passing rate for target volumes was found to be above 96% for a 3%/3mm criteria. Differences in tumor control probability were within 2.5% for liver and breast, however, for head-and-neck and prostate patients the differences were up to 6.5% and up to 11% for lung patients.

We conclude that approximations introduced in analytical dose calculation methods can result in significant range uncertainties for heterogeneous patient geometries or introduce a systematically reduced dose in target volumes. Routine MC simulations for treatment planning or verification may be necessary to ensure full target coverage to the prescribed dose levels. In particular for clinical trials comparing photon vs. proton treatments, MC simulations may be required to avoid bias due to differences in dose calculations.

SP-0112
Proton beam monitor chamber calibration in clinical practice
C. Goma1
1Swiss Federal Institute of Technology Zurich, Department of Physics, Zurich, Switzerland

This talk describes the reference dosimetry of clinical proton beams. The main goal is to clarify the application of the IAEA TRS-398 dosimetry Code of Practice to modern proton beam delivery systems. A clear distinction is made between (i) those proton beam delivery systems that should be calibrated with a mono-energetic field, and (ii) those delivery systems that should be calibrated with a mono-energetic field. For these second type of delivery systems, a word of caution is issued on the use of cylindrical ionisation chambers. Contrary to the IAEA TRS-398 recommendations, this talk presents different arguments in favour of taking the effective point of measurement of cylindrical chambers into account when positioning the reference point of the chamber at the measurement depth. Finally, this talk also discusses the comparison between reference dosimetry and other independent dosimetry techniques, such as Faraday cup dosimetry and water calorimetry.

SP-0113
Myth and reality of image guidance and adaptive treatments in proton therapy
M. Engelsman1
1Delft University of Technology, Holland PTC, Delft, The Netherlands

The finite range of protons makes the delivered dose distribution, particularly in case of IMPT, very sensitive to any uncertainty and change in patient anatomy. In the best case, the patient anatomy and the treatment plans are robust over the entire treatment course such that treatment adaptation is not necessary. Adaptive therapy is, however, not simply a buzz-word, especially not for the relatively new indications for proton therapy in the thoracic and pelvic region. Existing and new proton therapy centers are working towards a framework that allows them to:
1) determine which patients will benefit from a treatment adaptation,
2) efficiently adapt and validate the treatment plan.

The tools for such a framework are; volumetric image-guidance, dose-recalculation and accumulation, and plan-reoptimization. This presentation will discuss the needs for these tools, their availability and integration, and the current reality in plan adaptation in proton therapy.

Symposium with Proffered Papers: Advanced treatment planning techniques

SP-0114
Adaptive dose painting in head and neck
J. Giralt1, A. Seoane2
1Hospital Universitario Vall d’Hebron, Radiation Oncology, Barcelona, Spain
2Hospital Universitario Vall d’Hebron, Physics, Barcelona, Spain

The benefit of intensity-modulated radiation therapy (IMRT) in the treatment of head-and-neck cancer (HNC) has been demonstrated in numerous studies. Highly conformal radiation allows for a high dose to high-risk areas, whilst sparing adjacent organs at risk (OAR) such as the parotid glands. Clinical studies have shown that IMRT reduces grade-3 xerostomia in comparison to three-dimensional conformal radiotherapy. The next step is to develop dose-escalation studies, that so called “Dose painting”. Dose-painting IMRT is aimed at exploiting inhomogeneous dose distributions adapted to tumor heterogeneity. Tumor regions of increased radiation resistance receive escalated dose levels, whereas radiation-sensitive regions receive conventional or even de-escalated dose levels. Dose painting relies on biologic imaging. On the other hand, the changes to the dose distribution during treatment based on specific patients variations due to weight loss and tumor shrink must be corrected. For that purpose Adaptive Radiotherapy is developed. This is done by means of:

a) Image guided RT: Repositioning of the patient at the time of treatment
b) Dose tracking: Computing fraction dose based on daily cone-beam CT, accumulating dose by deformable registration and evaluating the accumulated dose at different organs
c) Replanning: Adapt the dose to a systematic volumetric changes and compensate for undesired dose accumulation.

We will review the whole process and we will discuss the clinical data published and some of the new trials that are under evaluation.

SP-0115
Adaptive treatment planning in soft tissue sarcoma: Why and when is it necessary?
C. Dickie1, A. Parent1, P. Chung1, C. Catton1, P. Ferguson1, J. Wunder1, B. O’Sullivan1
1Princess Margaret Cancer Centre, Radiation Medicine Department, Toronto, Canada

Radiotherapy is an integral part of soft tissue sarcoma (STS) multidisciplinary management, with local control in excess of 90 % for disease arising in the extremities. From our recently published Phase 2 study of preoperative image-guided intensity modulated radiation therapy (IG-IMRT) to reduce wound and combined modality morbidities in lower extremity soft tissue sarcoma (LE-STS), approximately 20 % of the patient population required replanning during their course of radiation therapy (RT) due to soft tissue/tumour volume changes exceeding 1 cm as measured on daily cone beam CT localization used for RT guidance.

Previous work evaluated the dosimetric effect of tumour volume changes (TVC) for preoperative IMRT of LE-STS to determine critical indicators, as measured on daily CBCT localization, to motivate plan adaptation. We found that a 1 cm TVC deviation on CBCT imaging was a reliable threshold
to identify potential target underdosage for increasing target volumes during IMRT to consider adaptive RT. Tumor shrinkage had insignificant dosimetric consequences relative to tumour coverage and normal tissue sparing for IMRT treatment in this study of 18 patients; 11 growing and 7 shrinking.

This lecture will focus on an adaptive study in progress at The Princess Margaret which is an extension of the previous study to compare a parallel opposed pair technique, conformal approach, and IMRT, for 26 patients that required plan adaptation for significant TVC during radiotherapy. Target coverage and normal tissue sparing will be compared for the shrinking and growing cohorts in order to communicate evidence based critical indicators for adaptive IMRT, conformal or POP planning for STS patients.

Adaptive issues and strategies will be discussed for LE-STS radiotherapy, using case examples to highlight the different considerations and critical thresholds for various RT techniques.

SP-0116
Automatic planning strategies
B.J.M. Heijmen1, P.W.J. Voet1, M.L.P. Dirix1, A.W. Sharfo1, L. Rossi1, S. Van de Water1, D. Fransen1, J.J. Penninkhof1, M.S. Hoogeman1, S.F. Petit1, A.M. Méndez Romero1, J.W. Mens1, L. Incrocci1, S. Breedveld1
1Erasmus MC Cancer Institute, Radiation Oncology, Rotterdam, The Netherlands
2Elekta AB, The Netherlands

Purpose/Objective: Treatment plans are commonly generated by dosimetrists in an iterative trial-and-error procedure, aiming at steering the TPS towards an acceptable solution. Plan generation may take up to several days of workload. Moreover, final plan quality may strongly depend on the skills and experience of the dosimetrist, and on allotted time. At Erasmus MC, systems for fully automated plan generation have been developed to replace the labour-intensive and operator-dependent trial-and-error approach. The core of all systems is “Erasmus-iCycle” (Med Phys. 2012; 39(2): 951), an in-house optimizer for lexicographic multi-criteria plan generation. For prostate, head and neck, and cervical cancer patients treated at our linacs, automated planning is in full clinical use. For Cyberknife treatment, similar systems are being developed for both the variable aperture collimator (IRIS) and the MLC, using Erasmus-iCycle pre-optimization and final plan generation with the clinical TPS (Multiplan, Accuray Inc). For intensity-modulated proton therapy (IMPT), Erasmus-iCycle has been extended with novel algorithms for fast plan generation and plan delivery, saving per patient a substantial amount of in-room time compared to plans generated with classical optimizers. Novel strategies for robust IMPT planning are being explored.

Results: In a prospective clinical H&N cancer study, treating radiation oncologists selected the Erasmus-iCycle/Monaco plan in 97% of cases rather than the plan generated with Monaco by trial-and-error (IJROBP 2013; 85(3): 866-72). For a group of 44 cervical cancer patients, dual-arc VMAT Erasmus-iCycle/Monaco plans were superior to plans generated manually by an expert cervical cancer planner using Monaco, spending many hours; reduced small bowel V15Gy, V45Gy, and Dmean, bladder Dmean, and rectum Dmean, all p<0.001. For 30 prostate cancer patients, differences between Erasmus-iCycle/Monaco VMAT plans and manual VMAT plans, the latter generated by an expert planner with up to 4 hours planning hands-on time, were statistically insignificant (IJROBP 2014; 88(5): 1175-9). All attempts to use automatically generated plans as a starting point for manual generation of further improved plans have been unsuccessful.

Conclusion: Automatic plan generation with consistent high plan quality and vast reductions in planning workload is feasible. For prostate, head and neck, and cervical cancer patients all clinical plans are currently automatically generated. For other sites (breast, lung, liver), automated planning is being investigated. Use of automated planning for Cyberknife and IPMT is being explored.

OC-0117
Differential dosing in MRI guided spinal stereotactic body radiotherapy to reduce the risk of fractures
J. Hes1, J.M. Van der Velden1, E. Brand1, J.H.W. De Vries1, J.G. Bijzet1, M. Van Vulpfen1, M.E.P. Philippens1, W.S.C. Eppinga1, E. Seravalli1
1UMC Utrecht, Department of Radiation Oncology, Utrecht, The Netherlands

Purpose/Objective: Concern has been raised about the extreme dose-fractionation schemes and large biologically effective dose used in spinal SBRT because of the greater probability of vertebral compression fractures (VCF). Prevention of VCF is challenging because the metastatic disease lies within the segment at risk. In attempt to reduce the risk of VCF, we introduce ‘differential dosing’. MRI guidance is used to deliver a high radiation dose to the metastasis exclusively. Adjacent healthy appearing bone marrow spaces which may possibly contain subclinical disease receive the conventional low dose of 8 Gy. Differential dosing has the potential advantage of lowering the risk of VCF by sparing the unaffected, healthy bone tissue surrounding the metastasis while also treating the subclinical disease. In this work, the technique used to create differential dosing treatment plans and the accuracy of dose delivery are presented.

Materials and Methods: VMAT plans were created for 10 spinal metastatic patients using Monaco (Elekta, Sweden) treatment planning system. Two 10MV photon beams/partial arcs were employed. Doses of 18 Gy to the metastasis (PTVb) and 8 Gy to the surrounding bony compartment (PTVe) were prescribed in one fraction. A maximum dose of 25.2Gy and a mean dose in the range 17-19Gy were allowed to PTVb. Treatment plans were optimized according to the following priority list: spinal cord dose constraint (V10<0.35cc), PTVb coverage, PTVb mean dose, PTVe dose gradient, PTVe