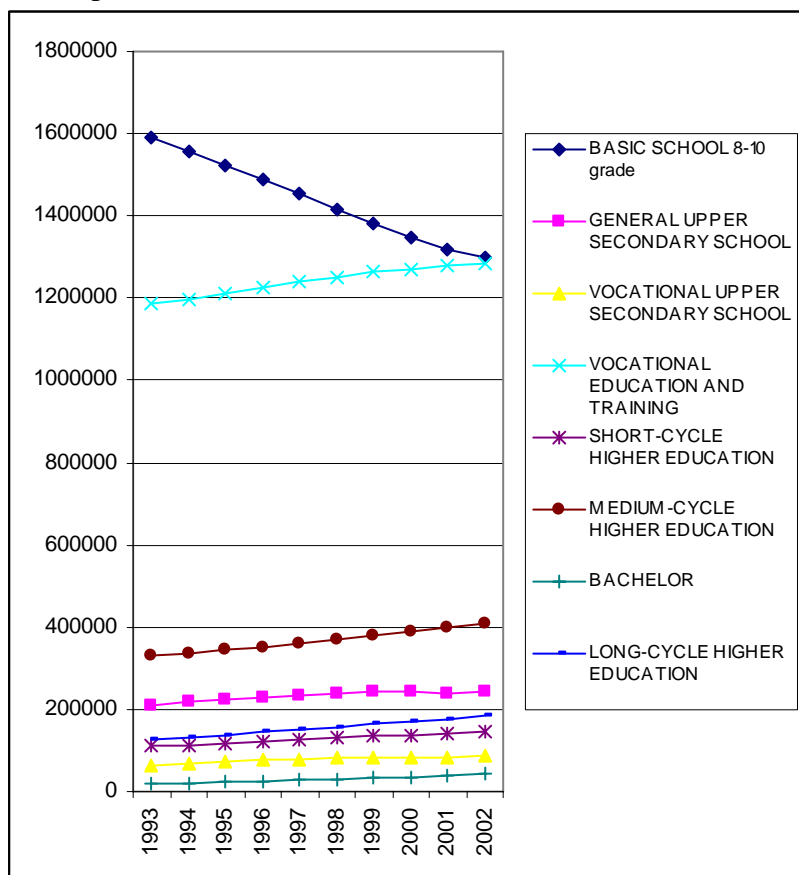
The educational level of the working population changed substantially during the 1990s. The proportions of people with a bachelor degree, a master degree or a vocational qualification increased, while the proportion of the labour force with only an elementary school education decreased during period 1993 – 2002.

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<sup>1</sup> Economic Survey of Denmark 2003, OECD

<sup>2</sup> Denmark in numbers 2003, The State bank of Denmark

## Development of the educational level in Denmark.



Source: www.statistikbanken.dk

### 2.1.2. Overview by broad industrial group (manufacturing/services)

The Danish economy is roughly divided into the following areas listed in the table below<sup>3</sup>.

Area of economy	Percentage of GNP
Primary sector (agriculture, mining, etc.)	5
Secondary sector (Manufacturing and construction, etc.)	27
Tertiary sector (service, trade and public services, etc.)	68

In connection with the public and statistical classification and analysis, the Danish Ministry of Industry often uses the concept of resource areas. The following 12 resource areas or industrial groups represent approximately 90 per cent of Danish business activity<sup>4</sup>:

- Food
- Furniture and clothing
- Tourism

<sup>3</sup> Beskrivende Økonomi (Informative Economics), DJØF Publishing

<sup>4</sup> Medico/Health – A Business analysis, The Danish Ministry of Business

- Construction
- IT/Communication
- Transport,
- Energy and environment
- Medical/health
- Metal and production technology
- Commerce
- Knowledge based services
- Operational Services

These resource areas are broad domains of business, including suppliers of products and services, under which companies operate under similar conditions, such as dependence on a qualified labour force; research and education centres; and specialised suppliers. The 12 areas are categorisations of companies into broad industrial domains interrelated across branches and sectors.

### 2.1.3. Forecasts for medium-term

A number of Danish and international authorities and organisations have made forecasts of economic performance in Denmark. The table below shows the short-term estimates<sup>5</sup>:

Authority/organisation	GNP Real growth		Unemployment % of work force		Inflation %		Trade balance % of GDP	
	2003	2004	2003	2004	2003	2004	2003	2004
Ministry of Finance	1.6	2.4	5.6	5.3	2.3	1.9	3.0	3.0
European Union	1.5	2.2	5.0	4.8	2.4	1.9	3.1	3.1
OECD	1.6	2.6	4.7	4.4	2.4	2.3	2.9	3.6
Danish Economic Council	1.5	2.2	5.6	5.2	2.3	1.7	2.8	3.1
Danish Industry	1.7	2.0	4.8	4.5	1.9	1.9	2.7	3.3
The Danish Confederation of Trade Unions (LO)	1.6	2.2	5.7	5.7	2.4	2.0	3.0	3.0
Danske Bank	1.2	1.8	5.7	5.6	2.5	1.5	2.8	2.7
Nordea Bank	1.2	2.1	5.7	5.5	2.5	2.0	2.9	2.9
Jyske Bank	1.3	2.3	5.7	5.7	2.1	1.9	3.1	3.2
<b>Median</b>	<b>1.5</b>	<b>2.2</b>	<b>5.6</b>	<b>5.3</b>	<b>2.4</b>	<b>1.9</b>	<b>2.9</b>	<b>3.1</b>

In the medium-term, national policies in Denmark focus on the freezing of taxes and cuts in public expenditure. Against this background, the Danish ministry of Finance is expecting the following key figures in the period towards 2010:

- A surplus in the public finances equal to 1½-2½ per cent of GNP
- 2.2 per cent annual growth in productivity within the private sector
- A reduction of public debt in relation to GNP in 2010

<sup>5</sup> Cf. <http://www.fm.dk>



- A reduction in the number of unemployed by 85,000
- Lower taxes from 2004 toward 2010
- Inflation rate less than two per cent per year

#### **2.1.4. Forecast for long term**

All labour force forecasts are currently pointing in one direction. Employment is expected to increase among all groups. The trend will be particularly strong for the group with a vocational training and a business education. According to the Danish Workers Movement's Business Council (arbejderbevægelsens erhvervsråd) there will a shortage of between 100,000 and 125,000 highly educated people in 2009. On the other hand, the number of people with only an elementary school education is expected to decrease by about 73,000 by the year 2009.

## **2.2. Overview of industry policy**

### **2.2.1. National industrial policy**

OECD recently made a critical assessment of industrial policy in Denmark, which states that:

*The national industrial policy should focus on supporting the private sector and thereby ensuring fiscal sustainability. One of the main factors in doing so is to raise the supply of labour as well as the education level.*<sup>6</sup>

#### **General framework conditions**

Danish industrial policy focuses on the following general objectives:

- improving productivity by increasing the economic incentives to work;
- improving the framework for foreign and domestic investments;
- supporting new entrepreneurs and business start-up;
- supporting research and development (R&D) in the private sector and in the main public education facilities.

In order to reach these objectives, national industrial policy is currently focused on<sup>7</sup>:

- *The creation of better conditions for entrepreneurship*  
Efforts are taken in areas such as tax cuts, modernisation of the public sector, and the reduction of the administrative burdens of new regulation for private companies.
- *Increasing the use of knowledge and resources*  
Policies are aimed at reforming the education system, developing regional growth strategies, and at creating better co-operation between the private sector and knowledge institutions.
- *Improving the competitiveness of selected business areas*  
In this area, the national industrial policies are aimed at the creation of private-public partnerships, liberalisation of the energy market, and at increasing the flexibility of the financial sector.

<sup>6</sup> Economic Survey of Denmark 2003, OECD

<sup>7</sup> Intended Growth, The Danish Government, 2002

- *Focused globalisation approach*

In the context of globalisation, national industrial policy focuses on the implementation of a green card system, the creation of strategies for the Baltic Sea Region and on the development of a growth strategy for the Oresund Region.

### 2.2.2. Approaches to industrial development

In addition to these overall objectives, national industry policy rests upon a dual approach: *Resource Areas* and *Clusters*.

Since the beginning of 1990s industrial policies have been orientated towards a number of business areas, the so-called *resource areas*. As mentioned above, the resource areas should be seen as coherent blocks of business areas, within which the businesses operate under similar frameworks conditions. On the basis of detailed analyses of each resource area, actions has been taken to improve access to qualified labour; research and education centres; specialised suppliers; and so on.

In addition, and with a more specific focus, public authorities are successively monitoring the performance of the so-called *competence clusters*<sup>8</sup>. These clusters are Denmark's corporate *spearheads*, i.e. those business areas that create high growth of value and employment and that perform well on international markets. For example, the Danish cluster of *pork meat exports* accounts for about € 2.7 billion annually, which makes it the world's biggest exporter of the product.

The competence clusters are anchored either nationally or regionally. The *sea* and *windmill industries* are examples of national competence clusters. The IT and *cell phone industries* in Northern Jutland are examples of regional competence clusters. Many of these clusters are quite knowledge intensive, which means that education, strategic co-operation and the access to researchers and fiscal assets are key factors in the approach to industrial development.

### 2.2.3. Sectors where the country is strong

The cluster of medical and surgical equipment is among the best performing clusters in Denmark. The following table shows a number of well-performing competence clusters<sup>9</sup>.

Level of performance	Competence cluster
High performance in world market and in Denmark	<ul style="list-style-type: none"> <li>• Medicine production and trade</li> <li>• Fur production and trade</li> <li>• Medical and surgical equipment</li> </ul>
High performance in world market but low in Denmark	<ul style="list-style-type: none"> <li>• Organic chemicals</li> <li>• Clothing and fabrics production</li> <li>• Circuits and semiconductors</li> <li>• Carpet production</li> </ul>
High performance in Denmark but low in world market	<ul style="list-style-type: none"> <li>• Architect and engineering</li> <li>• Cellular phones</li> <li>• Paint, ink and furnish</li> <li>• Movies and video production</li> </ul>

<sup>8</sup> Cf. <http://www.workindenmark.dk>

<sup>9</sup> The Danish Competence Clusters, The Danish Ministry of Economic and Business Affairs

- Trade with electrical components
- 

In contrast with the previously mentioned resource areas that covered 90 per cent of the total Danish private sector, the competence clusters cover only part of the private sector, but that is considered the most competitive part of Danish industry.

#### 2.2.4. How key sectors are supported

Besides the general framework conditions that are established through the overall industrial policy, selected key sectors in Denmark are supported through more specific efforts. Among these is the Green Card system, which is established in order to attract qualified experts from abroad and a special tax discount for researchers and scientists. In addition, individual business and action plans have been prepared for a number of major resource areas, such as, *Tourism*, *The Environment* and *IT/Communication*. Two examples of national action plans for specific business areas are shown below.

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#### Area: Tourism

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*Actions:*

- *Private-public cooperation regarding product development*
    - *Improved turnover and competitiveness through strategic collaborations and frontrunner projects*
  - *Effective business service and branding of Denmark*
    - *Effective business counseling in relation to enterprises within the tourism sector*
  - *Reduction of administrative burdens*
    - *To make it easier to start and run companies within the tourism sector*
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#### Area: IT/Communication

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*Actions:*

- *Regulation of the telecommunication market*
  - *Analysis of, and better framework conditions of telecommunication services*
  - *Home Pc strategy and financial support*
  - *Increased IT security*
  - *Implementation of Digital signature*
  - *Securing common standards of data transfer*
  - *Financial support for the IT sector in Jutland and Funen*
  - *Increased IT research effort*
- 

In addition, actions are being taken to liberalise the energy, financial and transport markets<sup>10</sup>. Even though these actions are aimed at boosting the development within these specific sectors, the efforts are expected also to have an effect in other sectors that depend on the development within the energy, financial and transport markets.

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<sup>10</sup> Intended Growth, The Danish Government, 2002

## **2.3. National overview of approaches to local economic development**

### **2.3.1. Institutions and programmes responsible for innovation in Denmark**

The following programmes are among the most important in the Danish innovation support system.

- The Development Contract Scheme
- The Growth Fund
- Technology & Innovation centres (TIC)
- Approved Technological Service Centres (GTS)
- Innovation Environments

#### **The Development Contract Scheme**

This programme offers financial support for highly innovative cooperation projects, where there is cooperation between at least one research institute, one or more approved technology service centres and a number of private enterprises. The cooperation project shall be well defined and it must be clear that the private enterprises will derive a commercial benefit from it. The financial support more or less corresponds to the contributions of the research and the technological services provided by the other participants.

From 1994 to 1996 a total budget for the development contract scheme amounted at DKK 264 million.

#### **The Growth Fund**

The Growth fund aims at strengthening the development and innovation of small and medium sized enterprises (SMEs) by offering financial support, especially for innovative and high tech companies with a strong position in the market. The financial support is given as loans, investments or as support for counselling.

The total capital foundation is DKK 2.1 billion.

#### **TIC-Centres**

The TIC Centres offers Free and impartial counselling for all Danish SMEs. Each of the counties have had TIC Centres until recently. From 2003, some of the centres have been integrated with regional development support Centres, operated by the counties and municipalities.

#### **GTS**

The Approved Technological Service Centres (GTS Centres) are independent, specialized technological support institutions closely related to research institutions, offering counselling within their specialized fields. The counselling is strictly focused on research intensive enterprises. The GTS employ 3000 experts and researchers and have a yearly budget of DKK 2.2 billion.

#### **The scheme for Innovation Environments**

Innovation Environments offer innovation grants or loans at a maximum of EUR 100,000 for new, innovative enterprises in their early stage, or innovative projects being established within a well defined market area of the programme. The Innovation Environments receive financial support from the state and are appointed on the basis of a tendering procedure.

### **2.3.2. Institutions responsible for industrial development at a national level**

The institutions that are responsible for the local industrial development in Denmark are primarily the local institutions, that is to say, institutions in counties, municipalities, organisations as well as educational institutions.

Legislation in 1997 provided counties and municipalities with opportunities to enter into more active co-operation with private enterprises and thereby to engage more actively in business development policies at the local level. Based on this legislation, the counties and municipalities have broadened their involvement in business development and the composition of objectives, strategies and means for achieving industrial development at the local level.

The Danish Ministry of Economic and Business Affairs is responsible for overall policy in the area of industrial development, and the National Agency for Enterprise and Housing is the executive body of the Ministry with responsibility for a number of business development programmes.

#### **Counties**

Denmark is subdivided into 12 counties which have relatively large degrees of freedom in relation to local business policy. They may enter into public-private company start-ups and co-finance business supporting activities. An example of such activities are the regional business development centres that are increasingly integrated with a former state supported national network of Technological Information Centres (TICs). The TICs offer management and technological advice for SMEs within defined budgetary limits.

In many cases the counties have a key role in relation to activities in the field of vocational training and continuing training and education.

#### **Municipalities**

Danish municipalities in general are small, covering from a few thousand inhabitants to some hundreds of thousands in a few cities. Several of the municipalities have established local business and development offices in order to encourage the development in their area. It is mainly the larger towns and cities that are politically and financially involved in the operation of incubators, education and knowledge centres or local science parks.

### **2.3.3. National industrial policy at a local level**

Compared with the majority of other countries, local industrial development in Denmark is quite balanced and evenly distributed between the geographic regions. It is a principal of national industrial policy to maintain a balanced regional development<sup>11</sup>.

However, there are regions where growth and development is falling behind. Typically, these regions have a high level of activity in the primary sector (agriculture and fishing). The local municipalities and the counties are responsible for the preparation and implementation of a sustainable growth strategy for these regions in cooperation with central government.

### **2.3.4. Approaches to industrial development at local level**

In addition to the efforts made by the counties and municipalities, the national authorities have taken a number of initiatives to promote industrial development at local level. These initiatives include:

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<sup>11</sup> The Regional Growth Strategy, The Danish Government, 2002

- Support to business development strategies in low growth areas;
- Financial support to municipalities with low income levels;
- Simplification of the agriculture law;
- Regional business assistance;
- National infrastructural investments in the regions;
- Special tax deductions in rural areas (transport expenses).

Moreover, the Ministry of the Interior publishes a yearly statement of the objectives for regional development in Denmark, containing descriptions of regional consequences of new legislation and new initiatives for regional development.

As an example, the government in 1995 took the initiative to establish a number of local Business Development Networks (Erhvervsknudepunkter). Within these networks, a number of municipalities can agree on common policies and initiatives in the areas of labour market and industry policy.

Moreover, there are various action plans and regional funding available in connection with different national fiscal budgets. An example of such funding is the social and regional fund, which holds assets of about € 0.6 billion to be distributed until 2007.

## **2.4. The national educational and training system**

At the age of seven, Danish children begin the obligatory, basic education of 9 to 10 years in a municipal school. After this, he or she may continue with upper secondary education in a grammar school or a vocational school (business college or a higher technical school). These schools offer three-year programmes as well as training opportunity schemes of shorter duration (so-called *AMU* courses which are also available at other institutions). The *AMU* centres offer a variety of courses ranging from door attendant courses and roof construction courses to supplementary courses for laboratory technicians.

Universities, specific business schools and engineering colleges are increasingly popular, and it is very common to receive up to five years of education from these institutions after having finished three years of upper secondary education. The government provides study grants for up to 60 months for studying at these institutions (€ 589 per month).

### **2.4.1. Institutions responsible for education and training**

Both Sweden and Denmark have a number of educational institutions at university level. The major institutions responsible for education and training in Denmark are the following:

- DTU (Danish Technical University)
- AAU (Aalborg University)
- KU (University of Copenhagen)
- AU (Aarhus University)
- Various engineering colleges
- Various business schools

The major institutions offering education and training at university level in Sweden are the following:

- Lund University and Bleking Institute of Technology
- Umeaa University
- Karolinska Institute (Medical University)

- Luleaa University of Technology
- Chalmers University of Technology
- Gothenburg University

The following details on the education and training system within the medical technology sector are given selectively, as the primary focus has been given to DTU and AAU that are considered to be the important and representative actors within the field.

#### **2.4.2. Description of education and qualifications system**

DTU offers education in fields such as biotechnology, communications technology, nano-technology and development of technologies within sustainable energy, as well as almost all engineering disciplines. Its location in the north of Copenhagen results in contact and co-operation with the Oresund Region. Hence, DTU is positively integrated in the R&D divisions, both state-funded and within private research. In 2002, DTU accepted about 67 students within biotechnology alone. Typically, the number of PhD students at DTU corresponds to approximately 10 per cent of ordinary students.<sup>12</sup>

AAU produces a large number of highly qualified graduates within biomedical technology and related areas. At present, there are 50 students of biomedical science and engineering, but the number is expected to rise to 80 within the next five years. Currently there are 50 PhD students.

#### **2.4.3. The provision of initial education and training**

It is possible to take a bachelor's degree (typically 2½ to 3 years of study); but it is more common to continue (typically for 5 to 6 years) with more specialized studies aiming at a master's degree. A few students continue to attain postgraduate qualifications (PhD), especially within the biomedical sector.

#### **2.4.4. The provision of continuing education and training**

Education directly aimed at the labour market has high priority in Denmark. The aim is to build up a good educational system to service its citizens with *life-long* education. The system is called AMU (Labour Market Education), and has existed for more than 50 years.

The main aim of AMU is to develop business related qualifications in the labour force with a focus on blue collar jobs. The training is subsidised by the state through different education programmes.

#### **2.4.5. Industry and education links**

With a high number of graduates, the county of North Jutland strives to attract more companies within life sciences, and the figures show that this has already happened. Within the last four years, the number of companies within this sector has risen from 18 companies to 40. Many of the companies are spin-offs from the research environment at AAU<sup>13</sup>. Traditionally, spin-offs from universities are not a common model in Denmark. Sweden is much more advanced in this regard. This may be due to the fact that Swedish academic researchers have the right to commercialise their own innovations, which encourages entrepreneurial activity. In Denmark, the ownership and royalties on patents are split among researchers, universities and partners.

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<sup>12</sup> Cf. <http://www.adm.dtu.dk>

<sup>13</sup> Cf. <http://www.nc.auc.dk>

In order to meet market demands, two new important educational courses have been established. The first one, initiated in 1998, is a *Master in Biomedical Technology* at the department of Health Sciences at the University of Aarhus (AU), and it is multidisciplinary as the course involves collaboration between the Engineering College of Aarhus and the hospital of Skejby. Bachelor students in engineering or medicine can apply for the course. Around 20 students have graduated since 2000, and the department accepts more and more students every year<sup>14</sup>.

As of September 2003, DTU in collaboration with the University of Copenhagen offered a new tailor made interdisciplinary course within medicine and technology for hospitals and the industrial sector. Sixty students have been taken on during the first year, out of the 115 who applied<sup>15</sup>.

In contrast with the University of Aarhus, the course gives students an opportunity to specialise in medical technology in their basic training, that is to say, their bachelor's degree. Consequently, they are even better prepared for the requirements of the industrial and health care sectors.

Finally, the Medicon Valley of the Oresund Region has set up the Medicon Valley Academy (MVA), which covers the fields of biotechnology, medical technology and IT. They supply the sector with conferences and seminars as well as coordination of projects by, for example, establishing links between medical institutions and companies.

#### **2.4.6. Main strengths and weaknesses of the education and training system**

The main weakness of the education and training system is the limited capacity to take students, which is due to lack of teachers or financial resources. Apparently there is an unmet demand for new courses in the medical engineering sector.

Another problem is that universities have difficulties in retaining teachers and professors at the universities because of the attraction of jobs in the private sector. This may result in a falling quality of teachers and professors.

The main strengths of courses within medical technology seem to be the close contact with industry and the ability to meet the particular requirements the industrial and health care sectors.

### **2.5. Organisation of health care system**

#### **2.5.1. Regulation of the health care system**

Health care provision in Denmark is largely in the public sector, as 85 per cent of health care costs are financed through taxes. The responsibility for running the services is decentralised, and mostly lies within the regional authorities, which cooperate with the government and local authorities.

#### **2.5.2. Extent of public and private provision**

Private health care expenditure mainly covers user payments for medical products, dentistry (dental care is free for children under the age of 18) and physiotherapy. According to the Ministry of the Interior and Health, the total public and private health care expenditure corresponds to roughly 8.3 per cent of the gross national product (GNP)<sup>16</sup>.

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<sup>14</sup> Cf. <http://www.biomedtek.au.dk>

<sup>15</sup> Cf. <http://www.biotechdenmark.dk>

<sup>16</sup> *Medicoindustrien i tal – 2002* (The medico industry in numbers – 2002), The branch organisation of Medico technology, 2003



Private health insurance is increasingly gaining a larger foothold and is often provided by employers as a fringe benefit. The number of private health insurance policies has risen from 118,000 to 234,000 in the most recent year<sup>17</sup>. In combination with cost effectiveness analyses of hospitals, the outcome has been the closure or merger of local hospitals. This is seen in the table below.

	1995	2000
Public hospitals*	102	64
Number of citizens per hospital bed	181	257

\* Public hospitals do not include psychiatric hospitals (17 in 1995 and 12 in 2000).

There are 39 private hospitals that are accepted by the Danish main private health insurance company (2003 figures) and they contain 165 hospital beds<sup>18</sup>.

### 2.5.3. Main challenges facing provision of health care

With a very low population increase and the prospects of an ageing population combined with a strong political pressure to reduce taxes and the development of new more expensive technologies, the service level in the hospitals and nursing homes is under pressure. These are the main challenges to Danish health care today.

<sup>17</sup>Cf. <http://finansforbundet.dk>

<sup>18</sup> Cf. <http://finansforbundet.dk>

### *3. The medical technologies sector*

#### **3.1. Broad description of sector nationally**

In broad terms, Medical technology is a small, but strong business area in the context of the overall Danish private sector. In conjunction with related business areas like medicine production and other private service companies in the health sector, this competence cluster contributed seven per cent of total Danish exports in 1998, while it represented only one per cent of the total private sector<sup>19</sup>.

Danish medical device manufacturers comprise a handful of large companies and many small ones. There are about 550-800 production and sales companies in Denmark and at least 44 per cent of the facilities are located in east Zealand; 174 in the regional authority district of Copenhagen and 67 in that of Frederiksborg.

Aarhus, the second-largest regional authority district, has 79 production facilities. Ten manufacturers are either listed independently on the Copenhagen Stock Exchange or owned by listed companies<sup>20</sup>.

In Aalborg and Odense there are smaller, but still significant competence clusters of medical technology firms, all of which have close relations with the local hospitals and universities and are very research intensive.

Danish owned companies locate a large part of their production abroad. In addition to domestic production amounting to € 1.7 billion in Denmark, the value of products manufactured abroad by Danish owned companies amounted to about € 1.1 billion.

#### **3.2. Performance of the sector (growth in employment and output)**

The number of employed in the overall medical technologies sector increased by 28 per cent over the period 1992-1998. That brought the total employed within medical device manufacturing to about 15,000-18,500 people. In Sweden, about 20,000 people, spread among 1,500 different companies, are employed in medical technology. In the whole of the EU, 2003 estimates suggest that the medical technology sector involves 7,000 business entities, which employ about 350,000 people.

The Danish production generates value added for society of about € 1 billion. Danish medical device manufacturers recorded a turnover of € 1.7 billion in 2000. Seventy-nine per cent of the products were exported<sup>21</sup>.

The production figure for Denmark is € 262 per head of population, which makes Denmark the largest producer of medical devices per head in the world. In Sweden, the production figure per head of population is about € 121.

The industry's profit margin was 15.7 per cent 1999, substantially higher than the 6.5 per cent average for manufacturing industry as a whole.

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<sup>19</sup> Medico/Health – A Business analysis, The Danish Ministry of Economic and Business Affairs

<sup>20</sup> Cf. <http://www.medicointustrien.dk>

<sup>21</sup> Medicoindustrien i tal – 2002 (The medico industry in numbers – 2002), The branch organisation of Medico technology, 2003

The growth in exports has also been substantially higher for the medical technologies industry than for the rest of the Danish exports. In the period 1991-2001 exports rose by 173% compared with the average of 73 per cent over the same period. In addition, the value added per employee is about € 110.000 annually, which is 25 per cent higher than for other resource clusters in Denmark<sup>22</sup>.

### 3.3. Performance of the industry in relation to sub-sector

In general, it is possible to divide the medical technologies sector into two sub-sectors: first, the manufacture of instruments for medical diagnostics, treatment and relief of handicap, including hearing aids; and, secondly, the manufacture of disposable medical instruments and products<sup>23</sup>.

*The manufacturing of instruments for medical diagnostics, treatment and relief of handicap, including hearing aids.*

As the larger of the two, this sub-sector had about twice as many employees and three times the turnover compared with the *disposable* sector (see below). However, in recent years the sub-sector did experience a relative decline of seven per cent in the number of employees and turnover compared with the overall sector. This decline was mainly due to budget cuts and efficiency projects in the public health sector. In contrast to this development, the hearing aid manufacturers experienced a substantial growth in the previous decade.

*Manufacturing of disposable medical instruments and products*

This sub-sector experienced strong growth in the period 1992-1998 mainly due to some of the main players such as Maersk Medical and Coloplast. The main customers were mostly municipalities, counties, and the individual end users. The demand for products has slowly been increasing. This sub-sector is characterized by substantial advantages of scale and it is becoming increasingly difficult to establish new production start ups in the sector.

It is possible further to divide the medical technology industry into more sectors. A LEK study from 1996 thus segmented the medical technology industry in EU into the following 12 sub-sectors and assigned the following shares of the market to each<sup>24</sup>:

- In Vitro Diagnostic (18 per cent)
- Disposable devices (17 per cent)
- Ophthalmic and optical devices (13 per cent)
- Electromedical/mechanical devices (12 per cent)
- Imaging (10 per cent)
- Dental devices (7 per cent)
- Surgical reusable devices (6 per cent)
- Non-active implantable devices (5 per cent)
- Aids for disabled persons (4 per cent)
- Anaesthetic/Respiratory devices (4 per cent)
- Hospital hardware (3 per cent)
- Active implantable devices (2 per cent)

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<sup>22</sup> Bio-/sundhed (Bio-/health – A new partnership for growth), Public Task force, 2002

<sup>23</sup> Medico/Health – A Business analysis, The Danish Ministry of Business/Aston Lisbjerg

<sup>24</sup> The global competitiveness of the European medical device industry, The L/E/K partnership, Paris, 1996

Unfortunately, no more recent study has been conducted or published, and the figures may now be a little out of date. In addition, no such numerical analysis of sub-sectors has been carried out for the medical technology sector in Denmark alone. Perhaps the Danish industry is too small for such subdivisions.

### 3.4. Extent of intellectual property generation

The number of applications for patents is one clear measure of the results of R&D investments. However, there is a clear difference in research policy between Denmark and Sweden, which results in Swedes being substantially more motivated towards entrepreneurial activity, as already mentioned in section 2.4. Swedish academic researchers have rights to their own inventions whereas Danish researchers are subjected to sharing the rights with project participants.

The concept of efficiently protecting scientific knowledge through patenting is an important device for controlling competition, especially as the ability of companies to attract venture capital greatly depends on a strong position within patents.

Difference in patenting policies between Denmark and Sweden may explain some of the differences in the figures seen in the following tables, as may differences in the size of the sector within each country<sup>25</sup>. The first table shows the number of patents applied for in the medical technology sector in the years 1990-2000.

	Denmark	Sweden	Finland	Bayern	LOC	CA	NC
1990	28	133	11	127	50	351	20
1991	25	118	17	121	57	325	21
1992	35	117	13	137	54	393	24
1993	37	165	26	139	59	435	22
1994	44	157	32	112	59	599	32
1995	46	209	34	98	50	631	22
1996	10	182	31	107	51	649	31
1997	55	212	31	115	71	710	33
1998	70	237	50	144	81	1,075	41
1999	67	216	50	156	82	1,136	33
2000	84	234	54	180	109	1,236	59

Proportionately, Denmark has progressed more than Sweden. But the years since 2000 have involved so much development in both Denmark and Sweden, that it is impossible to say what the figures would show today.

The next table shows the number of patent applications as part of the total number of inventions in the world within the medical technology sector, 1990-2000.

<sup>25</sup> The tables are adapted from "International Benchmarking af Bio-Sundhedsområdet i Danmark", National Agency for Enterprise and Housing, September 2002. LOC: London, Oxford, Cambridge; CA: California; NC: North Carolina

	Denmark	Sweden	Finland	Bayern	LOC	CA	NC
1990	0,21	0,99	0,08	0,95	0,37	2,62	0,15
1991	0,19	0,90	0,13	0,92	0,44	2,48	0,16
1992	0,26	0,85	0,09	1,00	0,39	2,87	0,18
1993	0,26	1,17	0,18	0,99	0,42	3,09	0,16
1994	0,25	0,88	0,18	0,63	0,33	3,36	0,18
1995	0,24	1,10	0,18	0,51	0,26	3,31	0,12
1996	0,19	0,88	0,15	0,52	0,25	3,14	0,15
1997	0,25	0,96	0,14	0,52	0,32	3,23	0,15
1998	0,31	1,04	0,22	0,63	0,36	4,73	0,18
1999	0,29	0,94	0,22	0,68	0,36	4,94	0,14
2000	0,60	1,68	0,39	1,30	0,78	8,90	0,42
<b>1990-2000</b>	<b>0,27</b>	<b>1,02</b>	<b>0,18</b>	<b>0,74</b>	<b>0,37</b>	<b>3,90</b>	<b>0,17</b>

The table shows that the number of patent applications in Denmark as part of the total global number of inventions within medical technology has increased from 0.21% to 0.6%, which is, again, proportionately, a substantially larger development than, for example, in Sweden.

When comparing the extent of R&D in contrast to manufacturing or sales, figures show that Denmark and Sweden are much alike. The table below shows the numbers (percentages) employed in R&D as a proportion of all employment in the medical technology industry<sup>26</sup>.

	Denmark	Bayern	Finland	Sweden
1990	-	4	6	3
1991	4	7	5	3
1992	4	7	6	3

This table shows that Denmark and particularly Sweden deploy proportionately few of their employees within R&D. But when these figures take into account both the total number of employees and the total number of companies, as in the table below, then the distribution is partly explained.

<sup>26</sup> International Benchmarking af Bio-Sundhedsområdet I Danmark, Erhvervs- og Boligstyrelsen, September 2002

<b>Approx. 1999 figures</b>	<b>Denmark</b>	<b>Bayern</b>	<b>Finland</b>	<b>Sweden</b>
Number of employees	18,000	48,000	12,000	20,000
Number of companies	750	400	800	1,500
Average number of employees	24	120	12	13

The two tables in combination show that Bayern has large companies, which focus on R&D, while Sweden has many more small companies, which do not focus on R&D. Denmark has more companies of intermediate size, which do not focus much on R&D either. Finland has the fewest number of employees within medical technology and many small companies. In that context the proportion of employees engaged upon R&D compares very favourably with the other places.

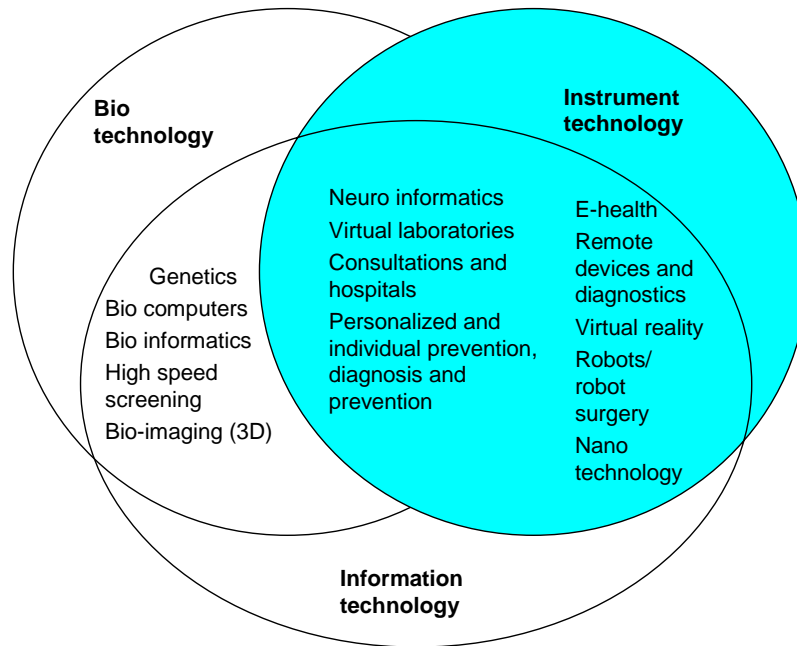
### **3.5. Linkages to other industries**

Companies within the medical technology sector naturally collaborate with the educational sector and public research institutes as well as private companies. Many collaborators constitute other players within the health sector. Innovation typically results from interaction and cooperation between the company, customers, suppliers, competitors and other related companies. Other industries, which link with the industry of medical technology, in particular, and the bio-health industry, in general, include the following:

- The telecommunications industry (wireless communication)
- The IT industry
- Various fields within the technology industry

The advantage of collaboration is primarily the sharing of knowledge and expertise across the boundaries of the business. The result is a technology mix. Small companies struggle to survive if they try to carry through an unsuccessful research project on their own and larger companies cooperate in order to obtain the quickest and most effective R&D. It saves them both time and money to do so. A graphic illustration of the linkages between the closest industries is given below<sup>27</sup>.

<sup>27</sup> Medico/Sundhed – en erhvervsanalyse, Erhvervsfremmestyrelsen, 2001



Companies which operate effectively within the three main technology fields are likely to gain a competitive advantage.

### 3.6. Final consumer of products/services (public/private health care, patients)

The annual cost of health care in Denmark is € 11.1 billion, which is equivalent to 8.3 per cent of the gross national product (cf. section 2.5), or about € 2.100 annually per head of population; that proportion is slightly more than in Sweden where 7.9 per cent of GNP is devoted to health care<sup>28</sup>.

Health care expenditure per head of population varies greatly from country to country. Denmark ranks high in international comparisons, but Norway, Germany and the USA rank even higher. In relation to the total European market which totaled € 41 billion in 1999<sup>29</sup>, the market in Denmark is comparatively small totaling € 0.9 billion, while the Swedish market was € 1.2 billion in 2000.

The export of medical technology from Denmark in 2000 was equal to 79 per cent of the industry's output. The main major customer is the public health services in different countries, such as Sweden, Germany, France, England and the US. In Denmark, it is mostly the local county or municipality, which is responsible for the hospitals, nursing homes and clinics. An increasing proportion of the market is provided by private clinics and payments by the individual end user.

### 3.7. Ownership/key players in industry

The Danish medical technology industry is characterised by a few major players; 75 per cent of the total industry's turnover is accounted for by just 10 companies, which constitute the key players in the industry. Some of the central companies are the following:

- Coloplast (healthcare products and services within ostomy, incontinence, wound, breast and skin care.)

<sup>28</sup> Medicoindustrien i tal – 2002 (The medico industry in numbers – 2002), The branch organisation of Medico technology, 2003

<sup>29</sup> Eucomed Study 2000 Edition

- Radiometer (provider of blood gas equipment)
- Maersk Medical (catheters, surgical aids to drainage bags, wound care and infusion devices)
- Ambu International (diagnostic products, life-supporting and training equipment and solutions to hospitals and rescue services)
- B-K Medical (diagnostic ultrasound products)
- Oticon (manufacturer of hearing care solutions)<sup>30</sup>
- GN Resound (also known as Danavox) (digital or non-digital hearing instruments)

In addition to the major key players, the industry has a range of small, but innovative companies.

Educational institutions and hospitals also fulfil critical roles in both Denmark, even though they do not have the same financial incentives. Some of the most important institutions are mentioned in section 2.4. Others are Ideon, Symbion, Medicon Valley Academy and the Science Park in Aarhus.

### 3.8. Characteristics of employment

#### 3.8.1. Wages

The unemployment rate within the health sector in general is one of the lowest in the country. This naturally has an effect on rates of pay, particularly for the best qualified employees. But there is not the direct association between level of unemployment and rates of pay that might be expected, especially in relation to other sectors. Indeed, the trend in wages and salaries in recorded bio-health businesses has followed the trend of other businesses, in general.

In an international benchmarking of the Danish bio-health sector, which includes the medical technology industry, the National Agency for Enterprise and Housing reports the following growth-rate from 1995-99 in value increments and salary increases (per cent)<sup>31</sup>:

	Pharmaceutical industry			Medical technology industry		
	Value increment per employee	Salary increase per employee	Growth factor	Value increment per employee	Salary increase per employee	Growth factor
Denmark	8,59	3,61	2,38	4,84	3,15	1,54
Finland	5,09	2,39	2,13	10,95	2,44	4,49
Sweden	14,13	8,96	1,58	-5,64	4,65	-1,21
California	8,24	9,61	0,86	10,00	4,18	2,39
North Carolina	22,10	10,28	2,15	3,82	6,96	0,55

The growth factor is computed by dividing the value increment by salary increase. A high positive growth factor shows that the value increment exceeds the salary increase.

The table shows that the Danish salary increases in both the pharmaceutical and the medical technology industry were second to lowest (only Finland experienced lower salary increases)

<sup>30</sup> Part of the William Demant Group

<sup>31</sup> Report from September 2002 by "Erhvervs- og Boligstyrelsen"



despite the fact that the growth factor surpassed all four countries in the pharmaceutical industry and both Sweden and North Carolina in the medical technology industry. The report shows, however, that the average labour costs per employee in both industries in Denmark were among the highest, approximately € 49,000 in the pharmaceutical industry and approximately € 36,000 in the medical technology industry. In 1999, both industries were overtaken by only California. Finland had the bottom position in both industries with labour costs amounting to about € 26,000 and € 24,000 respectively. Sweden also had labour costs amounting to approximately € 24,000 in the medical technology industry while they were on a par with Denmark in the pharmaceutical industry.

### **3.8.2. Quality of employment**

The quality of employment naturally depends on the supply of candidates from the university and other educational institutions. As mentioned earlier, the health sector generally experiences one of the lowest unemployment rates in the country, resulting in little competition in the market. Nevertheless, the judgement of the Danish bio-health sector in general is that Danish employees do have the required qualifications and are able to exhibit a competitive power compared with those in foreign countries. And yet, in a report by the National Agency for Enterprise and Housing from 2002, it emerged that only one third of all employees within the whole sector of bio-health had had tertiary education (more than vocational training)<sup>32</sup>. The number, however, was expected to be much higher for the medical technology sector, in particular.

### **3.9. Skill profile of employment**

According to a report by Epinion<sup>33</sup>, companies within the bio-health sector are seeking skill profiles within the following three main categories:

- A wide range of technical and theoretical skills obtained from education, including possible research experience
- Subsidiary knowledge relevant to the sector, for example IT and product control
- Personal and general qualifications.

The three most sought after personal qualities, which employers tended to regard as more important than technical, theoretical and IT skills, were as follows:

- Ability to co-operate
- Analytical skills
- Skills of communication

### **3.10. Extent of unmet skills – needs and reasons**

Based on the available information, it is difficult to form a judgement on the extent of unmet skills specifically within the medical technology industry.

According to the report drawn up by Epinion, the bio-health sector (manufacturing of medical and surgical equipment constituted approximately five per cent of this sector in 2000<sup>34</sup>) is in no need of

labour, generally. But particular, rapidly growing areas within the sector do experience shortages of labour. The industry of medical technology is to some extent comparable to that of biotechnology, which hired 500 new employees within the 40 largest companies in 2002. In such circumstances it becomes difficult to find not only enough but also well qualified candidates.

In addition, there is growing demand for people with particular types of qualification. That is especially the case for the relatively new competence cluster of telecommunications in the northern part of Jutland, which links the medical technology with IT technology. Private companies within the bio-health sector as a whole in Denmark and Sweden are specifically seeking a supply of labour with the following backgrounds:

- Bio analysts
- Graduate engineers (which in Sweden are expected to be in surplus in the long term)
- Physicists (primarily Sweden)
- Laboratory assistants
- Pharmaceutical chemists
- Researchers in general

Most significant for the employment situation in the Danish and Swedish health sector, in general, is the shortage of physicians, doctors and nurses.

### **3.11. The future of employment in the industry**

Despite the fact that the demand for qualified labour within the entire medical sector overall has been continuous, there is no sign that the supply will surpass the general demand in any near future. Several reports and newspaper articles support that conclusion. With declining interest in science studies, generally, lack of grants for educational courses and a growing medical technology and hence demand for qualified labour, not least post graduates, action needs to be taken. New specialized courses, which are attractive to students and the industry as mentioned in section 2.4, have been introduced but focus has to be put on attracting students to post graduate courses from scientific studies as well.

Peter Frank, political consultant from Medicon Valley, states that in year 2010 the medical/health sector will be lacking between 2300 and 5700 PhDs and an equivalent number of university candidates<sup>35</sup> especially from scientific and technical studies as well as medical science. However, the employment demand in the private sector is heavily dependent on venture capital, which is why the above-mentioned numbers are based on willingness from investors; a continuing ability to compete within companies; as well as an ability to remain in the market and possibly to control segments of it.

The expected demand for labour in the medical technology sector, specifically, is difficult to estimate according to the available information. In addition, different sources estimate the demand differently. Thus, another estimate is that the demand for researchers for the entire health sector

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<sup>32</sup> Bio-sundhedsarbejdskraft og -uddannelser: Udbud og efterspørgsel (The labour force and educations within bio-health: Supply and demand) by "Erhvervs- og Boligstyrelsen" et al, September 2002

<sup>33</sup> Epinion A/S Analyse, Efterspørgslen efter arbejdskraft på biosundhedsområdet (Labour force demand in the bio-health sector) , June 2002

<sup>34</sup> Bio-sundhedsarbejdskraft og -uddannelser: Udbud og efterspørgsel (The labour force and educations within bio-health: Supply and demand); by "Erhvervs- og Boligstyrelsen" et al, September 2002. This report includes the report by Epinion

<sup>35</sup> Cf. <http://www.biokemi.org>

will reach a minimum of 600 between 2002 and 2005. However, there is no doubt that the sector will be short of qualified labour. Therefore, it is critical that the whole health sector invests in research and development and remains highly innovative in order to attract newly qualified candidates and PhDs. This will prevent the industry from being subject to a brain drain by more tempting offers abroad, including pay; size of research budgets; research environments; and the availability of strong teams of researchers<sup>36</sup>.

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<sup>36</sup> Cf. Boersen, March 22<sup>nd</sup>, 2001

## 4. LOCAL AREA(S) IN WHICH THE SECTOR IS CONCENTRATED

### Main characteristics of area(s) in which industry located

#### 4.1.1. Employment growth, skill levels

The Oresund Region ranks fourth in the world for expected growth during the next decade. The value of establishing the Oresund Region has been quantified at €5 billion, which, of course, has favourable implications for the medical technology sector.

Medicon Valley/the Oresund Region has about 2.9 million residents, which represents 22 per cent of the total population of Denmark and Sweden. Moreover, 40 per cent all employees in the health industry in Denmark and Sweden are working in Medicon Valley, which represents 35.000 employees in the biotechnology, pharmaceuticals and medical technology sector.

The forecast for the Oresund Region towards 2008 shows a significant increase in employment on the Swedish side. Employment in Skåne is expected to rise by more than eight per cent, while employment on the Danish side is expected to rise by up to 3.5 per cent<sup>37</sup>. As part of this development, Medicon Valley is the largest growth centre in Scandinavia within the health related sector. In addition, it has been predicted that about ten companies a year will relocate into the Medicon Valley area.

There are 12 universities in the Medicon Valley area, of which Lund University is the largest and most diverse in northern Europe. Around 135.000 students are listed at higher learning facilities and there are 10.000 scientists, of which 4.000 are researchers with advanced academic degrees<sup>38</sup>. In addition, the area offers 26 hospitals of which 11 are university hospitals. Medicon Valley/The Oresund Region is ranked third in Europe regarding research and development in medicine and biotechnology/life sciences (including medical technologies). The region is surpassed only by Paris and London, and is ahead of Oxford-Reading; Cambridge; Berlin; and Brussels-Antwerp<sup>39</sup>. The rate of growth in employment within the medical technology sector is also relative high. In the period 1997-1999, employment increased by 51 per cent while turnover in Swedish medical technology rose by 102 per cent.<sup>40</sup> The rates of growth rate are estimated to be similar on the Danish side.

#### 4.1.2. Institutions responsible for development of industry locally/regionally

The two major institutions responsible for industrial development in the region are the publicly financed organisations *Copenhagen Capacity* and *Position Skåne*. Both institutions assist foreign companies in establishing activities in Medicon Valley<sup>41</sup>.

In addition, the Medicon Valley Academy (MVA) plays an important role in industrial development in the region. MVA was set up in 1997 as a regional Swedish/Danish network organisation with the

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<sup>37</sup> Business and opportunities in the Oresund region, Oresund Chamber of Commerce and Industry, 2003

<sup>38</sup> <http://www.medicovalle.com>

<sup>39</sup> <http://www.oresundnetwork.com>

<sup>40</sup> The Swedish biotechnology innovation system, VINNOVA, 2001

<sup>41</sup> <http://www.mediconvalley.com>

aim of providing a catalyst for integration and development in Medicon Valley. MVA's members include relevant university departments, health care organisations, most of the biotechnology and medical related companies, and associated organisations located in the region. In addition, there are five science parks in Medicon Valley, among which Ideon Science Park in Lund is the largest. But Medeon and Symbion are also high profile science parks.

#### **4.2. Main characteristics of medical technologies sector in area**

About 130 medical technology companies are registered in the Medicon Valley Academy. Below, are listed some of the principal Swedish and Danish companies:

Swedish companies:

- Atos Medical, which includes sales agencies from abroad (rehabilitation tools; ventilation tubes; disposable rhinology products; and an orofacial product assortment)
- Cefar (pain treatment and muscle rehabilitation)
- Crafcare, distributor for a North American company (electronic components such as signals, alarms and indicators)
- Dupont Chemoswed (intermediates for the pharmaceutical industry)
- Gambro AB (blood component industry)
- Gordic AB (manufactures filling machines, i.e. packing of effervescent and other tablets in tubes for the pharmaceutical industry)
- Haemonetics (automatic blood processing systems)
- Hemocue (systems to determine levels of haemoglobin and glucose in plasmas, serums, aqueous solutions as well as in capillary, venous and arterial blood)
- Jostra, world wide distribution (tubing pack production; membrane oxygenators; Hypo/Hperthermiasystems; heart-lung machines; and autotransfusion technology)
- Medical Rubber (customised injection-moulded precision components)
- Nolato Medica I (polymer products)
- Novaferm AB (fermentation equipment for cultivation of micro-organisms and cells)
- Pharma Vision Systems AB (automatic analyses of dry powder blends and particles)
- Umetrics, some European distributors (provider of graphical analytical methods, i.e. software solutions)

Danish companies:

- Ambu International (diagnostic products; life-supporting and training equipment; and solutions to hospitals and rescue services)
- Becton Dickinson (IT-enabled health care)
- B-K Medical, Danish headquarter but is located all over the world, including Sweden (diagnostic ultrasound equipment)
- Coloplast, which distributes worldwide (health care products and services within ostomy, incontinence, wound, breast and skin care)
- Danavox (also known as GN Resound), many worldwide company locations, including Sweden, and five production locations apart from the Danish headquarter (hearing aids)
- Knudsen Plast A/S (disposable articles for hospital and health sector; special packaging for the pharmaceutical industry)
- Maersk Medical, also known as Unomedical. European head office is in Denmark (catheters; surgical aids to drainage bags; wound care and infusion devices)
- Oticon, has 15 distributors worldwide, including Sweden (hearing aids)
- Radiometer, many distributors worldwide (IT solutions for blood gas analyses; transcutaneous instruments)
- Widex, production companies and distributors located worldwide (hearing aids)

Furthermore, both Sweden and Denmark are sub-suppliers for several companies, for example the American company COOK (wound; ostomy and continence care products; catheters; endobronchial blockers; cardiology products; connecting tubes; biopsy sets; needles; dilators; airway management; liver access sets)<sup>42</sup>.

#### **4.3. Main characteristics of employment in the medical technology sector**

As most of the Danish and Swedish medical technology sector is represented in the Medicon Valley, wages as well as quality of employment are similar to those at the national level, as presented in section 3.8. Danish labour costs were among the highest and Swedish among the lowest in a comparison with Finland, California and North Carolina. However, increases in Danish salaries through 1995-99 were second lowest, while Swedish salary increases in the same period were the second highest.

Moreover, information on salaries needs to be related to the overall costs of doing business. Although Denmark has high levels of income tax, that is counterbalanced by low corporate tax at just 30 per cent. In addition, because welfare is publicly financed, employers' social security contributions are among the lowest in Europe at 1.23 per cent.

Both Sweden and Denmark are known for their highly qualified workforces and strong research environments. These and other strengths, combined with solid economies and the ability to keep pace with general developments, mean that both countries have been able to attract many foreign companies.

The developments within the Medicon Valley have been so strong that about 60 per cent of the total work force in the region is employed within the fields of Medicon Valley. Naturally, this provides a highly intellectual society, which is also attractive for foreign investors.

#### **4.4. Main catalysts at a local level for development of industry**

The main historical influence behind the development of the Danish medical industry in Medicon Valley lies in the Danish health care system founded in the 1960s. The health care system in Denmark was at the time unique and advanced. The system established the basis of a general demand for health services, and, combined with the infrastructure, the higher education institutions and a number of entrepreneurial companies began the development of the industry at the local level.

Much of the current development is now attributed the following three influences.<sup>43 44</sup>

- The relative maturity of the sector (mature R&D pipeline with product focused companies and access to funding and academic knowledge and expertise);
- The presence of four fully integrated pharmaceutical companies (Novo Nordisk, AstraZeneca, H. Lundbeck and LEO Pharma), which provide funding and attract highly qualified employees to the region. In addition they branch out to other related areas and thereby ultimately support other sectors, including the medical technology sector;

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<sup>42</sup> All information on the various companies has been gathered through <http://www.mediconvalley.com>

<sup>43</sup> Bio-/sundhed (Bio-/health – A new partnership for growth), Public Task force, 2002

<sup>44</sup> Commercial Attractiveness of biomedical R&D in Medicon Valley, The Boston Consulting Group, 2002

- The overall national approach and focus in Denmark and Sweden supporting the Oresund Region and the dynamics of the cooperation across the borders.

#### **4.5. Linkages to other industries locally, nationally, internationally**

Medicon Valley is generally seen as having particular competitive strengths in four major business areas; diabetes research; inflammatory research; neuroscience; and cancer<sup>45</sup>. These areas are in several cases integrated in business ventures within the medical technology sector. Within R&D, there are strong links across the Oresund but various reports have found evidence that the integration between the Swedish and Danish sides of Medicon Valley could be improved<sup>46</sup>.

The four major pharmaceutical firms located in Medicon Valley (mentioned above) promote several linkages between industries, especially across the biotechnology and information technology sectors, such as, *Bio Informatics; Health Information; E-health Solutions; Remote Diagnostics; and Nano-Technology*.

Section 4.2 presented a list of key players in the medical technology industry in the Swedish and Danish regions of the Medicon Valley. Many of these companies are subsidiaries of international corporations or companies, which can give access to resources (such as. knowledge and expertise in other business areas and capital) that gives competitive advantages to smaller companies.

As an example, the Swedish company *Nolato Medica I*, which is part of the Nolato Group, has a foothold not just in the medical technology sector but also within telecommunications; white goods; the automotive industry; and consumer electronics. Another example is the American founded company COOK which also contains other interests than the medical technology sector, including companies that manufacture specialised industrial parts and offer such commercial enterprises as transportation and travel; real estate; retail services; and entertainment.

#### **4.6. Importance of local skills supply in development of industry**

##### **4.6.1. Employees recruited from local/national/international labour markets**

The table below shows the level of education among Danish employees in the bio-health manufacturing sector compare with those of immigrant or imported employees (1998-figures)<sup>47</sup>.

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<sup>45</sup> Commercial Attractiveness of biomedical R&D in Medicon Valley, The Boston Consulting Group, 2002

<sup>46</sup> Viden på tværs i Medicon Valley (Knowledge across Medicon Valley), Aston Promentor, 2002

<sup>47</sup> Bio-sundhedsarbejdskraft og –uddannelser: Udbud og efterspørgsel (The labour force and education within bio-health: Supply and demand), Erhvervs- og Boligstyrelsen et al, September 2002

	Country of origin			
	Denmark	Sweden	European Union	Rest of Europe
Basic general education	28,8	19,5	12,5	42,2
Upper secondary education	4,3	3,4	4,3	5,8
Business college	2,0	0,8	0,9	0,6
Vocational training	33,8	28,8	32,7	25,1
Shorter further education	12,9	11,0	10,5	5,9
Medium-length further education	6,1	12,7	10,5	3,6
Bachelor	1,0	0,0	0,9	0,5
Graduate of higher education (candidate)	9,3	20,3	20,6	5,4
Postgraduate student	1,0	0,0	0,9	0,3
No information	0,8	3,4	6,3	10,7
Grand total %	100	100	100	100
Grand total	28,482	118	447	1,144

The table shows that Danish bio-health manufacturers employ foreign employees with various levels of education. Striking, though, is the proportion of foreign employees compared with Danes who are graduates of higher education, which suggests that there is a shortage of well educated Danish employees available to the sector.

To attract an international workforce it is important to be able to offer schooling with international curricula. In Copenhagen alone, there are ten international schools. In addition, the Swedes have developed plans to establish schools in Lund and Kristianssand to supplement those in Helsingborg and Malmö.

#### **4.6.2. Attractiveness of the area or industry to inward migrants**

The Oresund Region and medical technology industry is able to attract qualified immigrants on the basis of the fact that the industry is primarily situated in a cluster, making the area highly intellectual and characterised by a valuable amount of shared knowledge.

Furthermore, to attract foreign employees, the Danish government set up favourable tax rules (only 25 per cent in 1992 for expatriates (scientists, management and researchers)<sup>48</sup>. This means that foreign researchers can settle in Denmark and have an attractive tax arrangement for 36 months over a ten year period. There are several other rules or conditions attached to this tax arrangement, such as the extent to employment and taxation in Denmark prior to being included in the arrangement, in combination with a stay of more than seven years.

#### **4.6.3. Role of higher education institutions in supplying highly skilled/qualified labour**

The role of all the universities and university hospitals as well as other relevant educational institutions within the Medicon Valley Region, has significant influence on the supply of skilled and

<sup>48</sup> Cf. <http://www.partner-revision.dk>



qualified employees. The close co-operation between universities and private companies, in particular, facilitates the education and hiring of qualified candidates.

#### 4.6.4. Importance of other institutions in supplying skilled and qualified labour

The Medicon Valley Academy has initiated a number of PhD programmes as part of establishing a higher collaboration between hospitals, private companies and universities from the Medicon Valley Region.

The MVA PhD Programme will fund 50 per cent the wages, study fees, and administrative costs of the project, given that the collaborating companies pays the remaining 50 per cent. Foreign students are also encouraged to apply. In order to obtain MVA-funding, the PhD project must have commercial development possibilities or an element of business promotion. Furthermore, the project should contribute to research related innovation within the company.

The idea of the MVA PhD Programme is not only to support private companies and the research skills of students, but also to promote competition rather than cooperation. All in all these programmes contribute higher level research, commercial development and profit for the bio-health sector but also provides benefit for society as a whole.

#### 4.7. Extent to which growth is inhibited by skills supply

Despite an expected increase in the supply of candidates, PhDs and other educated employees, the rapid increase in the demand for highly skilled labour suggest that there will be a shortage in the supply of skills. Recent studies have shown that in the year 2010, the health sector could face a shortage of around 2.300 to 5.700 PhDs mainly within the technical and health related areas and a similar number of candidates with relevant university degrees.

Scenario	Shortage of PhDs in the bio-health sector		
	2005	2010	2020
Minimum deficit	1.000	2.300	5.6000
Maximum deficit	1.000	5.700	9.6000

The main bottleneck in Medicon Valley is thus the limited supply of skilled PhDs. In addition, there are also signs indicating bottlenecks in relation to the overall supply of skilled labour.<sup>49</sup> A general decline in the number of young people is expected to affect the supply of highly skilled labour in the period 2005 to 2010.<sup>50</sup>

The future shortage of skilled employees can be limited by an increase in the numbers produced by the various universities and other education institutions. Furthermore, it will be important to attract skilled labour from other countries in order to minimize the shortages. But the forecasts still suggest that there will be a shortage, especially at the PhD level which, in turn, could inhibit the growth of the medical technology sector in Medicon Valley.

<sup>49</sup> Competence clusters in the capital region, Oxford Research 2002

<sup>50</sup> Bio-/sundhed (Bio-/health – A new partnership for growth), Public Task force, 2002

## 5. Conclusion

### 5.1. Identification of main catalysts for the development of the industry

Denmark and Sweden have always had a high quality health care system. In consequence, there was, from the start, an associated demand for high quality health care products, including medical technology devices. This early demand effectively launched the medical technologies industry and many of the companies created at that time are still operating successfully. Oticon, for example, is nearly 100 years old, while companies like Radiometer and Coloplast have also been in the industry for a long period. These and other experienced major companies have played an important part in the development of the industry and created a platform on which many new companies have been able to build.

The Danish and Swedish health services are among the best in the world, both technically and in terms of quality of personal service, and domestic demand is one of the main stimulants to future developments.

The high quality of the Swedish and Danish industry also generates demand from other countries, which drives the industry further forward. Exports of medical technology products have long been strong and the export rate reached 79 per cent in 2000.

In addition, the development of the industry is supported and progressed by a differentiated but interactive scientific infrastructure, made up of local educational institutions, hospitals and science parks. As a result, R&D has a high priority at every level. In that context, institutions like *Copenhagen Capacity's*, *Position Skåne*, and *Medicon Valley Academy* play key roles.

### 5.2. Importance of inter-industry linkages and agglomeration

The clustering of companies, who operate in the same business area through R&D institutions and science parks, provides potential for the sharing of resources, knowledge and expertise. These benefits assist the companies in innovating and producing high quality products and services, resulting in a positive economic development for the area, in which the cluster is located.

The primary inter-industry links within the *Medicos Valley* are constituted by the four major business areas in the region: diabetes research, inflammatory research, neuroscience and cancer. These areas also have linkages to the medical technology industry. However, central links to the industry are also being created by companies, which are not necessarily located within the *Medicon Valley* region. Typically, these companies operate within the area of information technology, such as wireless telecommunication.

Another important benefit resulting from inter-industrial linkages, concerns the supply of skilled employees. For instance, the intellectual profile of the medical-cluster in *Medicon Valley*, can make the companies more attractive to able, skilled and highly qualified employees than companies outside the cluster.

Finally, the inter industry linkages between the companies, R&D institutions and science parks play an important role in respect of exports. Because of the sharing of knowledge and expertise, the companies are able to offer a wide range of products, thereby making them less vulnerable to developments in the international market.

### **5.3. Major obstacles to the future development of the industry**

A major problem for the future development of the industry is the expected shortage of highly skilled and qualified employees. It is estimated that, by 2010, the sector as a whole may be short of as many as 5,700 PhDs. The strength and competitiveness of the cluster rests heavily upon its human resources and the accumulated body of knowledge on which they draw. Such a shortage of key employees would be highly damaging to the sector.

Furthermore, a serious shortage of highly qualified employees is likely to set up a series of vicious circles. First, a shortage within a company will make it less attractive to new recruits as it will be less able to offer the quality of colleagues and teamwork that they seek. Secondly, major shortages will be damaging to the educational institutions. There is likely to be an even greater gap between salaries in university teaching and those in the private sector thereby drawing professors and other teachers into industry and business. The result will be shortages of teachers and the less able graduates becoming teachers, which, in turn, will contribute to further shortages of students and highly qualified employees.

There are three further threats to the industry in Denmark. The first is the danger that employment outside Denmark might become increasingly more attractive to Danish researchers. The fact that they do not enjoy the benefit of intellectual property rights to their own inventions, unlike, for example, their Swedish counterparts may contribute to such a trend.

Secondly, the supply of venture capital to the industry is not yet a problem but the indications are that if there is a continuation of developments since 2002 then it could become one. Without venture capital prospects for the industry would be seriously threatened.

Thirdly, labour costs incurred in production phase could become an increasing problem. There is already a growing tendency to locate new production facilities in economies where the wage levels are lower than those in Denmark and that tendency will almost certainly grow.<sup>51</sup>

### **5.4. Diversity of major players**

Unlike many other places the strength of the Swedish/Danish Medical Technology sector is that it is broadly based on a diversity of major players rather than being dependent upon just one or two leading companies. That is one of its main strengths.

The top ten medical technology companies in Denmark are all very important as they account for 75 per cent of the total turnover and many of them are world leaders within their particular sub-sector. Moreover their products are, to a large extent widely differentiated and not dependent on those of others

It is the number, diversity and interaction between the different players, that supports the growth and development of the medical sector.

At the same time, first, at the national level, the public institutions behind Medicon Valley and universities such as DTU and Lund University do play important roles in promoting the sector. Secondly, companies like Novo Nordisk, AstraZeneca, Lundbeck and LEO Pharma do fulfil a critical role for the sector, in terms of specialised knowledge; the attraction of highly qualified labour; access to venture capital; and inter-sector cooperation.

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<sup>51</sup> The latest example is Coloplasts decision to place the majority of the increased production facilities in Hungary – instead of Denmark (August 2003)

## **5.5. Development of intellectual property at local level (i.e. whether intellectual property imported from elsewhere)**

Section 3.4 explored Denmark's role in patent applications within medical technology. As most of the medical technology sector is located in the Oresund Region, the figures given in section 3.4 reflect those of the Danish part of the Oresund Region as well. The figures showed that the number of patents applied for rose by 200 per cent from 1990 to 84 in 2000. In Sweden, the number of patents applied for within the medical technology sector rose by 76 per cent to 234 in the same period.

This shows that Denmark is advancing quickly within the industry of medical technology in Scandinavia. Finland rose by 391 per cent to 54 patent applications and California rose by 252 per cent to 1236 patent applications; while Bayern only rose by 42 per cent over the same period.

The extent to which Medicon Valley involves research, as compared with the manufacture and sale of medical technology, is not immediately clear. The proportion of employees engaged in R&D relative to all employees within medical technology was not particularly high in Sweden or Denmark (three per cent and four per cent, respectively) compared with Bayern (seven per cent) and Finland (six per cent). Sweden and Denmark have medical technology industries of medium size, while Bayern and Finland have relatively small industries.

The figures suggest that a relatively large proportion of activity in Denmark and Sweden is devoted to manufacture and sales. But it is very likely that most of the research within medical technology in Denmark and Sweden takes place in the Oresund Region, that is to say, the Medicon Valley. If that is the case, the proportion of employees involved with R&D in the Medicon Valley, as opposed to Denmark and Sweden, as a whole, will be more competitive with the proportions in Bayern and Finland.

A distinctive feature of the medical technology industry in Denmark is that it is mature and experienced, and many companies are old and well established. This has an influence upon research programmes, as the time span between research, development and production is relatively short.

In future, more R&D is to be expected in Medicon Valley as the new Medicon Valley Academy PhD programme is being promoted and requires cooperation between private companies and universities.

The extent to which Denmark imports its intellectual work force was shown in the table in section 4.6. This showed that the bio-health manufacturing sector does hire a substantial number of Swedes and citizens of the EU. Recruits from abroad are primarily graduates but foreign employees with just a basic general education or minimal vocational training are also attractive to the industry in Denmark.

## **5.6. Future opportunities for the industry**

The medical technology industry in Denmark generally, and Medicon Valley, in particular, is known by its value adding products and high level of exports to countries around the world. The domestic markets, in Denmark and Sweden are themselves relatively small. The main opportunities for development and growth therefore lie in increasing sales in international markets and gaining access to new international markets. Export sales can be expected to increase and local R&D in Medicon Valley can be expected to grow.

There are also major future opportunities for the industry in Medicon Valley in closer collaboration between medical technology, biotechnology and information technology. The three industries are all strongly represented in Medicon Valley. Their common location provides companies with the opportunity to enter into joint R&D and production. This development will meet the demand from service providers and end users who are increasingly expecting an even wider and more sophisticated range of products within self-diagnostics, bioinformatics, nanotechnology and E-health. Similarly, such collaboration will provide an immense opportunity to develop products in connection with the related research sectors in which Medicon Valley is strongly represented; that is to say, cancer, diabetes, inflammation and neuroscience.

Finally, increased integration across the Oresund will create a demand for a more diverse supply of skills and give companies in Medicon Valley a further competitive advantage in recruitment. The additional supply of qualified manpower is likely to come mainly from the Swedish side in view of the expected shortage of PhDs and other researchers on the Danish side.

### **5.7. The importance of skills supply**

The supply of skills is of key importance in Medicon Valley. It is R&D, and hence highly qualified people which drives exports and growth. Skills are important at a number of interrelated levels. Able, trained and qualified people are essential to undertake the necessary research which attracts the all important venture capital. If the medical technology industry in one region becomes short of key workers then highly qualified researchers will be attracted to other regions which have stronger research teams and more and better research resources.

In order to meet the demand for skilled and highly qualified employees, new educational programmes have been set up. An example is the Medicon Valley Academy's PhD programme, which seeks to promote collaborations between hospitals, private companies and universities. In addition, educational programmes in medical technology have also recently been established at the first degree level and have received a lot of interest.

### **5.8. Importance of links with local education institutions**

The Medicon Valley Academy's PhD programme is one example of important links between the medical technology industry and local educational institutions. Other examples include the University of Aarhus and Danish Technical University. Both the industry and educational establishment are increasingly acknowledging the importance of linkages and collaboration. The Medicon Valley region alone contains twelve universities of which Lund University is the largest. The universities in the Medicon Valley region alone have around 135,000 students enrolled and 10,000 scientists of whom 4,000 are researchers. The region also offers five science parks as well as 26 university hospitals of which eleven are university hospitals, which provides the region with great institutional resources for Research and Development.

A link between an educational institution and one or more companies is of great benefit as it promotes research in general. Secondly, it provides students with opportunities to gain practical experience and skills as well as a theoretical education and prepares them better to work in the industry immediately after they have finished their education. Thirdly, it provides companies with opportunities to identify and developing their future employees, in advance.

## 5.9. Future skill needs of the industry

The education sector has been seeking to give higher priority to skills for the medical technology industry. In particular, new educational programmes that focus on medical technology have been established. These have proved attractive to students and student demand currently exceeds the supply of course. Whether these programmes are accepting enough students and whether the current level of growth will continue, it is difficult to tell. There is no doubt about the growing demand for highly qualified employees in the medical technologies and health sectors. We have repeatedly highlighted the likely shortfall of PhDs by the year 2010 and thereafter. In addition, there is expected to be a general shortage of highly qualified people in all subjects over the coming years.

In most ways, the prospects the medical technology industry look good. Whether or not they are fulfilled will depend heavily on the extent to which there is a continuing supply of highly qualified people to staff necessary research and development.

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