In order to prepare for the clinical start and to train a group of medical physicists, dosimetrists and radiation oncologists, working in different centres and with different treatment planning systems, in proton treatment planning we started the Proton School in January 2012 [3,4]. We have had a couple one day face-to-face meetings with lectures and workshops, two four day courses and biweekly teleconferences. The purpose with the face-to-face meetings was to give everyone the same basic knowledge in proton treatment and planning. It also gave the students a chance to get to know each other, which eases the discussions during the teleconferences. Prior to the bi-weekly teleconferences the centres were expected to create treatment plans for selected patient cases in the proton TPS. Also, as preparation for these sessions relevant scientific articles were distributed for discussions in the group. During the teleconferences, the desktop of the proton TPS was shared for everyone to view and/or demonstrate. The teleconferences consist mainly of discussions about the suggested plan solutions, patient immobilisation, margins, dose distributions and plan robustness. The four-day courses were mainly directed to dosimetrists and physicists and jointly arranged with Varian and with clinical experts to increase the skills in treatment planning for protons. Many of the participants of the proton school, has also attended other courses, like the PSI winter school, ESTROs ion and proton course as well as PTCOG meetings and courses.

Still we are faced with challenges; which patient groups do we treat in general, which do we start with? Thinking protons instead of photons has been the greatest challenge for the group as a whole. How do we create the best plan? This includes selecting robust beam angles and thinking about what the protons interact with on its way to the target volume. Discussions about target volumes has been frequent, as the use of them. Delineation is a major issue, not only for CTV/PTV but for other structures the protons might interact with in its beam path, as well as optimisation structures to provide the best plan and thereby “steer” the spots. The school has worked out well with active participation both in planning and discussing, helping each other in gaining experience in a field where we are novices.

An important step is now to use and produce standardized treatment protocols, a treatment planning manual and other types of common instructions and check lists so that all seven centres create plans in the same technical manner.

References
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SP-0372
The delivery of proton beam
L. Lederer1, A. Lomax1, A. Bolsi1, F. Albertini1, L. Mikroutsikos1, A. Lehe1

1Paul Scherrer Institute (PSI), Center for Proton Therapy, Villigen PSI, Switzerland

Proton therapy is a high-precision radiotherapy technique. Since 1996, image guided proton therapy (IGPT) has been applied at PSI, using the spot scanning technique. Patients are positioned and imaged remotely at a dedicated CT. In addition, the second generation Gantry 2 with an in-room sliding CT was taken into operation in November 2013. Fixation of the head is achieved by bite block or mask. In the prone position, we mold a special head support which facilitates a reproducible and comfortable position for fixation. In small children, special care must be taken in forming the moulage to ensure that the airways are kept free. On a daily basis, a patient’s positioning is checked by means of orthogonal CT scout images. When the position is correct, the patient is transported with a robotic transport system to the treatment station, Gantry 1, while maintaining the fixed position.

We estimate that our remote patient positioning method facilitates a patient throughput of up to 40% higher than in-room positioning, because the often time-consuming process of positioning and imaging takes place outside the treatment room.

In addition, and in contrast to photon therapy, proton therapy is very sensitive to range changes. It is therefore important that during the daily pre-treatment imaging process, changes in the patient’s anatomy (such as weight gain or loss) or body cavities (e.g. swelling due to sinustitis) need to be monitored and taken into account.

Based on a comprehensive analysis of 300 patients, it has been established that we achieve a positioning accuracy of less than 2 mm for head and neck cases. After almost 20 years of clinical operation, the proton delivery system at PSI has proven its reliability.

In the future, there will be a new challenge: The spot scanning technique will be used with Gantry 2 for target validation, as in the lung.

Symposium: Integrating health economics in research

SP-0373
Why health economics matters in radiation oncology research
Y. Lievens1

1University Hospital Ghent, Department of Radiation Oncology, Gent, Belgium

In developed countries, the total expenditures on health care have shown an almost continued increase over the last decades, and, not unexpectedly, the cost of cancer care has not been spared of this steady growth. The economic impact of health - and cancer - care can be measured as total spending, percent of national gross domestic product (GDP), or the cost to care for a single patient. In 2010, the European Union member states devoted an average of 9.0% of their GDP to health spending, a significant increase from the 7.3% spent in 2000, but a slight decline compared to the peak of 9.2% reached in 2009, consequence of the economic crisis affecting many countries as of the middle of 2008. In Europe, cancer care costs consume about 5% of the global health care budget, ranging between 4.1% and 7%. To the best of our knowledge, radiotherapy only consumes about 5% of the global cancer care budget. The variation in cancer care expenditures is more striking when focusing on the annual amount of money spent per capita: whereas the European average is 2,441€, some...
countries devote around 6,000€ per capita annually, compared to others that only spent as little as 350€. These increases, along with the global economic crisis, have stimulated the interest for more accurate information about the exact health care costs and on the way we spent our money. Health services research (HSR), a "multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviors affect access to health care, the quality and cost of health care, and ultimately, our health and well-being" is intended to guide the decisions of managers and policy makers about the design and implementation of health care programs. Heath Technology Assessment (HTA), one component of HSR, addresses five central questions related to efficacy, effectiveness, efficiency, availability and distribution of health care and thus plays an essential role in modern health care by supporting evidence-based decision-making in policy and practice. Answers to the question of efficiency - or cost-effectiveness - are typically given by economic evaluations (EE). Full EEs involve the quantitative evaluation of both costs and outcomes, or consequences, of competing interventions. An appropriately performed EE is incremental, that is, it measures the extra cost incurred in order to obtain the incremental improvement in outcome. Understandably, the inputs used to perform such EEs have to be chosen with care if one wants to derive results that correctly support decision-making on resource allocation. Apart from the indispensable data on effectiveness, the accurate computation of the cost component is equally important. The presentation will zoom in on the above aspects of HSR through examples from radiation oncology and evaluate why it is important to invest in this type of research.

**SP-0374**

**How to incorporate cost calculation into our research?**

N. Defourny¹

¹ESTRO, Hero, Brussels, Belgium

The methodology used to measure cost in economic evaluations in healthcare, as in clinical studies, is key to determine the health economic study's robustness. On-going literature review, investigating how costing is conducted in radiotherapy shows that one third of selected articles did not follow any conventional cost accounting methodology [Defourny 2015]. This demonstrates the absence of clear practices in reporting cost calculation [Graves 2002] and the lack of understanding the influence of a cost calculation method on final cost results [Doshi, 2006]. A feature of the healthcare sector is the coexistence of different types of accounting: NHS reimbursement’s billing, hospital finance’s invoices, insurers’ clients’ bills and so forth. These similarities tend to create confusion on how to implement costing exercises in a clinical study [Kaplan, 2014]. Cost accounting captures real economic cost not the ‘financial accounts’ [Mankiw, 2007]. The economic value of an expense, commonly known as the opportunity cost, is defined as the value of the benefit you could have realized by investing the same amount of money in taking the best alternative option. Economic theory measures item by item. The field of radiotherapy is innovating rapidly. These innovations are often associated with better health, but also with higher costs. As healthcare budgets are scarce, we are increasingly asked to show that the effects of new radiotherapy techniques are worth the extra costs. In this presentation I will explain how to undertake such an analysis. This presentation provides an introduction to the principles and practice of economic evaluation. Topics include different types of economic evaluation, trial-based and model-based economic evaluation, use of quality-adjusted lifeyears and interpreting and presenting evidence. Throughout the presentation I will provide practical examples from the field of radiotherapy.

**Poster Discussion: Dosimetry**

**PD-0378**

**Proton range assessment using prompt gamma monitoring of realistic pencil beam scanning treatments**

G. Janssens¹, J. Smeets², F. Vander Stappen², D. Prieels¹, I. Peraeli², E. Clementel¹, L. Hotoiu¹, E. Sterpin¹

¹IBA, Research, Louvain-la-Neuve, Belgium

²Politecnico di Milano, Dipartimento di Elettronica Informazione e Bioingegneria, Milano, Italy

Université Catholique de Louvain, iMagX ICTEAM Institute, Louvain-la-Neuve, Belgium