



Vetenskapsrådet



THE FUTURE OF SWEDISH RESEARCH!

**OVERVIEW 2014
MEDICINE AND HEALTH**

THE FUTURE OF SWEDISH RESEARCH

The Swedish Research Council developed a series of overviews and analyses in 2014 which serve as the foundation for the Board's summary conclusions and recommendations on research policy choices to promote Swedish research in the coming 5 to 10 years. This project is designated "The future of research" and will be summarised in a final report in the summer of 2015. As a whole, the material serves as the foundation in the documentation the Swedish Research Council is compiling for the government's upcoming research bill in 2016.

Overviews have been put together for the following seven research domains:

- humanities and social sciences
- natural sciences and engineering sciences
- medicine and health
- educational sciences
- artistic research
- development research
- research infrastructure

THE FUTURE OF SWEDISH RESEARCH! OVERVIEW 2014 MEDICINE AND HEALTH

SWEDISH RESEARCH COUNCIL

Box 1035

SE-101 38 Stockholm, SWEDEN

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ISBN 978-91-7307-291-5

VR1607

THE FUTURE OF SWEDISH RESEARCH!

OVERVIEW 2014

MEDICINE AND HEALTH

FOREWORD

The overview within medicine and health is part of the knowledge base that the Swedish Research Council has compiled to provide a basis for decisions in preparation for the government's upcoming research bill and to allow scientific councils, academic councils and committees to set priorities. It can also be used as reference material in the research sector.

The Scientific Council for Medicine and Health (henceforth referred to as the scientific council) asked some twenty senior researchers to describe, with the support of their colleagues, the research in their respective fields. The aim was to get a picture of the current status of medical research in Sweden and also get some idea of future questions. Once the texts had been processed by a working group within the scientific council, the research community as a whole was given the opportunity to give their views and opinions via a web forum. The texts describe large parts of Swedish research but make no claim to be exhaustive. Based on the extensive underlying documentation, the scientific council has drawn up a summary that emphasises some broad fields where research should be supported. The focus, however, is on the important structural issues that create prerequisites for research of high quality.

Mats Ulfendahl

Secretary General for Medicine and Health at the Swedish Research Council

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SAMMANFATTNING

De föreliggande ämnesöversikterna inom medicin och hälsa ingår, tillsammans med de rekommendationer som ges, som ett underlag till Vetenskapsrådets strategier för svensk forskning 2015–2020. Ämnesöversikterna sammanfattar läget för forskningen inom de 24 ämnesområden som definierats inom medicin och hälsa. De är framtagna av framstående forskare verksamma vid svenska lärosäten, vilka har uppdragits att sammanfatta befintliga styrkor och svagheter, beskriva trender och tendenser (även internationellt), ge rekommendationer för att stärka forskningsområdet, samt belysa gemensamma problem och frågor för att stärka den medicinska forskningen generellt. Utifrån de trender, styrkor och svagheter som presenteras i ämnesöversikterna har ett antal utmaningar identifierats och en rad strukturella åtgärder föreslås i den föreliggande texten.

Utmaningar för framtida forskning inom medicin och hälsa

Forskning inom medicin och hälsa innebär i sin bästa bemärkelse ett konsekvent och långtgående åtagande med målet att ge kunskap och förståelse av den friska och sjuka människan, samt förebygga, upptäcka, bota och lindra sjukdom. Den bästa forskningen är driven av enskilda forskares idéer och nyfikenhet och detta utgör grunden för nytänkande och därmed genombrott. Medicinsk forskning i Sverige har under senare år tappat i konkurrenskraft. I jämförelse med andra länder bidrar forskargrupper i Sverige med relativt få internationellt uppmärksammade innovativa upptäckter och genombrott. För att säkerställa att svensk medicinsk forskning framgent förmår generera genombrott som leder till långsiktig nytta för samhället på nationell och internationell nivå är det därför avgörande att vi kan identifiera och stödja originalitet inom forskningen. En förutsättning för detta är att stöd ges till den bästa, forskarinitierade forskningen. Genomförandet av ett antal konkreta förslag skulle på ett dramatiskt sätt förbättra resursutnyttjanden inom svensk medicinsk forskning och härmed öka chansen till framtida genombrott.

Strukturella åtgärder för att stärka forskning inom medicin och hälsa 2015–2020

- Grundläggande forskning bör prioriteras för att möjliggöra genombrott och nytänkande samt ge ny och nödvändig kunskap.
- För att främja långsiktighet och kvalitet i forskningssystemet är det angeläget att öka medlen till forskarinitierade projekt som fördelas till enskilda forskare i nationell konkurrens (så kallade fria projektbidrag).
- Den professionella utvecklingen av yngre forskare måste förtydligas och nya tjänster utlysta i öppen konkurrens måste skapas för att säkerställa rekryteringen av framtidens forskare. Ansvaret för detta bör främst ligga på lärosätena.
- Forskningsverksamhet och tid för forskning för kliniskt verksamma yrkesgrupper måste utvecklas. Särskilda initiativ bör tas för att uppmuntra den grundläggande medicinska forskningen samt forskarutbildning av framtida läkare tidigt i karriären.
- Forskarrörlighet mellan lärosäten samt internationellt utbyte måste öka för att främja nytänkande och stimulera utbyte av forskningsidéer samt för utveckling av ny forskningsmetodik.

SUMMARY

The subject overviews in medicine and health, along with the recommendations given, provide an important contribution to the Swedish Research Council's strategies for Swedish research from 2015 to 2020. The subject overviews summarize the state of Swedish research in the 24 subject areas defined in medicine and health. They have been compiled by prominent researchers working at Swedish universities who have been assigned to summarize existing strengths and weaknesses, describe trends and tendencies (at the international as well as Swedish level), provide recommendations to strengthen the research field, as well as illustrate common problems and issues in order to strengthen medical research in general. Based on the trends, strengths and weaknesses presented in the subject overviews, several challenges have been identified and a series of structural measures are proposed in this text.

Challenges for future research in medicine and health

Research in medicine and health is a consistent and far-reaching commitment with the goal of providing knowledge and understanding of human health and illness, as well as preventing, discovering, curing and reducing illness and mortality. The best research is driven by the ideas and curiosity of individual scientists, and forms the basis for innovation and thus breakthroughs. Research in medicine and health in Sweden has become less competitive in recent years. In comparison to other countries, research teams in Sweden are making relatively few internationally recognised innovative discoveries and breakthroughs. To ensure that Swedish medical research is capable of generating breakthroughs that lead to long-term benefits for society on the national and international level in the future, it is crucial for us to be able to identify and support originality in research. To achieve this, it is necessary to support the best investigator driven research. The implementation of several concrete proposals would dramatically improve the use of resources in Swedish medical research and thus increase the chances of future breakthroughs.

Structural measures for research in medicine and health 2015–2020

- Fundamental research should be prioritised to enable breakthroughs and innovation as well as provide novel and necessary knowledge.
- It is necessary to increase funding for investigator-initiated research projects allocated to individual researchers via a national competitive system (free project grants) in order to promote a long-term perspective and quality in the research system.
- The systems for professional development of young researchers must be clarified, and new positions must be created in open competition to secure the recruitment of the researchers of the future. The Swedish universities have the primary responsibility for this commitment.
- Research time and activities for groups of clinical practitioners must be improved and developed. Special initiatives should be taken to encourage fundamental medical research and postgraduate education for future clinicians early on in their careers.
- The mobility of researchers between higher education institutions and international exchange programmes must be increased to promote innovation, promote the exchange of research ideas and develop novel methodology in medical research.

RECOMMENDATIONS

Structural recommendations

Research funding

Researcher-initiated basic research

Research teams and physical research environments need to have sufficient resources and flexibility to launch and conduct innovative projects and to be able to exploit research breakthroughs, generated locally or internationally, quickly and in the best possible way. Financial support should be given to researchers who conduct innovative research of high quality. A basic prerequisite for improving Swedish research is that funding is primarily given to investigator-initiated projects, in open competition, and via quality-based funding at local level. Stable, long-term funding will ensure that the best researchers are given the opportunity and the time to tackle important and challenging questions. A more long-term approach and collaboration between funding providers should be striven for when funding the different stages of a researcher's career (young, junior and senior researcher). It is important to offer internationally competitive grants to be able to retain and recruit the best researchers, but it is also important to achieve a good balance between broad and cutting-edge research among the best researchers.

- The scientific council recommends that long-term investigator-initiated project grants for both basic and clinical research in Sweden should be the predominant form of funding offered by the Swedish Research Council.

Special initiatives

Environments with large groups of researchers have been in focus for several years and have been awarded very large amounts of money while other well-qualified groups have been given a minimum of support – a difference that cannot be justified by differences in scientific quality. It has also become clear that large grants awarded to constellations of this kind have a number of undesirable effects. First, strategic research environments and centres lead to a cementation of research funding, making it very difficult to change the research landscape on the basis of new hypotheses, findings and breakthroughs. Second, they create a lower threshold for receiving support at the expense of more qualified researchers in medicine and health generally. Third, it is difficult to meet the demands for equality in funding between the genders.

The negative development, with a declining number of research projects initiated by Swedish researchers that achieve international recognition, is to some degree due to the fact that the increased funding that has been allocated to medical research in recent years has largely been earmarked for different kinds of non-permanent, targeted special initiatives rather than being used to increase the project grants open to individual researchers in free competition. There are also problems in this regard concerning short-term special funding that – to be able to reach the entire target group of researchers – is distributed through separate calls where the application pressure is high and the success rate very low.

In recent years, the Swedish Research Council has also prioritised very expensive international recruitment initiatives. A small number of researchers have thereby received a disproportionately large amount of support at the same time as many prominent researchers receive no support at all from the state's main funding provider despite their being regarded as national leaders in their fields of research and the assessments that have been made where their research is considered to be of very high quality. All in all, this kind of funding has led to a drastic reduction in the number of researcher-initiated basic research projects that have been granted funding. It is also problematic that the international recruitments have not been sufficiently anchored in the existing strong research teams. Our experience is that free project grants, which are subject to competition and reach several

strong researchers, constitute a better form of research funding and should therefore make up a very large portion of the funding. This view has broad support throughout the research community.

- The scientific council considers that investigator-initiated research must be prioritised instead of initiatives focused on research environments. The Swedish Research Council's main task shall be to support creative, competitive researchers while the responsibility for creating strong researchers should lie with the higher education institutions (HEIs).
- Grants targeting specific subject areas may be justified on the basis of societal needs but should not be made at the expense of free project grants.

Efficient collaboration between research funding providers

By dividing responsibility for research in medicine and health between various state providers of research funding, there is a great risk of losing clarity and long-term approach. Funding is also fragmented by the introduction of short-term forms of funding. The subject area Medicine and Health requires clearer coordination to be able to encompass broad and translational approaches such as both “bench-to bedside” and “bench-to society” in order to ensure that the whole value chain, from basic research to application, is explored. The Scientific Council for Medicine and Health occupies a unique position in this respect through its relationship to the health and medical care services involving several different principals – the state, county councils and other funding providers – which leads to further complexity in getting a coordinated grip on research.

- The scientific council recommends that a single funding provider is given cohesive, long-term responsibility to administer the state resources for research in medicine and health in Sweden that are subject to open competition.

Researchers of the future: support and professional development

Regrowth of competitive researchers

A clear, attractive career path structure, from doctoral student to established research team leader, is required in order to improve the regrowth when it comes to young researchers. The professional development after a PhD should be designed on the basis of a system where each step is subject to competition and the main focus is put on scientific qualifications. Consultations between universities and funding providers should give opportunities to better dimension the number of positions at different levels. The establishment of a clear career path structure is expected to contribute to better possibilities to conduct successful research and to stake out a good professional career. Today's temporary post-doc positions are too short for the proficiencies required to lead a research team to become apparent, for example the ability to supervise a post-graduate student all the way to a PhD degree. The time limitation, governing the time period during which a candidate may apply for such a position after his/her PhD, is not ideal and entails a risk that the researcher will focus his or her tenure track work on safe projects and not on projects that entail innovation and thereby risk-taking. At the same time it is important to point out that the responsibility for the individual career lies with the researcher him- or herself. Several research funding providers have chosen to invest very large amounts in a few prominent junior researchers and often the same researchers. This has undermined the possibility to support the relatively large group of junior researchers who are not yet established but who initiate new research with a view to build up a strong platform for independent and prominent research.

- The scientific council proposes that a system be created with a clear, attractive career path structure with dedicated resources, where each step is exposed to competition, for junior researchers from doctoral student to established research team leader. This will enhance the possibilities to recruit the best Swedish and international researchers for a life-long career in Sweden.

- The scientific council therefore proposes that a 6-year tenure track position equivalent to assistant professor be reinstated.
- The scientific council recommends that the focus on prominent junior researchers be reassessed and the resources instead reallocated to a larger number of junior researchers in order to enable a broader focus on this group of research leaders that is so very important to Sweden.
- The scientific council considers that a fairly long postdoc period after the PhD, in accordance with international practice (3-4 years), followed by a fairly long tenure track position would create better and clearer conditions for young researchers. The same tenure track requirements shall apply to both foreign postdocs, who conduct their research in Sweden, and Swedish postdocs going abroad.

Forms of employment – distribution of responsibility between external research funding providers and HEIs

The financial responsibility for postdoc researcher positions is not fully clear. This has led to a strong desire on the part of the HEIs to be able to finance positions with project grants, thereby undermining their value as project support. Funds from state providers should cover project costs, while the responsibility for funds to employ researchers should be the responsibility of the HEIs and the faculties. Much of the research in medicine and health is conducted today by PhD students, unlike in many other countries where postdocs have a more prominent role. At the same time, there are requirements associated with post-graduate studies relating to the learning outcomes, design and time frame. This sometimes results in a major focus on safe, short-term projects with no innovation or risk-taking. At its best, this will enable a person who completes his/her post-graduate education to both conduct research projects from idea to publication and gain experience of innovative projects of relevance to his/her continued professional career in for example the health care sector, the industry or the academic world.

- The scientific council considers that Swedish universities should contribute to the creation of a uniform system of positions to promote the recruitment of internationally competent researchers, regardless of where they are in their careers as researchers.
- The universities must shoulder the responsibility for funding different forms of employment for researchers actively engaged in research in medicine and health. The state should create better conditions by increasing basic grants earmarked for the establishment of medical research positions.
- Clearer directives must be laid down for post-graduate studies as regards the post-graduate student's personal responsibility, combined with an assignment where the supervisor and the post-graduate student have a joint responsibility to raise the scientific level.

Internationalisation

International and national mobility

Sweden today has few researchers at a really high level. Many fields of research are also facing a generation shift. There is too little mobility among researchers between Swedish HEIs. Incentives that stimulate and facilitate mobility between higher education establishments at all stages of a researcher's career are expected to have a positive effect on top research. This would promote the exchange of ideas, new methods and research projects between Swedish and international teams of researchers. In this context, there is a need for increased collaboration between Swedish universities, R&D in the health care sector and funding providers in order to facilitate researcher mobility and access to advanced equipment and infrastructure. Increased international mobility is desirable for young, junior and senior researchers. This includes both young researchers after their PhD degree and longer and shorter periods of external research for more established researchers – so-called sabbaticals, a longer stay at another university – are one example of exchange activities that were more common before but where the possibilities to obtain local or national support have been greatly reduced.

- The scientific council considers that the possibility should be reintroduced for Swedish researchers to be based at a foreign university for a shorter or longer period (3-12 months) and for researchers in other countries to come to Sweden.
- The scientific council proposes that the Swedish Research Council investigate forms of funding that would enable more researcher exchanges between Swedish and international universities and research institutes.

International recruitment

An extensive recruitment of foreign researchers to Sweden is currently taking place within the framework of the Swedish Research Council's activities. The recruitment has been commissioned by the Swedish government. International recruitment offers a possibility to strengthen Swedish research and is highly important for both junior researchers and established research team leaders. International recruitments are very expensive and resource-intensive. They must therefore be strongly anchored in existing structures and involve a very clear commitment on the part of the recruited person to conduct his/her research in Sweden. At the same time, this may not replace other important measures aimed at improving the level of Swedish research.

- The scientific council considers that the current international recruitment programmes must be reassessed. The Swedish Research Council should instead increase the allocation of researcher-initiated project grants.

Research infrastructure

National and local facilities for equipment and technology

Several large infrastructure efforts have been made on the national level when it comes to the centralisation of advanced equipment and high competence. It is now important to ensure that researchers throughout the country take advantage of these opportunities. Access to advanced, expensive research equipment and other infrastructure constitutes an important success factor. It cannot only be ensured via national centres, but must also be accompanied by local investment possibilities. It is also important to emphasise that there is a swift technological development taking place in many fields of research. The technology that is purchased today is not always the same technology that will be used tomorrow. There is a danger that the high research infrastructure costs will steer resources away from being distributed to individual researchers' projects. In parallel with the building up of national facilities, the local build-up of advanced resources and competence has tailed off drastically. Such resources also include animal experiment activities, where the technological advances open up new possibilities that to an increasing degree require specialised facilities but also greater availability of researchers. This need can be assumed to expand substantially. This is an unfortunate situation and the balance between the distribution of resources to national and local infrastructure needs to be modified to the benefit of local infrastructure. A shortage of modern equipment at the local level reduces the possibilities to conduct front-line studies. There is little possibility today to purchase advanced equipment since all funding providers have chosen to support national infrastructure. To counteract this and in order to reintroduce support at the local level, consultation is needed between different funding providers.

- The scientific council recommends that funds for infrastructure be redistributed from national resources to a call for local resources within the Swedish Research Council. This form of support should be so designed that the equipment can be utilised by many users and can be successively renewed. In return for the grant, the recipient organisation should take financial responsibility for the activities by ensuring that technically competent staff is engaged.
- The scientific council considers that, in the long run, it is an attractive model to transfer responsibility for infrastructures to the universities by means of higher basic funding grants that are earmarked in order to secure the renewal of technically advanced equipment for medical research that is suitable to be handled at the local level.

Bioinformatics

To be able to process the large amounts of data generated in today's research correctly one often needs an education in bioinformatics. In these large databanks, the technological development has made it possible to identify human carriers of genetic mutations that impair the function of a gene as well as a protein offering protection against disease. The people who can integrate and analyse large amounts of molecular-genetic data and biomedical data, namely the bioinformaticians, form a key group in this research. In recent years, national resource centres have been set up, which strive to provide national service to create the large amount of genetic information needed to attain these goals and to provide bioinformatics support when it comes to the interpretation of results and analyses. This is probably not a successful concept, since bioinformatics will be central to all research projects in the future and since the bioinformatician is a key person in the planning and analysis of the research. If this part is limited to a national resource centre, all biomedical research in Sweden will in practice be centralised, which is a threat to the research conducted at the different HEIs.

- The scientific council recommends that national postgraduate schools be set up, with bioinformatics as the main theme, in order to ensure that Sweden maintains a high level of expertise and contributes to the development in this field.
- The scientific council proposes that academic positions be established for this professional category and that possibilities are provided to create sufficiently large groups that can develop and renew the field.
- The scientific council considers that a focus on bioinformatics should be integrated in cross-disciplinary education programmes for clinical researchers and researchers from medical and technical faculties.

Collaboration between research funding providers, the hospital and health care sector and the industry

Clinical research

The future will put great demands on Swedish research to achieve a more effective use of the state's research resources. An important element in this work is to increase the quality and scientific production of clinical research and basic patient-centered research. There are relatively few innovative clinical publications where the studies originate from and are led by Swedish researchers. There is also a growing tendency to participate in international collaborations rather than drive them. At the same time, Sweden is well placed to take a leading role in a greater number of studies. Several important measures are needed to secure and develop the clinical research in Sweden.

- The scientific council recommends that the research resources allocated to university hospitals and county councils, including ALF funds, should be subject to more local competition and also to qualitative evaluations.

Research time and merit ratings for clinicians after dissertation and increased academisation of the health care sector

Research is not attractive to many clinicians because of its low merit rating and the difficulty of combining research with clinical duties. To strengthen the regrowth of researchers, active in clinical research, closer collaboration is needed with health care providers. Post-graduate studies and research should be given more space and form a distinct part of the clinical activities at the university hospitals, and be given a clearly defined merit rating in a clinical career. Better conditions must be created to be able to give clinicians the time and opportunity to conduct successful research. The value of the research to good health care should be reflected in an increased academisation of the university clinics, with clearly defined research assignments and more academic leadership. New PhD holders and other clinical professionals need forms of positions that are well-established both in academia and at the clinics, and that allow the research activities to be combined with part-time clinical duties. Suggested forms of position are for example a medical residence or specialist employment

combined with a tenure track work, or an assistant lectureship for postdocs. A dialogue is also needed with professional associations about how to adapt the specialist education to the post-graduate education to allow both to be accomplished within a reasonable time.

In addition to specific positions with a high research portion, the possibilities to co-opt clinicians into the academia should be reviewed. To achieve continuity in the research, the co-optation, at for example the senior lecturer level, should begin within a reasonable period after the PhD was awarded. The problem that arises today is that the co-optation period for senior lecturers is severely limited and the exercise cannot continue in cases where the clinician has not attained the level of professor. Better possibilities for co-optation are also needed to enable educational activities to be developed at for example university clinics. A similar development should be pursued to allow the co-optation of postdocs into the industry.

Stays at prominent foreign research institutes and hospitals are few, but such stays are of great value and should be encouraged and supported for clinicians after dissertation.

- The scientific council proposes that academic positions be established at tenure track level for clinicians after dissertation doing medical residences or employed as specialists.
- The scientific council recommends that the possibilities and the forms for co-opting postdocs from the health care sector and industry to the academia be devised to allow a formalised academic association during their entire professional careers.
- The scientific council considers that a stay at another research institute or higher education establishment, inside Sweden or abroad, should be given higher priority when filling clinical positions and be included in a future effort to increase the researcher exchanges between Swedish and foreign universities and research institutes.

Post-graduate education for physicians and active clinicians

The research time for active clinicians is an important factor in strengthening medical research in Sweden. To use our Swedish patient material in the best way, we need researching physicians and other professional clinical groups, who can ask the important questions and who then have the time and resources to be able to map, collect and analyse the patient material. Post-graduate studies early in a person's career should be encouraged and may preferably be started during or immediately following the undergraduate studies. Early post-graduate studies increase the chances of continued studies after the PhD degree. Studies begun later on the contrary entail a risk of being prolonged due to high parallel production demands in the person's clinical activities. In one of the former and often utilised career paths, which had distinct advantages, the medical student first obtained the PhD at a pre-clinical unit and then pursued a career as a successful clinically active researcher. This has become increasingly less common in recent years, among other things as a result of the pre-clinical units' decreased resources and the declining importance of the pre-clinical subjects in the medical training programmes, which is unfortunate.

- The scientific council proposes that 6-year positions (3+3 years) with 50% research and 50% clinical activities be established at both post-graduate and postdoctoral level.

Geographical distribution

Increasing numbers of patients are being treated in primary care and research requires coordination with specialist clinics. For many diagnosis groups, centralisation to a limited number of hospitals is desirable since this can give improved treatment outcomes. There is also a desire to concentrate research geographically to a small number of strong centres, which however do not always correspond to the geographical distribution of patient flows. In particular in the case of point-of-care research, a strong connection between active research constellations and clinics engaged in research is desirable, which should be taken into account. Such a connection strengthens the research and makes it easier to implement new knowledge in health care. It also

enhances the possibility for biobanking and post-graduate studies to include patient series that represent several or most catchment areas.

Systematic biobanking and registers

Good opportunities exist to increase the quality of Swedish research based on better registers and biobanking and on access to them. In this respect, greater collaboration is needed between health care principals and research funding providers. It is also important that funders of health care prioritise research and sample taking and that these lines of thought permeate health care at all levels. Biobanking should be done in a standardised fashion. To best utilise biobanking, links should be created between already existing biobanks and quality registers. Possibilities for conducting successful studies based on biobank material and registers depend on both the amount of material and its structure and characterisation. Sweden is a small country and for many diagnosis groups national collaboration is needed for conclusions to be drawn based on patient series of sufficient size. Collaboration to be able to include samples from several local biobanks in joint studies needs to increase. A nationwide infrastructure to collect patient samples in biobanks would enable the patient materials to be sufficiently extensive. It is also of great value if patient samples from private health care can also be collected in biobanks of equivalent kinds. This should be done in close collaboration with public health care, which already has an established infrastructure at all university hospitals. It is important that Swedish patients can be included in studies, for example of new alternative treatments. This will include more patients with specific molecular/genetic characteristics against which the treatment has been devised.

- The scientific council proposes that a national coordinator be appointed to ensure efficient utilisation of biobanks and quality registers with extended responsibility for patient safety.

Clinical trials

The past 10 years have seen a significant decline in the number of reported clinical pharmaceutical trials in Sweden. There are several reasons for this. The industry today develops drugs within narrow therapy areas that are intended for fewer patient groups, which gives other prerequisites – fewer studies, fewer study centres and a smaller number of patients who need to be included. There is also a clear trend towards increasingly fewer studies in Sweden and the rest of Western Europe. At the same time, it should be emphasised that Swedish researcher-initiated clinical research should not be confused with Swedish participation in pharmaceutical drug trials controlled by the pharmaceuticals industry. These are various kinds of activities of varying value for Sweden as a research country. Many important clinical trials concern treatment involving surgery, rehabilitation, care or medical technology. Other important trials concern pharmaceuticals, but where there is no commercial interest in the funding of for example studies of approved drugs with a weak evidence basis, where the current use can be questioned, or in comparative studies of competing drugs. These trials are as a rule researcher-initiated and are highly dependent on the support of local/regional clinical trial centres and funding from the Swedish Research Council, or an equivalent funding provider, to be conducted.

- The scientific council considers that better structures and prerequisites must be created in the health care sector in order to meet such needs, and that the merit rating for those researchers/physicians who take part in these studies must be clarified.

Research and collaboration with the pharmaceuticals industry

In recent years, the pharmaceuticals industry has gradually reduced the amount of research done in its own laboratories and to a greater extent sought collaboration with established groups of researchers in the academia and in small research companies. The collaboration with the academia takes place in global competition, making it increasingly more important for Swedish research teams to secure world-leading expertise and find ways to improve their visibility in the international research arena. This means that academic research will become increasingly interesting to global investors. At the same time, there is a greater need for funding for

studies, in the academia/healthcare sector, aimed at small patient groups and where there is little interest on the part of the industry. It is however fundamental to allow new pharmaceutical companies to develop with the aid of new innovations that emerge not only from clinically applied research but first and foremost also in basic research.

Sweden has substantial opportunities to be an attractive country for global industrial research collaboration. Health care registers based on personal ID numbers, biobanks and quality registers that can be interlinked for matching purposes are often mentioned as competitive advantages. Internationally, Swedish participation is considered to be reliable and of high quality, which should be safeguarded. The challenge in recent years has been the health care sector's limited possibilities to make time for clinical research activities. What is more, trial conductors' connections to new drugs have created a debate around bias. Thereby they have often been disqualified from participation in decisions on continued use of new products, which has reduced their involvement in these research projects. Greater transparency, security in future intellectual property rights, clearer pronouncements from the principal concerning the importance of collaboration and more scope in the everyday activities for participation would make Sweden even more attractive and create prerequisites to regain the unique position we once had in the research world.

TOMORROW'S CHALLENGES

New knowledge and breakthroughs through basic research

In the Medicine and Health area, the Swedish Research Council provides funding for both clinical applied research and basic research. Research has never had such great possibilities as today; the significant advances in technological development and research methodology in recent years have created opportunities to map the human genetic and protein composition at a level that we could not have dreamed of earlier. This knowledge is a prerequisite for understanding disease development and exploiting that knowledge to develop new, more effective drugs. Basic research and clinical research are parts of the same research process. Basic research describes how cells function and disease is as a rule a result of cells not functioning optimally. Recent years have seen a growth in the belief that clinical research support can give results faster, in the form of new treatments, but this is not the case. Breakthroughs in research can rarely be commissioned or steered but occur spontaneously, both in basic research and in clinical research.

There are several examples of the great clinical impact of basic medical research. Pacemakers are one example of a medical engineering innovation that was developed in Swedish research projects and resulted in the first implantable device to ensure a normal heartbeat. Another example is the mapping of the human chromosomes, where a special dyeing technique developed in Sweden has laid the foundation for several breakthroughs in diagnosing chromosomal mutations in cancer patients and the development of more effective drugs, for example Glivec for the treatment of patients with chronic myeloid leukemia.

Yet another example is the discovery of the bacteria *Helicobacter pylori* by Australian researchers in the 1980s and that this bacteria causes gastric ulcers. The discovery, which was rewarded with the Nobel Prize in 2005, has enabled effective medical treatment with antibiotics and drugs that reduce the stomach's production of hydrochloric acid, and has thereby led to previous costly surgical treatment largely having ceased. There are many other examples of how basic research has dramatically changed people's lives (antibiotics, DNA diagnostics, MRI, vaccinations). It is important to emphasise that these discoveries have not developed through a particular focus on resolving a medical problem, for example a disease, but through support for free research created by an individual researcher's inquisitiveness and ability to constantly define and test new hypotheses. Breakthrough research cannot be commissioned – it is impossible for us to know in which field of medicine the next major breakthrough will occur. There is no reason to believe that a focus on the major national diseases has a greater impact than research on diseases, where we have limited knowledge and are unable to provide adequate treatment today. *It is the opinion of the scientific council that good research must be supported, not steered. The way to more breakthroughs in Swedish medical research is therefore to support the best and most innovative researchers through increased project grants.*

Individualised medicine

One of the biggest problems in modern health care is that many patients with common diseases do not respond to medication. This causes great suffering and entails enormous costs for medicines and drug development. One important reason is the complexity of common diseases, caused by changes in the interaction between thousands of genes. This is very difficult to understand solely through detailed studies of individual genes. There is a great need to develop the research of the future to improve the patient's situation, not only through more effective remedies and alleviation of the disease but also by adapting forms of care to the needs and wishes of the individual.

One of the biggest opportunities and challenges is the infinite amount of information, about disease development and treatment, which can be obtained by integrating large amounts of data, linking information about a person's genetic composition, gene expression in different tissues, and protein profile to information about disease and treatment. Sweden has been a forerunner in this field by reason of its extensive, unique disease registers and biobanks. Many countries, not least the US, have seen the possibility to do this by linking information from patient records and clinical tests to a biobank that is created by asking patients if they consent

to their samples being used for research. It is crucial to the future of biomedical research in Sweden that measures be taken to enable a simplified and ethically acceptable collection of biomaterials (for example a blood sample on every visit to the doctor or tissue samples from surgical operations) and link them to information from patient records and registers, not least the Prescribed Drugs Register. Characterisation of genetic compositions and protein profiles of healthy people and people with various diseases can act as a catalyst for Swedish biomedical research, and take advantage of the lead that Sweden has had in this field through its unique biobanks and registers. The most important outcome of such research is that it can provide individual information about disease development and treatment. In addition to better care, this will also lead to socio-economic advantages with shorter periods of sick leave and better possibilities to choose medication according to need. Individualised care can also be seen as a linchpin in an equal society where age, gender and ethnic background mean that individuals have different needs and wishes depending both on their condition and on their personal experiences.

Preventing disease and ensuring good health for patients with chronic diseases

One of the research objectives in medicine and health is to explain and prevent the occurrence of diseases. Prevention, early diagnosis and a good life with a chronic disease are important areas and challenges for the future. One field of research that has not received attention equal to its importance, as regards the future health of the population, is prevention and early diagnosis. Evidence-based preventive measures and more early diagnostics are a few of the major challenges for the future.

Every fourth health care patient suffers from at least two chronic diseases. More and more people are living longer and with a good quality of life. This development requires great expertise in several areas, for example primary care, specialist care and municipal health and medical services. These will become important places for research and arenas where different fields of research meet. An increasing number of patients will need life-long treatment. The knowledge of disease sub-groups and pharmaceutical effects therefore needs to increase to optimise the effect of the treatment and minimise the side-effects. In addition to drugs and other medical interventions, more knowledge will be needed about new forms of interventions, which strengthen the individual's physical and mental functioning, and their own responsibility for their health and quality of life. The needs are composite, the treatments less invasive, the decisions complex and the technological development specialised. New technology will also demand better prerequisites for more treatments to be given in the home environment.

The model systems of the future

With the help of extensive screening techniques, a great many molecular deviations are today detected in patients with different diseases. Today's analysis systems are however often inconclusive as to whether a mutation can contribute to disease or not. Today and in the future, conclusions regarding biological mechanisms will require *in vivo* studies. Insofar as these cannot be conducted on human beings, animal experiment systems are a necessary prerequisite. The availability of well-functioning such systems will be crucial to the future development, where we will be expected to develop drugs based on known causal relationships. New technological advances now provide new opportunities to be able to genetically tailor animal models, which will in turn give better possibilities to translate mechanisms from genes discovered in humans to laboratory animals. In parallel with this, today's *in vitro* systems also need to be improved to make them a more flexible tool to be able to extend discoveries made *in vivo* in humans and laboratory animals.

It has become increasingly difficult in recent years to carry out experimental research on animals, first and foremost due to an increasingly complex regulatory framework, often in combination with diffuse application and the escalating cost of animal experiments. In order to nonetheless be able to conduct the necessary research, and to be able to take advantage of the opportunities, considerably more investment and strengthened funding of experimental animal research are needed, alongside a new regulatory framework. At the same time,

it should be organised into units that can maintain a high genetic, environmental and technological standard. These units must be flexible, researcher-centred, and be adapted to the research that is actually to be conducted in order to facilitate effective and reality-based research.

The Swedish Research Council is a governmental agency under the Ministry of Education and Research. Within the Research Council there are separate decision-making bodies. In 2014 these scientific councils, advisory bodies and committees compiled overviews of trends and challenges in six different research domains and an overview of research infrastructures in particular. The initiatives taken within the scope of “The future of Swedish research” are part of the Swedish Research Council’s measures to support and strengthen researcher-initiated fundamental research, point out strategically important areas and promote an effective research system. These initiatives are taken on a recurring basis in the run-up to the Government’s Research Bills. The full versions of the overviews were published (in Swedish) in 2015. The final report from the project is called: Direction to the Future Swedish Research System: Goals and Recommendations.



Västra Järnvägsgatan 3 | Box 1035 | SE-101 38 Stockholm | Sweden | Tel +46-8-546 44 000 | vetenskapsradet@vr.se | www.vr.se

The Swedish Research Council has a leading role in developing Swedish research of the highest scientific quality, thereby contributing to the development of society. Besides research funding, the agency advises the government on research-related issues and participates actively in the discussions to create understanding of the long-term benefits of research.