



FOBIS – Foresight studies on biomedical sensor

How will biomedical sensors shape the healthcare systems of the future? How can they impact the quality and cost of healthcare and what are the business opportunities in the Nordic region? A Nordic consortium headed by SINTEF (Norway) and with the participants VTT (Finland), FOI (Sweden), S-SENCE (Sweden), STC (Denmark) and MedCoast-Scandinavia is conducting a foresight study on Biomedical Sensors. The project is supported by the Nordic Innovation Centre. The project revolves around a series of workshops, the first being held in Copenhagen 6 – 7th Oct. 2005, the second in Oslo 2nd Nov. 2005, the third in Stockholm 3rd March 2006 and the fourth in Finland 7th June 2006. More information is found on our web-site: www.nordic-fobis.net.

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A dissemination workshop from the FOBIS project will be held in Oslo 31th October 2006 at Rikshospitalet.

Highlights from the program:

- Live heart surgery monitored with biomedical sensors
- 2 seminars: Biodefence & Technology and innovation
- Panel discussion

Program & registration:

<http://www.nordic-fobis.net/dissemination>

Partners: Polyteknisk Forening, Intervensjonscenteret Rikshospitalet

Introduction

The health care systems of the industrialized countries are expected to undergo major changes within the next 10 – 15 years. The number of elderly people requiring treatment will grow considerably, so-called welfare diseases is increasing, and increasing use of new advanced treatments will occur. This will require a more efficient health care system offering better services. A number of new health care technologies will emerge and several will be adopted by the health care systems.

How will biomedical sensors shape the healthcare systems of the future? How can they impact the quality and cost of healthcare and

what are the business opportunities in the Nordic region?

This newsletter reports a summary of the fourth workshop and presents some biomedical companies in Denmark, Finland and Norway. Biomedical companies in Sweden were presented in the 3rd Newsletter.

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Project objectives

- To enable a strategic understanding of the possibilities and implications of the use of biomedical sensors for healthcare purposes by establishing likely scenarios for technology, applications and markets.
- To provide for a framework for commercially viable exploitation of biomedical sensor penetration in the Nordic region by enhancing a network of competencies relevant to technology and applications.

The Workshops

The project revolves around a series of workshops, the first being held in Copenhagen 6 – 7th Oct. 2005, the second in Oslo 2nd Nov. 2005 and the third one in Stockholm 3rd March 2006 and the last one in Tampere 7th June. The objectives of the workshops are to establish status, needs and perspectives for sensors in relation to health care and in particular the need for biomedical sensors.

4th Biomedical Sensors Foresight Workshop

VTT, Tampere, 7 June, 2006

The fourth FOBIS workshop was organized by VTT, which has been active in the area of biosensors for more than 20 years. The focus area for the research group at VTT is advanced systems for sensing phenomena at the molecular level. Molecular recognition is based on tailored coatings with functional molecules, and case-specific transducers. They are applied in immuno-, DNA-, and chemical sensors, and used in the fields of biomedical engineering, clinical diagnostics, as well as in monitoring the environment, industrial processes and food quality.

Program

The purpose of the third workshop was to try to answer the question “How do we get there?” and discuss and establish technology premises

and boundaries. Technology-driven scenarios were discussed and hands-on examples on sensor implementation in the healthcare sector were presented. Other topics for the workshop were to discuss and establish market enablers and restrictions and discuss the role of health care authorities and other public organs. The workshop included world-leading sensor experts and key stake holders and policy makers representing the health care sector and society.



Evening Programme: Sauna & Dinner at Merunlahti Outdoor Adventure Centre

Key note speakers at the 4th workshop

Prof Pankaj Vadgama, Director, IRC in Biomedical Materials, Queen Mary, University of London (UK)

Paul Mundill, R&D Vice President, Orion Diagnostica Oy (Finland)

Prof Niilo Saranummi, VTT (Finland)

Prof Jukka Lekkala, Tampere University of Technology (Finland)

Dr. Wolfgang Rossner, Siemens (Germany)

All workshop presentations may be downloaded!

www.itff.no/annet/fobis/workshop/Workshop_4

A poster exhibition was integrated with the workshop and used as an arena to discuss the workshop theme “What do we do now?”.

Keynote presentations

Clinical Biosensors - An interfacing Challenge and a Materials Question

So how much more chemistry do we really need?

Prof Pankaj Vadgama, Director, IRC in Biomedical Materials, Queen Mary, University of London (UK)

Professor Pankaj Vadgama gave a broad overview of surface interfaces and biosensors and presented several new results. He is currently director of the IRC



(interdisciplinary research centre) in Biomedical Materials, Queen Mary, University of London and Professor of Clinical Biochemistry, Queen Mary's School of Medicine & Dentistry. He has a profound career within bio-medical science and in particular in relation membranes for sensing and applications both in vivo and in vitro. Bio-compatible materials are also a very active research area of Prof. Vadgama.

The title of his presentation was *Clinical Biosensors: An interfacing Challenge and a Materials Question* with the subtitle: *So how much more chemistry do we really need?*

The presentation was introduced on the basis of the question: *why do we need biosensors?* Several good reasons were presented like label-free detection or no sample preparation is needed. Also, a biosensor can be extremely small and the application may not require specially trained personnel.

Implantable sensors have a large potential in many parts of the body. It may be intracranial, retina, cochlear (ear), contraction or displacement (e.g. for sphincter control), or even inertial sensors (acceleration, rotation) in the limbs.

The principles of biosensors were discussed. They are based on biochemical recognition and transduction. Many such processes can be found in nature and provides inspiration to the realization of artificial counterparts. Some of the more subtle aspects of molecular recognition were illustrated and the need for surface modifications in order to obtain specificity, proper transport, and long term stability was emphasized.

Relevant materials were discussed and especially different types of polymers. Examples of the formation of monolayers by self-assembly were given. Membranes constitute a very important part of many biosensors (as for biology in general). Key characteristics in relation to structure and pore size were given.

A number of commercial biosensors are available in particular for glucose sensing. The principles of some of these sensors were presented.

Implantable sensors have a large potential in many parts of the body. It may be intracranial, retina, cochlear (ear), contraction or displacement (e.g. for sphincter control), or even inertial sensors (acceleration, rotation) in the limbs.

What comes next in biomaterials relevant for sensors? The suggestion was that multilayer membranes will become very important, reactive surfaces will be much more sophisticated, and biomimetic (human made processes that imitates nature) will become very important especially as miniaturization continues.

Remote reading of implanted sensors will most likely be essential (wires in and out of the human body are very undesirable). A number of options do exist for this type of interaction. It may be optical, acoustical, radio frequency, microwave, inductive or capacitive.

At the end of his presentation Prof. Vadgama discussed which factors are driving development – or hampering development. He made the somewhat provocative statement that society is becoming increasingly resistant to new technology especially in the health care sector. The may conflict with actual needs. Regulatory conditions may contribute to undesirable

barriers. Cost is an important factor. However, in the health care sector it may not always be traceable how cost affects decisions!

Future in-vitro diagnostic (IVD) products – where are they and how to realise them?

Paul Mundill, Vice President, R&D, Orion Diagnostica Oy



Orion Diagnostica Oy is a biomedical company belonging to the [Orion Group](#), a health-care company in Finland. Orion Diagnostica specialises in rapid and easy-to-use clinical diagnostic and hygiene-monitoring

products aimed at enhancing the quality and effectiveness of health-care services as well as people's well-being.

Paul Mundill started his presentation by a reflection about future expectations when comes to in vitro diagnostics (IVD). He suggested that the chain of events involved in diagnostics has to be reduced. That means that such elements as sampling handling, interpretation of data, transport etc, has to be reduced or omitted. Technologies evolving should help to reduce one or several of these steps and presumably allow the patient to become more involved. Health care also has to address the ever increasing demand for diagnosis. This could be done by better preventive measures or by a stricter selection of what patients to diagnose. He also briefly analysed the driving forces for a changed IVD market. The drivers include the health providers, the patient group and the awareness of cost and risk management. For example in UK the use of Herceptin for early stage breast cancer has grown out of campaigning. He also introduced the different players on the IVD arena; namely, regulators, health providers, health insurers, patients, doctors, health centres, public organisations, media, scientific community, IVD companies and pharmacy companies. In the future interactions dependence within these groups will increase.

Mundill pointed out several critical aspects for the development of future medical IVD products. For example:

- Special requirements from disease oriented medical researchers.
- The progress in technology with new material and principles that can lead to alternative views.
- The pressure from more demanding users and customers.
- There are also an increasing pressure from health providers i.e. health insurers and developers.
- Pharmaceutical companies are locking for new markets.

There was also a discussion about the development of implanted devices. The following examples were mentioned; heart monitor/activator, delivery system for insulin, intestine camera and RFID (radio frequency identification). For example, implantable RFID microchips are already used for personal identification. Harvard medical school is evaluating the use of such chips in their hospitals and Dutch clubbers are reported to have had them implanted as night club ID.

The chain of events involved in in-vitro diagnostics has to be reduced.

This was followed by a brief discussion of some basic technology components i.e. binders and detection. Traditionally binders i.e. antibodies and enzymes are now replaced by synthetic imprinted and design surfaces. Detection based on labels attached to binders is replaced with design surfaces which respond to the binding event. Digitalisation allows for the processing of complex matrices of data and miniaturization allows for implantable and easy to use formats.

Mundill also from his own experience commented on the process for innovation. His advice was; do not look upon the innovation process as linear and well planned. Rather allow for jumps, surprises and irregularities.

He summarised his talk by high lighting the following points:

- Be clear about the problem and the future customer
- Walk the technology shop look for new ideas
- Combine ideas from different places
- Develop a concept in order to give it its maximum benefits
- Use internal and external finance sources
- Walk first before run
- All projects look like failures at the halfway mark

Why innovations of distributed ICT applications for health tend to fail?

Prof Niilo Saranummi, VTT (Finland)



Saranummi gave a presentation on "Why innovations of distributed ICT applications for health tend to fail?" Niilo Saranummi is Research Professor in Health

Technology at the Technical Research Centre of Finland (VTT). His research interests include system architectures, middleware, IST for personalized health and disease management, in one concept "pervasive healthcare". He is also active in innovation, technology transfer and technology policy setting.

Saranummi stated that healthcare is one of the most potent application areas for information and communication technologies (ICT). Pervasive healthcare include application of pervasive computing technologies for healthcare, health, and wellness management. It makes health care available everywhere, anytime – pervasively. Pervasive healthcare addresses those technologies and concepts, which integrate healthcare more seamlessly to our everyday life, wherever we are. Information based systems within today's healthcare that treat symptoms will move on to translational medicine with clinical genomics and genetic predisposition testing and from there to personalized healthcare.

ICT have been applied for health since late 80's. Saranummi asked if the projects do not address the questions right, or could it be that they are not addressing the right questions? The challenge is to mutually adjust the technology and the services (and if necessary the organization) so that a new better solution emerges. New services require a balanced integration of the ICT components into end-to-end solutions. In order to be successful it is important to select the right partners for the actor network and create an open environment for ideas to be exchanged. But it is also important to understand the limits set by the resources and business expectations, to get proof that the new solution has value. The health service provider has to be committed to the development of its services and be willing to carry out process and structural changes when necessary. And moreover, a SME must be able sustain the wait period.

Towards Integrated Molecular Diagnostics: Biomedical sensors – the missing link?

Dr. Wolfgang Rossner, Siemens (Germany)



Introductorily, Dr. Rossner described some of the trends for future medicine:

- Fusion of diagnostic tools (... and data)
- Diagnostics and therapeutics at the molecular level
- Preventive and earliest recognition
- Individualized and home based diagnostics & therapy
- Fully ICT supported

- Highly cost effective: Point of care, home care
- From reactive to proactive, predictive, preventive
- Combination of in-vitro and in-vivo diagnostics
- Completion of diagnostics towards therapy and progress tracking

In-vitro diagnostic will be based on bio sensors (lab-on-a-chip devices).

He then described what happens in Siemens as a system house. Some key elements:

- Integrated Molecular Diagnostics is a fusion of tools and data.
- Major trends:
 - Fusion between diagnostic tools (and data)
 - Imaging
 - ICT system compatibility
 - Highly cost effective (Point of Care)
- Everything goes down to molecular level
- Information technology has to be fully integrated to be cost effective
- PET & CT are combined. This needs specific protocols.
- Hardware side: Hybrid modalities (PET&CT, PET&MR).
- Integrating everything in ONE machine.
- Complementary structure to f.ex. ultrasound and CT.
- Basic aim: One way to do In-vitro Diagnostics

His presentation then highlighted some important topics for future development within the field:

- Bio chip & Micro array is today used to R&D. More to be used to practice diagnostics
- Specific patients need good practice to see if the disease is in the body.
- The medicine has to be matched to these requirements.

- In-vitro diagnostic will be based on bio sensors (lab-on-a-chip devices)
- The hardware is OK and not the current bottleneck.
- The disturbing specs are the complex single elements.
- Short process time essential (max 30 min)
- Ex, Quick lab! (chip card). Hand held system read out system possible to be linked wireless.
- Resonator is label free, highly sensitive and fast.
- Everything must be built around a technology platform

He then gave a case example presenting a Gravimetric Biosensor (FBAR) developed by Siemens.

Advantages with this biosensor:

- Highly sensitive
- Sensor and electronics on same wafer
- Highly packaging density through photolithographic process ability
- Quantitative and time dependent measurements
- It's the only gravimetric (acoustic) sensor that works in liquid and can be integrated into CMOS circuits.
- Therapy Control: Functional properties accurate for reproducibility
- Have to be activated months after they re fabricated.

Siemens is partner in an EU project launched last year: BIOGNOSIS (www.biognosis-info.de). The key objectives in this project are:

- Development of a unique resonator based integrated DNA and protein detection system for applications in medical diagnostics.
- Due to its easy to use and cost-effective nature, the system will allow fast and reliable DNA and protein based in-vitro testing.
- Aiming for point of care and doctor's office applications, e.g. early cancer

recognition, this approach will help improve public health.

- DNA and protein based markers for breast cancer will be identified and applied for a final clinical validation of the sensor system.

His presentation concluded with some challenges and needs towards molecular diagnostics:

- Improvement of processing (resolution, precision, reliability, yield)
- Essential role of biochemistry
- Increase multi-functionality by integration and miniaturization
- Interface to medicine, chemistry, electronics and IT
- Integration of wireless data transfer & self-sustaining power supply
- Full leverage of interdisciplinary added value

The mission of Siemens in this perspective is to shape the future of healthcare by:

- Identification of risk patients and preventing disease outbreak
- Diagnosing diseases early at their onset
- Enabling efficient therapies with measurable outcomes
- Increasing efficiency of healthcare delivery

To succeed with this, some key factors at Siemens are:

- A critical issue is multidiscipline integration!
- Siemens will increase quality and reduce costs
- There are new imaging techniques (10 min) which are cost effective.
- Personalisation is important.
- Future research area; Molecular technology (bio chemical information).

Wireless Biomedical Sensing - Challenges and Opportunities

Prof Jukka Leikkala, Tampere University of Technology (Finland)

Jukka Leikkala recently obtained the professorship at the Tampere Technical University of Technology at the Institute of Measurement and Information



Technology. Professor Leikkala gave a presentation on “Wireless Biomedical Sensing – challenges and opportunities.” He started with presenting the Sensor technology group at the Institute of Measurement and Information Technology. Research and educational activities of the institute are focused on the subjects of fundamental measurement science, sensor technology and measurement information technology. Special emphasis is placed on developing practical and theoretical skills through experimental work and research projects.

Leikkala continued his presentation with talking about the requirements, technological challenges and applications of wireless biomedical sensing. In Leikkala's opinion new technology, e.g. ambulatory or implantable wireless sensors, will dramatically change the way we understand healthcare today. This development provides the enabling technology for real long term monitoring of physiological functions in sports, home health care as well as in hospital environment. The healthcare system will become more mobile, demand driven, efficient, and person/patient friendly. New wireless sensors and measurement systems have a huge market potential. Leikkala said that wireless implantable sensor technology is the only way to realize reliable long-term monitoring of physiological signals.

Lekkala listed some of the most important projects and presented the BIRCA consortium, the center and alliance for biosensing research at Tampere Technical University of Technology. Lekkala concluded by saying that the present state-of-the-art technology enables development of completely new types of wireless devices for reliable long-term monitoring of physiological signals.

Panel discussion

(Notes by Dorothy S. Olsen, University of Oslo)

Participants: Pankai Vadgama (University of London), Paul Mundill (Orion Diagnostica), Niilo Saranummi (VTT Tampere), Wolfgang Rossner (Siemens AG)

Chairperson: Dag Ausen, SINTEF

In an informal panel discussion the participants were asked to comment on various aspects of the future development in the field of biomedical sensors. The panel was posed with several questions.



From the panel discussion

Highlights from the discussion

Where can biomedical sensors make the greatest contribution to future health care?

- Improve our ability to diagnose infectious diseases and to allay peoples' fear of being infected, which is becoming increasingly important. Within this area the diagnostics

of microbial infections should be an important area of interest in the future.

- Individual monitoring of the whole person will become possible. This will be based on physical measurements, rather than the difficult biochemical parameters. It would be an advantage to develop more intelligence on the patients' environment and the way this influences the physical measurement. In the case of long term vascular diseases, like diabetics and renal disease, continuous monitoring might make real treatment possible in comparison with today's "treatment" of diabetics with insulin which does not of course cure the patient.
- General improvements in preventative medicine, particularly the monitoring of risk patients.
- Greater flexibility in the choice of location for the treatment of patients will probably be common in about 10 years and we would expect to see more treatment at home.
- An ongoing project in New Zealand, was referred to, where heart patients are being sent home from hospital much earlier. Their testing begins earlier, usually at home before the patient is operated on; then the electronic records travel with the patient.

Technologically there is a tremendous potential, especially related to converging technologies, however technology alone does not create business.

What markers do the panel think are the most important to measure?

- Breast cancer markers
- Viral infection markers – distinguishing between bacteria & viral infection (these exist today, but are considered too expensive & therefore not used)
- Infection surveillance
- Insulin levels in diabetics is one of the most important area biomedical sensors can make a contribution. (Not only measurement, but also treatment in the future)
- Assessing the effects of shock on younger patients recently involved in accidents might be considered useful, especially in situations with a large number of shock victims. There are no simple ways of doing this today and the doctors experience is relied upon. Some simple measurements might help health personnel to decide on the most appropriate treatment. Before this could be developed, one would have to decide what should be measured.
- Various measurements related to monitoring of patients known to have heart disease. This could be combined with some kind of reporting on status to the patient and/or medical personnel.

How bright is the future business potential of biomedical sensors?

Technologically there is a tremendous potential, especially related to converging technologies, however technology alone does not create business. There is a growing understanding among health personnel of the potential of biomedical sensors for detecting and treating disease; however the driving factors are not very strong. The public are not asking for biomedical sensors, politicians are not asking for biomedical sensors. There are not many exciting success stories to catch the public imagination. We need something like a pacemaker, something practical, which the public can relate to and which would give input to the next generation of research.

The suggested areas for investment are:

- Surface science.
- Micro array based sensor system in a handheld device.
- There is a business potential in developing sensors related to fertility and pregnancy because there are people willing to pay for this.

The panel were asked if they see a possible market for short term monitoring of cardiovascular diseases. The panel say no. People are not yet willing to pay for non-continuous monitoring and the ability to transport the testing to a different location. It is possible that the advent of long-term reliable monitoring for the elderly will emerge as a driver for future development.

The national interests of the various health authorities vary and this makes it unlikely that a uniform model will be chosen. This variation makes it less probable that there will be any huge market opportunities.

The general opinion from the commercial participants is that this technology may become quite popular and profitable, but it has to be reliable and proven first (like the i-pod) there are some complex biochemistry problems to be resolved before the technology can be regarded as “0-failure”. Society requires that we make no mistakes. An example of this is the enormous problems caused by false negatives produced by screening.

What do the public want?

Electronic storage and easy access to personal health data for individuals e.g. the integration of test, therapy and historical data, available whenever and wherever the individual goes.

Various cheap types of monitoring may become attractive to younger and otherwise healthy people who are interested in technology. However some self-testing kits are available today like cholesterol test-kits, but they do not sell very well. It would appear that the public do not actually want to know the status of their health.

There are potential improvements in pre-natal screening; however this is not seen as a pressing problem for society.

The problem of safety of Alzheimer relatives for family, who may not live nearby is considered more pressing. Solutions for monitoring of patients movement and activities so that they do not get injured in traffic for example would be useful. The idea for an "Intelligent Environment" for Alzheimer patients or other elderly to live in was mentioned as a possible area of application, but again this would probably have to be financed by national health authorities.

What do health professionals want?

Reduced time between testing and certain treatments e.g. with some cancers, doctors want markers to be measured on the day, so that they can take the decision on treatment on the same day. There are traditions for certain types of monitoring and certain turnaround times on test results. Any solutions improving what is already perceived, as a problem should meet with interest among doctors, however other factors are also important and it is not enough to simply offer improvements, the economic benefits should also be obvious. There are other tests of serious conditions where the doctor wants the data quite quickly.

Generally more preventative medicine at all levels for all kinds of diseases and health problems.

Better quality information on the state of the patient, making it easier to make a correct diagnosis. There are some cases where doctors might see the benefits of continuous monitoring of patients in order to make a correct diagnosis. This would be a potential application, but would be confined to certain cases and unlikely to ever become mass-produced.

What do health authorities want?

Many of their concerns are related to the economics of maintaining health care for an aging population and to the economics and logistics of large-scale diseases like diabetes. There should be interest in all devices, which will assist in reducing the burden on society

of treating the terminally ill. We already spend large sums on treatment of the terminally ill; there are possibilities for cheaper treatment and hopefully some improvements in quality of life, making this an area of interest both for health authorities and for the public.

Some examples:

- Prevention of diabetes and heart disease
- Treatment of diabetes
- Monitoring of the terminally ill
- Devices making it possible for treatment to be carried out by unskilled carers
- Sensors making it possible to carry out certain treatments without skilled supervision
- Sensors making it possible to carry out treatment without expensive equipment operated by experts in hospitals

Security and public concerns about health data

It was suggested that the wireless transfer of medical data from sensors might make the public nervous. However, making the data safe for wireless transfer was not considered a serious problem by the panel. There are already different solutions in use in military environments.

The panel were asked about the role of insurance companies and if there is a risk that they will perhaps insist that we use sensors? Laws are beginning to develop on the illegality of implanting sensors against peoples will. There are also laws restricting insurance companies. It will be interesting to see how this develops

How will healthcare be carried out at the different locations in the future?

It was also suggested that strategic use of sensor technology would make it possible to design completely new models for health care. Some think that more testing, treatment and monitoring will be carried out nearer the home in a decentralised model. This would make the doctor's consulting room more important than ever and either the general practitioner (GP) or a local

pharmacist may be the primary contact for most illnesses.

More testing, treatment and monitoring will be carried out nearer the home in a decentralised model.

With better self-testing and logging of health data the role of the GP as the person who knows the patients history will become obsolete and it will be possible to have mobile teams of health teams to come to people's homes with devices instead of going to the doctor.

The panel were asked if it may be possible to get tests done in public places, particularly for young people. E.g. pregnancy tests in public toilets, especially for young people. The panel were a bit more reticent about this. This will of course be possible, assuming that self-testing become cheap and reliable enough, but at present there is no goal in this direction.

The concept of the "Smart Home" was brought up. Sensor technology and ambient intelligence could make this possible. The idea is that we place sensors at home where people need to be monitored; monitoring can be easily and cheaply installed, switched off, changed or removed.

The panel were asked what they thought of the idea of more therapy being carried out at home using a combination of sensors or web-advice? Most thought it sounded like a good idea, but some US organisations like this already exist, but they are experiencing financial problems.

It was pointed out that a test result is not necessarily the same as a diagnosis. Many results simply prove that the patient is ill enough to be sent to hospital for further tests. Certain tests are best carried out in certain places e.g. anticoagulant monitoring should be done on the spot, often by the doctor and anti-epileptic monitoring should be done immediately in out-patients.

The introduction of new products to the market often starts in universities or in hospitals. The information about the possibilities and the benefits are then spread through the system. It is important to

think about how new products could be diffused in the future. At the moment hospitals play an important role in the acceptance of new technologies. If hospitals are sending people home much earlier because of the costs, this could perhaps drive the need for sensors. E.g. to find out who is likely to get deep vein thrombosis before deciding who to send home. Hospitals are actually very good at implementing new technologies, they are generally slow to react, but once they have decided the changes can ripple through the system quite quickly. It was mentioned that Olou in Finland is pioneering a totally wireless hospital.

Consequences for existing national health services

It was also suggested that strategic use of biomedical sensor technology would make it possible to design completely new models for health care. Treatments, which are centralised today due to costs or to the need for skilled operators, may become simple and cheap enough to make radical changes possible. There are, however, big differences in the way different medical communities interact with their host communities cf. UK, Finland & Norway. The choice of solution might also be dependent on how the health service is respected in a country i.e. European model or American model. Will people do what the doctor advises, or will it depend on who pays? All these factors would suggest that each National Health Service will need to devise its own combination of technology and people which is acceptable to its population.

Future pressure on national health services might make it necessary to select those who receive treatment and those who have to wait. The general feeling of the panel was that all illness should be treated; using sensors would make it technically possible to exclude those who refuse to monitor their health or perhaps those who monitor and get bad results.

One critical point emphasised was the sheer mass of data, which biomedical sensors, used in continuous monitoring, can generate. Who should receive the data generated by the sensors and who should interpret and react to it? It will probably be necessary to

devise ways of sorting or filtering the data, or perhaps more electronic analysis, rather than everything going to the doctor. Existing traditions suggest that there is a strong feeling that a human being and in particular a doctor should be involved in analysing the data.

Technological opportunities

Converging technologies will undoubtedly assist in resolving many of the known problems and will probably present new possibilities for added functionality in sensors or new ways of integrating biomedical sensors.

Miniaturisation will probably continue as instruments improve, and as nanotechnology develops new techniques.

Other challenges

Although we all know that health is important, we are generally really bad about doing what is good for us. E.g. given a course of antibiotics, around 50% of the people in the room would not complete the course or would drink alcohol and ruin the effect of the medicine. This is an example of the public who know and understand the consequences, but still do not do what is best for their health. This poses a major problem for the concept of self-testing and the individual having more responsibility for his or her own health care.

It was suggested that it is not really lack of funding that limits future development, but our ability to phrase the question and to organise our ideas. The scientists working in this field maybe need to get better at communicating the potential, or perhaps of seeing the potential.

Implantable systems will require greater interdisciplinary collaboration. A possible solution may be to start hiring students who are interested in working in developing new areas of expertise and to develop more multidisciplinary courses and give training on how to work in a team.

One critical point emphasised was the sheer mass of data, which bio medical sensors, used in continuous monitoring, can generate. Who should receive the data generated by the sensors and who should interpret and react to it? It will probably be necessary to devise ways of sorting or filtering the data, or perhaps more electronic analysis, rather than everything going to the doctor.

Some of the panel raised the question if the research we are doing today is the right research? The direction in this field has been changed in recent years as a result of technological developments in other fields. This poses challenges on how to plan the research and to know if we are looking at the right things.

In recent years most western countries have encouraged much more research collaboration between industry and academic institutions. In fact, in most EU countries, this has become a necessity in order to get grants. The panel consider this to be an extremely negative development. Industry need to meet short-term economic goals and scientific development does not always fit in with the financial director's aims. It was the general opinion that science and researchers can advance without industry. There was a strong message from the panel members that it is necessary to get curiosity back into research and that there is a need for more exploration and basic research. There is a role for industry, but not to same extent as the various research councils seem to want. The researchers and the industrialists were actually in total agreement about this and believe that "innovative science" will eventually funnel down to useful things. They also pointed out the importance of the scientist or the researcher's motivation and were concerned that this might get lost if one industrialises the system too much. It is not possible to predict when science will deliver and it is restricting to nail it down to business plans.

Biomedical companies in the Nordic region

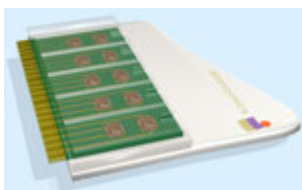
FOBIS tries to identify Nordic companies with products or services relevant for biomedical purposes. The overview is not complete, so please send us tips of relevant companies (addressed to Dag.Ausen@sintef.no) if some is missing. In the 3rd Newsletter we presented some of the actors in Sweden. In this issue we highlight some of the companies in Denmark, Finland and Norway.

Denmark

Atonomics A/S

København, Denmark, www.atonomics.com

Atonomics is targeting to become a leader in electro- and nano mechanical diagnostic Point of Care technologies. Their goal is to revolutionize the way DNA and antibody/antigen information is used in diagnosis. We will introduce a new technology standard of sensitivity, speed of analysis, convenience and low cost. Their first bioChip products are targeted towards the allergy field.



Chempaq A/S

København, Denmark, www.chempaq.com

Chempaq A/S is a Danish medical technology company founded in 1999 as a spinout from the Microelectronics Center (MIC) at the Technical University of Denmark. Their main product is the



Chempaq XBC – Point of Care Hematology Analyzer. The Chempaq XBC (eXpress Blood Counter) is the world's first true Point of Care (POC) hematology analyzer designed for primary care physicians who need access to decentralized blood test results within a few minutes.

Dako A/S

Glostrup, Denmark, www.dako.com

Dako is a world leader in cancer diagnostics. Cancers form when cells in the body grow out of control. Analysis of these cells forms the basis of Dako's products for in vitro diagnostics.

Novo Nordisk A/S

Bagsværd, Denmark, www.novonordisk.com

Novo Nordisk manufactures and markets pharmaceutical products and services that



make a significant difference to patients, the medical profession and society.

Novo Nordisk is a healthcare company and a world leader in diabetes care. The company has the broadest diabetes product portfolio in the industry, including the most advanced products within the area of insulin delivery systems. In addition, Novo Nordisk has a leading position within areas such as haemostasis management, growth hormone therapy and hormone replacement therapy.

PreciSense A/S

Hørsholm, Denmark, www.precisense.dk

The PreciSense System used for non-invasive glucose reading includes a microcapsule

placement unit and a light detecting non-invasive reader unit. The microcapsule placement unit poses the right dose of glucose-responding microcapsules in the upper layer of the skin, painlessly. The glucose assay components in the microcapsules generate a fluorescence signal that corresponds to the glucose level. The non-invasive reader unit monitors this glucose binding event through FRET, Fluorescence Resonance Energy Transfer, which is directly related to the concentration of glucose.

Radiometer A/S

København, Denmark, www.radiometer.com

Radiometer is the world's leading provider of blood gas analyzers. The analyzers measure blood gases and other parameters used to diagnose critically ill patients.



In addition to analyzers, Radiometer provides accessories, IT systems and support services for blood gas testing. Radiometer also produces instruments that measure blood gases transcutaneously.

UniSense A/S

Århus, Denmark, www.unisense.dk

Unisense Medical is dedicated to providing sensor technology to medical research. The company has a range of microsensors and auxiliary equipment and takes pride in helping scientists to take the best possible advantage of the potential of our technology. We have a close individual communication with all customers, to make sure that our extensive knowledge and know-how on different

technologies can serve as a help in designing and planning experiments.

Finland

Arctic Diagnostics Oy

Turku, Finland, www.arcdia.com

ArcDia introduces a new technique for rapid screening of Methicillin resistant *Staphylococcus aureus*. [ArcDia's Distributed Diagnostics](#) Concept offers decentralised clinical chemistry and immuno diagnostics for doctor's offices and health centres.

HyTest Ltd

Turku, Finland, www.hytest.fi

HyTest produces and markets a variety of biotechnology products, specializing in cardiac markers (such as troponin, myoglobin, crp, papp-a, myeloperoxidase, sCD40L, cystatin C), infectious and autoimmune disease reagents, hormones and toxins, human proteins, neuroscience products and molecular biology reagents for research and industrial applications.

Inion Oy

Tampere, Finland, www.inion.com

Inion is dedicated to developing and manufacturing novel medical devices based on innovative biomaterials. Inion



developed solutions feature a range of proprietary technologies and processes that offer significant benefits over alternative

methods and have won a growing number of the customers around the world.

Innotrac Diagnostic Oy

Turku, Finland, www.innotrac.fi

Innotrac Diagnostics provides hospital laboratory professionals and clinicians with Aio! Immunoassay point-of-care systems for cardiac and critical care testing, and diagnostics and pharmaceutical companies with contract manufacturing services in coated plate and diagnostic reagent production.



DNA diagnostic solution for the detection of microbes and antibiotic resistance. The key benefits of Mobidiag's new biochip technology for clinical laboratories are speed, accuracy, and ease of use.

Orion Diagnostica Oy

Finland, www.orion.fi

Orion Diagnostica is a biomedical company belonging to the Orion Group, the leading health-care company in Finland. Established in 1974, Orion Diagnostica specialises in rapid and easy-to-use clinical diagnostic and hygiene-monitoring products.



MedixBiochemica Oy

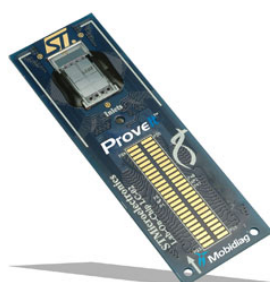
Kauniainen, Finland,
www.medixbiochemical.com

Medix Biochemica specializes in monoclonal antibodies and diagnostic tests for numerous medical conditions. We have successfully connected the scientific community, clinical laboratory services and high-tech diagnostics. We have full control over our own product development from raw materials to finished healthcare products, such as the Actim diagnostic tests. This forms a unique bridge between lab and life.

Mobidiag Oy

Helsinki, Finland,
www.mobidiag.com

Mobidiag develops the innovative Prove It™



Norway

Alertis Medical AS

Oslo, Norway, www.alertis.no

Alertis Medical AS is a medical device company pioneering a new and unique technology for biosensors that will help save patients health and lives by providing early information about critical changes blood perfusion and respiration. The miniaturized biosensors are easy to use and will save health care expenses. Alertis has developed a biomedical sensor using a new method to detecting ischemia based on an invasive CO2 measure. The product IscAlert™ is still in the development phase for commercialization and certification.

Axis–Shield AS

Oslo, Norway, www.axis-shield.com

Axis–Shield is focussed on the development and manufacturing of key in vitro diagnostic tests for use in the hospital laboratory and at the point of care. In



the former environment their products are available as stand-alone tests and also on the menu of many high throughput analysers marketed by the large global companies which dominate this marketplace. At the point of care their products include NycoCard and the new Afinion system. They specialise in the identification of increased risk of cardiovascular and neurodegenerative diseases.

BioGauge AS

Oslo, Norway, www.biogauge.no

BioGauge AS is a company dedicated to developing next generation bioimpedance techniques and instruments, based on the latest results from international research. The company office is situated at the Oslo Innovation Center. Main activities at the moment are:

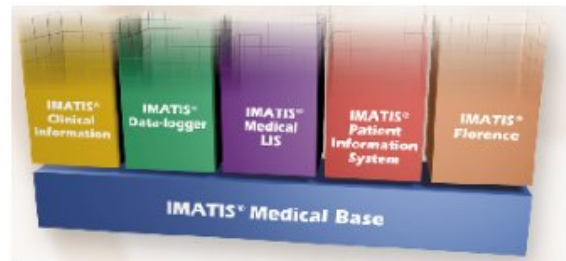
- Electrodermal response
- Skin hydration measurements
- Meat quality assessment

Cardiac AS

Porsgrunn, Norway, www.cardiac.no

CARDIAC is an innovative technology company working in the field of industrial and medical information and communication technology (ICT). Over several years, we have been

developing the IMATIS product as a middleware platform for our deliveries.



Based on a true infrastructure IMATIS Medical enables data –collection, –collaboration and –presentation of ALL kinds of data–elements. A real time database ensures optimal technical environment for ECG, EEG, and other waveform data. The integrated web–portal, offers a common user interface, and “Single Sign On” capabilities, for all installed systems.

dPCom AS

Oslo, Norway, www.sensometrics.biz

The company, former named Sensometrics, has developed a new method to monitor intercranial pressure by using a micro sensor. A micro sensor, PC based on line monitoring and software, offering a better pressure control than the existing shunts.

InvivoSense AS

Trondheim, Norway, www.invivosense.com

InvivoSense, former Optomed, is a Norwegian company devoted to the development of medical devices for diagnostics and monitoring of therapeutic procedures. Our technology is based on fiber optics and biotechnology. They have New method to detect tumors based on an in vivo sensor measuring PSA (Prostate specific antigene) . The product ”InviviSense PSA” is already in the market.

LifeCare AS

Oslo/Horten, Norway, www.lifecare.no

Lifecare is developing the SENCELL microsensor – a paradigm shift in glucose monitoring for diabetics. The sensor will be small enough to be injected under the skin – delivered through the tip of a pre-filled syringe. SENCELL will continuously transmit data wirelessly through the skin to a watch carried on the arm. The technology represents a new sensing technology based on osmotic readings.

Medi-Stim AS

Oslo, Norway, www.medistim.no

Medi-Stim develops, manufactures and distributes solutions for cardiac and vascular surgery. Medi-Stim's state-of-the-art applications are based on ultrasound-, transit-time- and Doppler-technologies. Medi-Stim's strategy is to play a key role in performing and developing quality control of cardiac and vascular surgery. Medi-Stim plans to contribute in the development of minimal invasive surgery.



Memscap AS

Horten, Norway, www.memscap.com

For medical and biomedical fields, MEMSCAP offer is based on two main products families, namely the multi-



purpose AE800 sensors family which main commercial applications are flow sensing in medical ventilators, as well as muscular force pressure, and the SP840 sensors family, dedicated to physiological pressure (including blood pressure).

Med-Storm Innovation AS

Oslo, Norway, www.med-storm.no

New method based on analysing skin conductance or emotional sweating for monitoring and detecting stress/ pain and awakening on patients. There is no reliable product available for this purpose today. MSI has already delivered and sold equipment for clinical research projects and for diagnostic purposes.

Mison AS

Trondheim, Norway, www.mison.no

MISON is the first company to resolve a compact integrati

SonoWand®
an Intraoperative Imaging System incorporating Image Guided Surgery with 3D Ultrasound and Power Doppler.



on of high quality 3D ultrasound and neuronavigation. Our expertise in this technology places MISON in a leading position in introducing our novel product SonoWand® to the neurological market.

Norchip AS

Klokkarstua, Norway, www.norchip.com

NorChip is a young, innovative biotechnology company engaged in the



development and production of sophisticated biomedical diagnostic kits based on the detection of RNA and proteins and in the development of miniaturized and fully automated IVD systems combining the latest advances in microtechnology, biotechnology and information technology. NorChip has received strong scientific support and acknowledgement from national and international research councils and foundations.

Nordiag AS

Bergen, Norway, www.nordiag.no

NorDiag is a biotechnology company aiming to reduce mortality and treatment costs of common cancers through detection at the early, curable phases of cancer development. The Company's first product, Genefec™, enables early detection of gastrointestinal cancers, including colorectal cancer.

WPR Medical AS

Arendal, Norway, www.wprmedical.no

WPR Medical is developing technology solutions for health care. WPR is a forefront company in close cooperation between medical expertise, biomedical technology and science. Their mission is to develop wireless surveillance and recording of vital medical parameters, done through a wireless Body Area Network (BAN).

Other information

The Swedish medical technology research has been evaluated. See this article:

<http://tentakel.vr.se/Nummer/2006-06>

FOBIS dissemination workshop

Rikshospitalet, Oslo, Tuesday 31 October 2006

A better life –a longer life?

Intimate collaboration between innovative technologies, on the body - in the body, in the hands of the doctor – in your own hands. Will knowledge about the smallest building blocks in life combined with new technologies, often invisible, change our conditions in life, expectations and health care? How will next generations homo sapiens improve, reset, prevent, renew and treat the different parts of the body? What are the possibilities and threats, where are the business opportunities?

The meeting will start at 2 pm with multimedia demonstrations and professional explanations, following to parallel work sessions and ending up with plenum discussions / distinguished speakers from 7 pm until 9 pm.

Program

14:00 – 18:00

1. 'Live' medical surgery using biomedical sensors
2. Seminar: Bioterrorism and biodefence
3. Seminar: Biomedical sensors – technology & innovation

18:00 Dinner

19:00 – 21:00

Plenary meeting, Polyteknisk Forening (open to everyone)

Do not miss this workshop!

Registration

<http://www.nordic-fobis.net/PF>

or phone +47 22 42 68 70

Invitation

<http://www.nordic-fobis.net/workshop/dissemination>

Partners



Rikshospitalet – Radiumhospitalet HF

The Interventional Centre

