European Society of Biomechanics
Newsletter
MAY 1997

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Biofluid Mechanics in Europe

Dieter Liepsch, Munich, Germany

Council Member

Biofluid mechanics is a relatively new field, dating from the late sixties, and deals with the fluid mechanics of all fluids in humans and animals, and sometimes also plants. These 'fluids' include air, blood, lymph and water. When I wrote my doctoral thesis in 1967 on the subject of blood flow in arteries "biofluid mechanics" was not yet a subject of study. The term was first introduced in 1973 by Professor E. Truckenbrodt of the Technical University of Munich. A course of study in biofluid mechanics and a regular program of scientific research was begun at the University in 1975. I have never stopped being fascinated with this field.

This field has a direct bearing on clinical issues including heart surgery, heart valve replacement, and the reaction of pharmaceuticals in the body

Biofluid mechanics is a complex field, including one of the most important and complex areas of study - blood flow and cardiovascular diseases. This area, far from being simply an esoteric field of study for engineers and mathematicians, has an enormous bearing on the practical (here, clinical) approach to Biomechanics - bypass surgery, anastomoses techniques, artificial heart valves, grafts, stents, venous and dialysis shunts; what are the optimal procedures, the best tools, the most effective and cost effective therapies, and how do we measure any of these parameters? These questions must be answered by turning to biofluid mechanics.

The hemodynamic environment must be defined and who better to do this than the specialist in biomechanics/biofluid mechanics

Biofluid mechanics is a discipline which uses or touches on many other disciplines including biology, medicine, biochemistry, biorheology, hemorheology, mathematics, bioengineering and physics. Long left to underfunded laboratories and the odd doctoral dissertation, this field has a direct bearing on clinical issues (see L. Ryd's Presidential Address in the last issue) including heart surgery and heart valve replacement, the reaction of pharmaceuticals in the body, surgical bypass techniques, ultrasound studies, and the role of hemodynamic reactions on the endothelial cells - a major element in the development of heart disease - the leading killer in the modern world. It is becoming increasingly obvious that physicians must understand, for example, the flow behavior of blood and its interactions with the cardiovascular system. The hemodynamic environment of the circulatory system, cell-cell, cell-wall interactions, endothelial responses to shear stress and other parameters must also be defined and who better to do this than the specialist in biomechanics/biofluid mechanics.

For last two decades the number of scientists worldwide who have found rich areas of research has grown. However it remains relatively small, unrecognized and desperately underfunded when compared to more commercial or more 'popular' fields. In the United

States and in Japan where forward-thinking planners recognize the market potential for products and services based on or derived from biofluid mechanics, entire institutions have been established and cooperation between multidisciplinary investigative teams is common. In Europe, the field is growing more slowly. There are groups or individuals working in this field in nearly every European country. Highly respected groups are working in Austria, Belgium, France, Germany, Great Britain, Italy, the Netherlands, and Switzerland.

A goal of our membership should be to develop a strong European group working in the field of biofluid mechanics

In answer to Dr. Ryd's call for the society to attract more clinicians, I say that biofluid mechanics is an obvious choice, neatly tying together the fields of engineering and medicine, bringing the basic research of the laboratory directly into the patient care field. A goal of our membership should be to develop a strong European group of scientists working in the field of biofluid mechanics under the umbrella of the European Society of Biomechanics. It would be heartening if grant reviewers would pay more attention to this field, especially in the European Union. There is a need for courses in this field and also for regular programs for research, student exchange and funding. I am looking forward to seeing this field take off and for the European Society of Biomechanics to be at the forefront.

ESB Research Award

Submissions are now open for this award, which will be made by an Award Committee under the chairmanship of Prof. Y. Missirlis. Researchers, whether members of the society or not, may compete by submitting three copies of full papers, before November 1st 1997, to

Prof. Yannis Missirlis
Deptartment of Mechanical Engineering,
University of Patras, 26500 Patras, Greece.

The winning paper will be accepted for publication in the Journal of Biomechanics. Papers in review may also be submitted for the ESB Research Award. The winner will recieve a prize of ECU 1,000 donated by Elsevier publishers, and will have the opportunity to address the society in plenary session at ESB 98 in Toulouse, France. Registration fees for the conference will be waived. Papers co-authored by members of the council or award committee are ineligible.

Teaching Biomechanics at a Distance - 10 Years On

This is the third contribution in a series on the teaching of biomechanics. In this issue, Sandy Nicol of the Bioengineering Unit, University of Strathclyde, Glasgow describes the development of a postgraduate qualification in Biomechanics by distance learning. Advice and further details can be obtained from Sandy Nicol. Tel: ++ 44 (0) 141 548 3028 Fax: ++ 44 (0) 141 552 6098 E-mail: a.c.nicol@strath.ac.uk

In the mid 1980s the Bioengineering Unit at the University of Strathclyde was approached by numerous orthopaedic surgeons and physiotherapists who wished to gain a better understanding of biomechanics. Unfortunately, they were unable to dedicate sufficient time to perform a part-time research project towards M.Phil. or Ph.D. and they were also unable to obtain leave of absence from their professional careers to study for one year to obtain an M.Sc. in Bioengineering. Faced with this frustration, the University was sympathetic to their call for an alternative learning medium in biomechanics. In April 1987 the Bioengineering Unit launched a new course entitled "Postgraduate Diploma in Biomechanics by Distance Learning". Initially, it was presumed that between 15 to 20

applicants would be obtained from across the United Kingdom. This was greatly surpassed when 80 applications were received and two courses of 20 candidates were run in the first year.

The format of the course involves 8 lecture "booklets" which are sent out to the candidates at intervals of 3 weeks. These booklets cover the spectrum of methods required to understand the mechanical principles applied to the mechanics of the musculoskeletal system. To this end, the booklets start with the definition of force, moment, velocity etc, but approach these new subjects in a way which differs to the normal mechanics text books. It was considered that pulley blocks, frictional sloping surfaces and other classical methods were inappropriate when most of the candidates would like to see examples of mechanics applied to the human body. It was therefore decided to use only anatomically based conditions for the introduction of inertia, lever arms, angular motion etc. This stage is then built upon to look at the generation of forces as a result of human motion and the incorporation of Newton's laws of motion.

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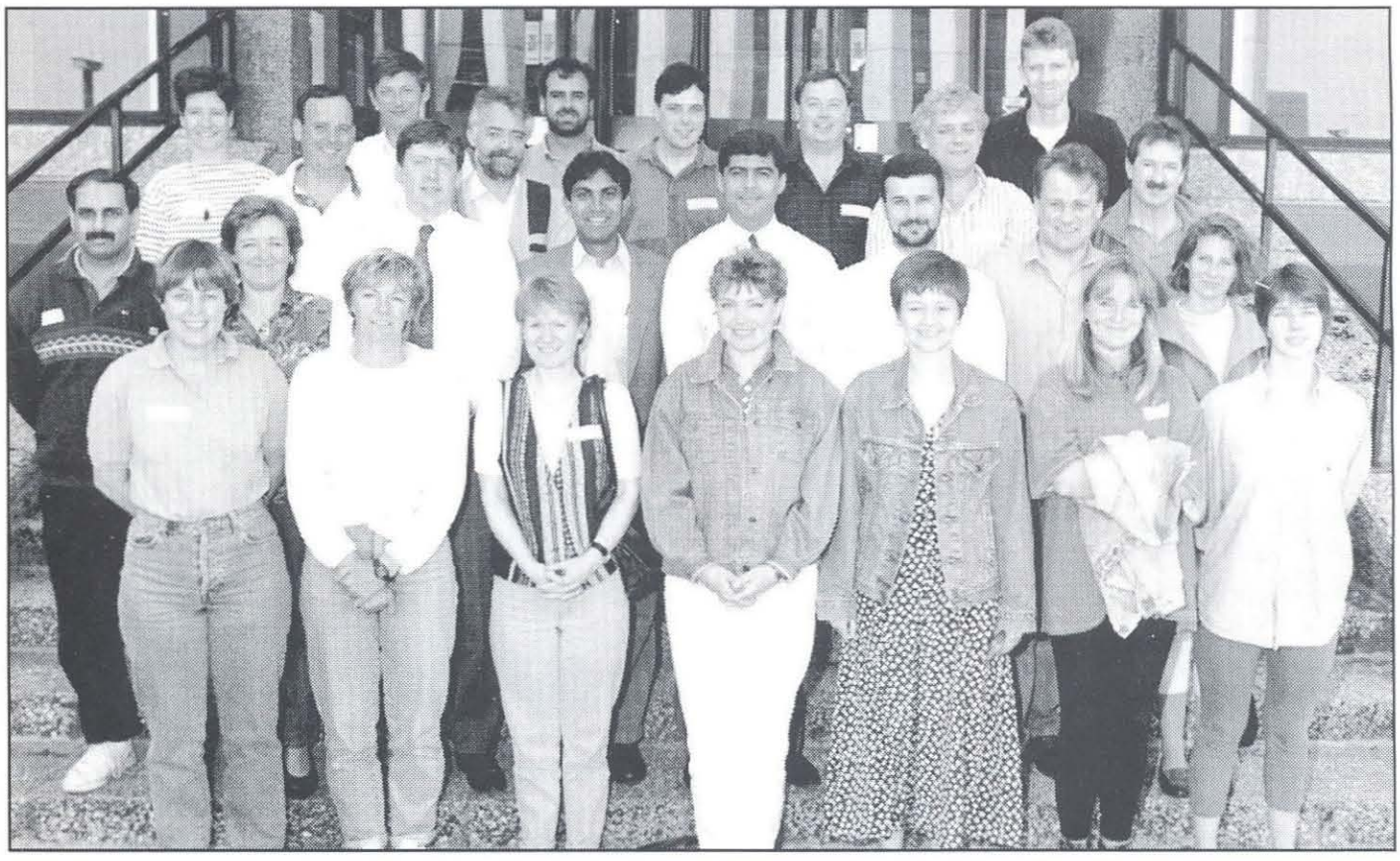
Newton's laws and equilibrium are fundamental concepts which are more easily established by the proper use of free body diagrams. These techniques are very different to the thinking processes of clinical decision making but numerous tutorial examples firmly establish the concept of a free body diagram as a "tool" of immense value. Thereafter, activities such as gait, jumping and upper limb activities can all be treated with a "toolbox" of principles. Halfway through the lecture booklets the candidates attend a one week session at the Bioengineering Unit in Glasgow where the booklet information is reinforced with lectures and the extremely important tutorial sessions. The tutorials are given by Ph.D. students and research assistants. The use of younger personnel is considered to be essential since they are closer to the learning stage than the more "mature" lecturers! It also gives access to fresh minds, who have not written the booklets and performed the lectures, so that the various concepts can be approached from slightly different directions until understanding is established. In order to expand the concepts of biomechanics, various demonstra-



The Class of 1994/95 – 25 people from several countries

tions are incorporated into the first week, which show the application of fundamental techniques to a wider range of projects. This is a deliberate step in order to show candidates that almost any human activity can be analysed biomechanically. At the end of the week, candidates sit a written open-book examination and they also take away personal force plate data so that they can analyse their own style of shod and barefoot gait.

The second part of the course involves the remaining four booklets followed by a second week at the Bioengineering Unit to cover such items as 3-dimensional moment vectors applied to limbs, rotation of bone axis systems, muscle forces to provide equilibrium and the study of ligament and joint contact forces for the activities concerned. This then leads to considerations of stress, bone remodelling, joint prosthesis design and other concepts. An introduction to tissue mechanics is provided by demonstrations of mechanical testing of skin and bone samples to highlight stress relaxation, viscoelasticity and moisture content parameters. Assessment of the instructional part of the course is completed by a second examination and submission of the force plate report.

This type of approach bridges the knowledge gap between life science and physical science graduates and allows each individual to take new skills and apply them to an area of interest within their own profession

With a limited amount of time in the instructional part of the course it is recognised that it is not possible to cover the whole spectrum of interest within the field of biomechanics. As such, the final stage of the biomechanics course gives the candidates the opportunity to develop research and investigative skills in an area of their particular interest. The research project is by far the most demanding element of the course, since the candidates are required to plan their own project, organise their methods and materials and to write up a dissertation about their findings. For full-time clinical personnel, it is difficult to break their normal routine and they are allowed up to 30 months for the completion of the dissertation.

There are two questions which should be discussed here. How has the course developed and how much have candidates gained from doing the course? To answer the first question, the course has been running for 10 years and in that time 280 students have enrolled with a further 55 students enroling in the Far East (Hong Kong and Singapore). The basic format has not changed, but some individual items have been updated as the world knowledge of biomechanics has been updated. A typical intake at Strathclyde University would be 25 students (see photograph) with a make-up of 40% orthopaedic surgeons, 40% physiotherapists and the remainder being chiropractics, anatomy personnel, sports personnel and engineering graduates. The success rate from the examinations at the end of each week is high with resits taken by some 10% of candidates. Most candidates succeed finally in these exams. On the research project, the projects range from very complex analytical methods, where candidates have the use of existing biomechanics facilities, down to simple and ingenious methods for measuring fundamental parameters. Although these projects are usually not worthy of formal journal publication, the feedback from candidates is one of a feeling of great forward progression. It has been stated several times that the sense of achievement at handing in the final dissertation is beyond belief!

On a more serious note, the benefit to people undertaking the course has been wide-ranging. Typical comments include "being able to sort out the rubbish within the literature", to having much more confidence in their clinical duties (therapy, surgery etc). Several graduates have continued with research and have successfully organised grants and awards to establish their career within biomechanics.

It is not the intension of this short article to highlight the benefits of one institution compared to other excellent centres around the world, but rather to give an insight into the experience gained from a particular approach to the teaching of biomechanics. It is felt that this type of approach bridges the knowledge gap between life science graduates and physical science graduates and allows each individual to take new skills and apply them to an area of interest within their own profession. In this way, they develop these skills to a higher level which allows them to conduct their professional duties confidently and scientifically. Readers who are involved in the teaching of biomechanics or training of biomechanics methods may wish to take on board some of the concepts of this course and the author will be very pleased to liaise with those who wish to do so.

Euro-Research Forum

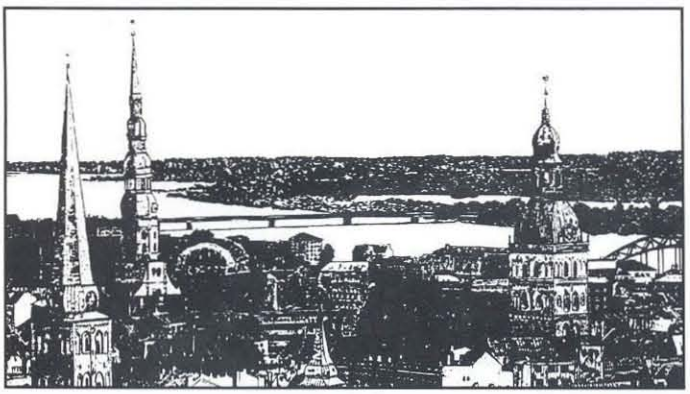
Professor Ivars Knets, Vice-Rector for Research and International Relations at Riga Technical University, Latvia, descibes an EC Tempus Joint European Project (JEP) and the widening of collaborative research opportunities in Europe. E-mail: knets@acad.latnet.lv

On September 1, 1992 the EU TEMPUS Joint European Project "Development of educational systems in bioengineering, biomechanics, and biomaterials for substitution of damaged biological tissue" started. This project was accepted for the period of three study years until August 30, 1995. Two institutions from Latvia were involved in the project: Riga Technical University and Latvian Academy of Medicine; University of Wales Swansea from the UK, and two universities from Italy: University of Padova and University of Bologna. Starting from September 1, 1993 the project was joined by University of Wales Cardiff.

The project aimed at the development of a wide range of different applied methods for study of advanced approaches in biomechanics of soft and hard biological issues

The coordinator of project was Professor Ivars Knets from the Laboratory of Biomechanics and Ergonomics of the Riga Technical University, the contractor was Reader John Middleton from the Department of Civil Engineering/Biomedical Engineering of the University of Wales Swansea.

The main objective of this JEP was to contribute to the professional development of personnel of these above mentioned two higher educational institutions in Latvia engaged in the teaching, research and practice of the areas of bioengineering, biomechanics and biomaterials.



The spires of the Dom Cathedral, and the churches of St. Peter's and St. Jacob's in Riga.

The wooden tower of St. Peter's was the tallest in Europe when it was built.

It was hoped to use this unique opportunity to establish more appropriate teaching programmes for post-graduate and doctoral students, and to develop relevant well-equipped teaching laboratories at both higher educational institutions of Latvia.

The project aimed at the development of a wide range of different applied methods for study of advanced approaches in biomechanics of soft and hard biological tissue, in bioengineering of both, the biological and the monitoring systems, and in the use of new biomaterials for substitution of damaged biological tissue. The subjects have been taught for years in Latvia but mainly in a theoretical manner, without the availability of modern instrumentation and monitoring technology. In recent years, as modern equipment becomes more available through the help of Western countries, it is very important to prepare our engineering and medical staff who should be able to work with this contemporary technology in these very rapidly developing branches of mechanics and medicine.

Different co-operative and training activities were carried out. Very important was a possibility for 23 Latvian academic staff members during these three years to visit corresponding Western partner universities for a month long retaining period. It gave them the possibility to reorganise existing and to develop new study courses and curricula for both, the master and doctoral studies and the post-graduate studies of persons already involved in active professional life. Extremely useful were master and doctoral studies of 14 Latvian graduate students in the corresponding Western partner universities for three month long study period. In both cases it gave the Latvian visitors the opportunity to feel the real

university life of Western countries, to improve their knowledge of English, to study the newest developments in the field concerned and to make a lot of personal contacts.

14 Latvian graduate students visited corresponding Western partner universities for three months long study periods

Important help to the Latvian partners were the lectures and workshops given by 14 academic staff members of Western universities involved in the project. It gave a possibility for a much larger number of Latvian students to attend lectures and even practical surgery demonstrations to learn the newest aspects in biomechanics and biomaterials.

At last, but not least, the important help was the new equipment provided, including modern computers with corresponding software, overhead and slide projectors, Instron testing machine and many other very needed things for restructuring our teaching laboratories to meet the requirements in high student training quality.

As a result of co-operation in the JEP the Laboratory of Biomechanics and Ergonomics of the Riga Technical University was restructured to the Specialised Institute of Biomaterials and Biomechanics of the Riga Technical University.

Meetings of interest to Biomechanicians to be held in Jena, Germany.

INNOVATIONSKOLLEG "BEWEGUNGSSYSTEME"

September 29-30, 1997, "I. Intertnational Conference on Motion Systems"
October 1, 1997, "II. Workshop of the Society of Technical Biology and Bionics"
October 2, 1997, "III. Biomechanics Workshop of the Morphology Studygroup"

For further information contact:
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Seidelstraße 20, D-07749, Jena, Germany.
email: Marion.Gerhardt@uni-jena.de
http://www.uni-jena.de/bewsys/start.html

7th Annual Meeting of the European Orthopaedic Research Society

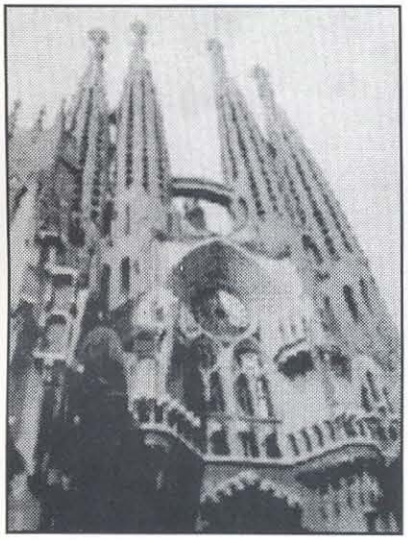
Gustavo Zanoli, M.D. from the University of Ancona, Italy attended the EORS Meeting in Barcelona and agreed to write down some of his impressions for us.

The first sunny weather after a rather rainy spring onset welcomed participants to the 7th Annual meeting of the European Orthopaedic Research Society in Barcelona, Spain on April 22nd and 23rd, 1997. For those of you who were not there to enjoy it these lines should be like an abstract from a paper in a language you can't read. So we will start first of all stating the **Aim** of the congress: Held just before the 3rd EFORT congress, this meeting was probably intended to bring together basic "musculoskeletal" researchers from various fields and orthopaedic surgeons and residents interested in research. **Materials and methods:** the venue was the Barcelona Conference Centre, a part of the huge "Fira", the Exhibition Centre where many other events were taking place at the same time: art, computer, tourism. This put up a nice and noisy atmosphere around the place and also made it extremely difficult to find a spare hotel room somewhere in town. 200 posters and 132 oral presentations, divided into two parallel sessions, covered all fields of orthopaedic research, and biomechanics was strongly present in at least eight of the sixteen sessions! As to the country distribution Germany, U.K., Netherlands and Sweden took the lion's share, accounting for nearly 80% of all oral presentations. ESB president Leif Ryd, chairman of the programme committee, must have had a hard time, since it seems that

200 posters and 132 oral presentations, divided into two parallel sessions, covered all fields of orthopaedic research

many abstracts had to be refused to fit in the scheduled times. For the first time, two symposia, a workshop on tissue culture and an Instructional Course Lecture (ICL) completed the program. **Results:** If you wish to judge yourself the quality of the papers you can order a copy of the transactions' volume from EORS' treasurer Hans Peter Scharf, fax n°: ++49-73-1177574. Otherwise you can trust me when I say that the level of presentations - at least the ones I attended personally - was in general quite high, especially when compared with the following EFORT conference; discussions - when enough time was allowed for them - were usually very lively, probably the most interesting part of the program: as a matter of fact, attendance was high even at the last sessions of the day. Surprisingly enough, the worse part of the meeting was probably the social programme. For those of you who remember the cheese and beier evening at the last ESB meeting in Leuven, or the Rathaus reception in Munich for the last EORS-EFORT combined meeting, you will be glad to know that you didn't miss much this time. **Discussion:** As a senior researcher from overseas told me during the meeting: "when we organised the first ORS meeting many years ago, there was only one session and every participant could understand what other researchers were doing. Now we are so many that we hardly understand what is said in our own session!" In fact most papers were either elegant scientific demonstrations of an obvious or intuitive concept (very useful but sometimes boring) or refined hi-tech solutions for a small sub-problem of a real issue (exciting but sometimes nebulous). This is probably normal for a research society. Still, it is important, especially in the case of combined meetings, when many non specialists come just to have a look around, to take care also of the educational aspect of what is said: symposia, workshops and ICLs are good solutions, but a lot must be done in this sense to reach the educational quality of those of the ORS or AAOS. **Conclusion:** we all organise and attend to many meetings in Europe, especially on the medical side: but if only a few congresses should be saved in our field, the EORS meeting should be one of them, provided that social events meet the standard requirements for the young (and hungry) researcher!

EORS meeting should be safe for the future, provided that social events meet the standard requirements for the young (and hungry) researcher



Temple of the Holy family, by Gaudì

– one of the highlights of Barcelona.

Dates to remember

8th Conference of the European Orthopaedic Research Society, Amsterdam .....May 7-10, 1998

11th Conference of the European Society of Biomechanics, Toulouse .....July 8-11, 1998

3rd World Congress of Biomechanics, Sapporo, Japan .....August 2-8, 1998

Honorary Members of the Society

According to the statutes of the society Honorary members are accepted by the Council of the Society who "have rendered special meritorious service to the society or who have performed unusual work evidencing a high degree of achievement in the field of biomechanics"

The roll of Honorary Members is:

ANTONIO ASCENZI

FRANZ BURNY

AURELIO CAPPOZZO

N GSCHWEND

RIK HUISKES

STEPHEN PERREN

JOHN SCALES

PETER WALKER

European Society of Biomechanics • Membership Application

I hereby submit my application for active membership of the European Society of Biomechanics

I (a) Family name:

I (b) Given Names:

II Date of birth (day/month/year):

III Office address:

Tel:

Fax:

E-mail:

IV Private address:

Tel:

Fax:

V Academic degrees and years awarded:

VI Present affiliation and position:

VII Actual activity in biomechanics:

Date:

Signature:

(not required if a written letter of consent with signature was already mailed or faxed)

N.B. – include a brief curriculum vitae and a list of relevant publications.

Mail to: Dr. Leendert Blankevoort
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Fax: +31 24 354 0555 • E-mail: l.blankevoort@orthp.azn.nl