describes the Dutch charter on a safety management system that sets out to perform a regular risk inventory, create a system for blame-free reporting, develop a system for data analysis and to put a system in place for implementation of improvements.
However incident reporting is only one element of risk management and should be seen as a tool to facilitate analysis and identify where change will be most effective. A range of methodologies can be used to assess and manage risk including Failure Mode and Effects Analysis (FMEA), Root Cause Analysis (RCA) Events and Causa lFactors Analysis (ECFA) and incident reporting, investigation and analysis.
Methodologies can be simple or very complex and are applicable in different settings but basically involve identifying factors that have led or could lead to incidents occurring and considering strategies to manage these factors.
It is also necessary to consider the organization and the environment in which radiotherapy is prepared and delivered and the personnel involved as these can also contribute to risk. As systems become more complex they become less transparent with greater opportunity for incidents to occur. Analysis of the functioning of the organization and its personnel can be facilitated by regular audit identifying risk areas.
Risk management should be seen as a proactive process designed to improve quality by reducing risk and the number of incidents that occur in our departments. Incident reporting and analysis is of no benefit without feedback and involving all appropriate staff in addressing the findings and implementing change. It is the responsibility of all professionals involved in the process and is most effective when a strong safety culture exists that is is actively supported with research and education. Finally risk management involves informing patients and the public in a timely and open manner to avoid speculation and sensationalism and ensure that radiotherapy is seen as an area where risk and its management is integral to practice.

SP-0376
Statistical methods for fitting of response/biological models to clinical data
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Purpose/Objective(s): The current era of evidence-based medicine demands rigorous analysis and modeling of treatment outcomes data to understand treatment efficacy, patient response, and design successful future clinical trials. Statistical methods play a pivotal role in evidence-based medicine for developing response models from biological and clinical data of individualized prognostic or predictive outcomes. In this tutorial, we will provide an overview of various statistical methods applied in radiotherapy for fitting of response/biological models to dosimetric and clinical data in radiation oncology.
Materials/Methods: Outcomes in radiotherapy are characterized by models of tumor control probability (TCP) and the surrounding normal tissue complication probability (NTCP). These models could be applied to optimize and evaluate the quality of different treatment planning modalities and are used in designing new radiotherapy clinical trials by estimating the expected therapeutic ratio of new protocols. A review of basic analytical and data-driven methods will be provided. Different statistical methods in both approaches using case studies and examples from our work and others in the literature will be presented.
Results: A step-by-step approach for the development of response TCP/NTCP models will be presented. In case of analytical models, parameters and outcomes confidence intervals will be assessed. In case of data driven-models, issues related to coding of categorical and continuous variables, collinearity, parsimony principle, dimensionality reduction, and endpoint type would be discussed. Strategies for dealing with missing data,imbalance events, overfitting, and model generalizability will be highlighted.
Conclusions: The main goal of this tutorial is to familiarize the radiotherapy practitioner with the different statistical methods for building and evaluating radiobiological models of a clinical endpoint. Different examples of TCP/NTCP model development and their application in clinical decision-making will be presented along with discussion of various inter-related issues.

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Multi-criteria optimisation algorithms in radiotherapy
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Real-life optimisation problems commonly have to cope with competing, but equally important objectives and therefore do not possess a unique, unambiguous solution. In fact, a given solution becomes the “optimum” only by a selection process, which is often interactive. This selection needs to resort to the same elements that make navigation in a foreign city effective: 1) each location should be accessible, 2) directions should be available, 3) a destination should be reached directly and precisely.
Accessibility. The term "Pareto fontier" has become known for the set of all competing solutions of a dose planning problem. The configuration, and even existence of this Pareto frontier is far from trivial in the general setting of dose planning, which is why usually only fluence distributions or idealized dose distributions (instead of deliverable plans) and physical cost functions (instead of dose-volume and some biological cost functions) are considered. Under these conditions, each point of the Pareto front can be reached by an unconstrained dose optimisation with a specific priority weight for each cost function. A more direct alternative is to turn all but one cost function into constraints and employ constrained optimisation, which also remains viable in the more general setting.
Orientation. A very thorough way of getting oriented is to explore every possible direction and see where it leads. In dose optimisation, each exploration requires a full dose optimisation and is hence time consuming. To work around this, navigation tools have been devised that rely on a set of pre-computed dose plans, and much effort has been devoted to reducing the number of these computations. An alternative within the framework of constrained optimisation is sensitivity analysis, which predicts the change in one cost function if another one is altered (i.e. the slope of the tangent to the Pareto frontier). This does not require pre-computation, but is restricted to small changes and hence relies on a good start location.
Arrival. No amount of information can avoid that the route to the final choice is a repeated cycle of getting directions and taking a step, especially when the number of competing objectives is large. Later steps could partially invalidate previous ones. Therefore, it becomes essential to treat already established cost function values as constraints. Besides for navigation “on foot”, constrained optimisation is also the key to various methods of automated route finding (i.e. proper simultaneous optimisation of multiple criteria) like lexicographic ordering or constraint prioritization. These methods capture the trade-off rules the expert would usually employ, and apply these rules in an attempt to perform at least the most obvious selection steps unsupervised.
Although multi-criteria algorithms are built on mathematically rigorous formalisms, the concepts derive their value from their interactive usability and the users´ preference, and are therefore ultimately subjective.

SP-0378
PET for delineation in radiotherapy: Reliability and opportunities
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Over the last few years, positron emission tomography (PET) has proved to convey useful information for treatment planning in radiotherapy. Within this framework, the most straightforward way to exploit this information is to use PET images to delineate a target volume. An abundant literature deals with this problem and many automatic or semi-automatic methods have been proposed, ranging from uptake thresholds to very complex segmentation algorithms. Yet, to date, the problem remains unsolved and few (or no) methods seem to succeed in combining accuracy (low bias) and precision (low variance across a broad range of observers, tracers, tumor sites, target size/shape, and camera models).
Several impediments cause this slow progress. The first and primary one includes all intrinsic, physical limitations of PET cameras. Images are blurred (positron annihilations are difficult to locate in wide gantries and in attenuating material) and noisy (annihilation counts are low). Noise is generally attenuated by smoothing the images even more heavily. By essence, blur complicates the segmentation problem, as it increases the uncertainty about the location of the target edges. Other, secondary causes have a methodological nature and result from the first one. Most segmentation methods stem from simple or very heuristic models that approximate roughly or even ignore the aforementioned effects, leading to inaccurate results. On the other hand, more complex methods are hindered by an over-fitting effect: they perform well on data they have been calibrated or tested with but they generalize poorly to other images, other camera models, etc. This leads us to the third impediment, which is the difficulty of validating the candidate methods on sufficient and appropriate data. In particular, robustness and reproducibility depend on the availability of a large number of images, covering most of the experimental domain, in terms of tumor sites, target sizes and shapes, camera models, etc. Each image should also come with a ground truth