curative (definitive or preoperative) therapeutic intent reported significant toxicity. To enable full interpretation of outcome toxicity data, both the specific tumor type and the related disease site being irradiated will require both to be specified as study eligibility criteria, together with a description of detailed radiation dose-volume dependencies within the treatment protocol. This will also facilitate identification of adverse radiation effects that are separate from toxic effects of the systemic agent. In addition to determining treatment safety, proof of biological activity and – ideally – target-dependent radiosensitizing ability of the investigational agent should be regarded as a study objective. Finally, if the study eligibility criteria employ the principles of defining both the tumor type and anatomic location of the specific target volume being treated, the resultant homogeneous patient population will also ultimately enable treatment response evaluation.

SYMPOSIUM: INACCURACIES AND NEAR MISSES IN RADIOTHERAPY AND HOW TO ADDRESS THEM

SP-0392
Taxonomies for synoptic reporting and analysis of radiation treatment incidents
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Synoptic reporting and analysis of incidents in radiotherapy, and elsewhere in medicine, means being directed to providing key descriptive information in a structured format. There are three principal advantages of synoptic reporting: completeness, lack of ambiguity and searchability. Firstly, the reporting and analysis forms, if well designed, will ensure that all key information required to understand the incident and to develop corrective actions is recorded. This meets the requirement of completeness. The problem of ambiguity can, to some extent, be mitigated by restricting responses to key elements of the report and analysis to predetermined lists of options with carefully thought out language. The third benefit of structured synoptic reporting is that the databases into which reports and analyses are entered can be rapidly searched and hence major issues flagged and trends identified. Additional flexibility is included in an incident learning system through incorporating free text boxes where the reporter and analyst can augment the basic information entered.
The presentation will commence with an overview of a generic incident learning system and will then introduce SAFRON and the U.S. national incident reporting initiative as examples of the implementation of such systems. The structure of these will be discussed identifying the synoptic and free text components. To understand where in the radiotherapy process the incident originated and where it was discovered process maps are used. The severity of an incident, which often determines the priority of the response and corrective actions, is an important component of the synopsis although severity can be hard to establish particularly as the consequences of a clinical RT incident may not be apparent for weeks or months. In order to implement effective corrective actions it is important that they follow from the identification of basic causes/contributing factors. The approaches of SAFRON and the U.S. implementation will be discussed in the context of these three synoptic elements.
As well as enhancing the quality and safety of radiotherapy, properly constructed incident learning systems can also help us to identify the most effective impediments to error propagation. Both SAFRON and the US system specifically include safety barriers in the synoptic reporting structure. The reporter/analyst is invited to identify those barriers which the error penetrated and that barrier at which the error was stopped.
Synoptic reporting aids clear communication and analysis of radiotherapy incidents. It can also guide the development of an efficient safety program by discriminating between more effective and less effective safety barriers.

SP-0393
The patient experience as a catalyst for change
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Following the death of her son as a result of medical error, the focusof Margaret's work relates to seeing adverse events as having the potential tobe catalysts for change as well as being opportunities for learning, identifying areas for improvement and preventing recurrence.
During her presentation she will provide a case study highlighting the gaps between the patient safety measures possible and those actually being experienced by patients (communication, record-keeping, diagnosis and test results, handovers, transitions in care, responding to the deteriorating patient, practising truly patient centred care).
She will also discuss:
· The case for involvement of patient and family in assuring safe care.
· The need to demonstrate professionalism in the aftermath of adverse events – transparency, disclosure, learning and preventing recurrence.
· The patient experience of care and the students' response to being exposed to that reality - the power of the story.
· The role of education in creating sustainableculture change.
She will offer some reflections on nuclear medicine from a patient perspective and propose the WHO Patients for Patient Safety collaborative/partnership model as a patient safety solution.

SP-0394
Quality indicators and standards in radiotherapy contouring
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Purpose: This lecture will present the actual scenario of contouring standards in Radiotherapy and how a correct segmentation of target and organs at risk grant a reliable treatment plan. An overview of all the anatomical districts will be offered together with a deepening in the delineation quality indicators, defined as contours adherence to International or Institutional Guidelines.
Method and materials: Different techniques and technologies such as high definition morpho/biological imaging, contouring atlases with or without tutorial purposes, different rigid and deformable commercially available coregistration softwares with autocontouring features have been presented in order to explore their role in gaining adequate standards in contouring procedures.
A brief overview of the main similarity indexes has been offered too.
Results: An adequate quality assurance in contouring is mandatory to grant a reliable treatment plan: in order to check the adherence of contours proposed by a manual delineator or by an autosegmentation software to adopted guidelines indexes, such as the Dice Similarity Index can be calculated, also for tutorial purposes.
Conclusions: Modern Radiotherapy (RT) can deliver high dose rates to extremely small volumes and high precision RT could mean significant dosimetrical error due to a unfitting dose coverage or to a systemic error caused by inappropriate contouring.
Modern technologies can help in maintaining adequate contouring standards but an Indipendet Check (IC) by skilled operators of the proposed structures remains mandatory.

SP-0395
Accidents and near misses in radiotherapy delivery, and the ACCIRAD project
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Serious radiotherapy accidents have been notified in France in 2005 and 2006 (Epinal, Toulouse). The main identified causes were organisational and human factors. In response, a national action plan, later part of the national cancer plan 2009-2013, was implemented by the Health Ministry between 2007 and 2012. INCa (French National Cancer Institute) was in charge of managing the national action plan which involved several stakeholders, including radiation oncologist and medical physicist societies.The national action plan was based on 33 national measures spread across seven fields as the quality and safety of the practices, the vigilance in radiotherapy, the human resources and training, the safety of facilities, the relationship with patients and the public, the strengthening of ASN's inspections and the monitoring and knowledge of the discipline. In addition to its inspection program, ASN has led 3 national radiotherapy measures :

- publication of a set of radiotherapy quality requirements and a strengthening of the regulations specifying the quality assurance (QA) obligations, including risk analysis ;
- publishing of guidelines for professionals on the notification of significant radiation protection events (SRPE) ;
- creation of an incident scale rating for the purposes of communicating to the public.

Since 2008, each year, ASN publishes the main findings of its inspection program in radiotherapy, stressing on the progressive improvement of safety treatments. Reports on SRPE, presenting the main causes of the events, are also put on ASN website. The increase of the number of notified events since 2008 demonstrates the improvement of safety culture, most of notified events being without any consequences to the health of patients. The feedback experience

is organised at national level, in close collaboration between ASN and radiotherapy professionals, leading to the publication of newsletters about the safety of patients.
Taking into account one of the main findings of the international conference on Modern Radiotherapy, organised in 2009, by ASN, in Versailles (France), the European Commission decided to strengthen the European Basic Safety Standard introducing new requirements related to events reporting and risk analysis, and to launch the ACCIRAD project led by the Greater Poland Cancer Centre (GPCC, Poland)[1], following the goal to issue an European guidance on these topics in 2013. A general questionnaire sent to member states in 2012 showed that more than half EU countries have already implemented in their legal system a requirement for risk analysis in radiotherapy, and classification, recording and reporting of adverse events and near misses. However, despite 15 years passed since 1997, in many EU countries the requirement for a legal framework regarding risk analysis and event's classification, recording and reporting systems was not addressed and the practical implementation of the systems was still incomplete.A 2nd questionnaire, still being analysed, should allow to identify pertinent risk analysis methodologies used by radiotherapy centres and also good practices for event's classification. On this basis, recommendations will be prepared by the ACCIRAD consortium to be included in the European guidance. The first results of these on going works will be presented at the Geneva ESTRO conference in April 2013.

SYMPOSIUM: ADVANCED METHODS FOR TOXICITY PREDICTIVE MODELS

SP-0396
Machine learning approaches to modelling dose-volume effects.
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Characterising the dose-volume response of normal tissue structures is an important part of optimising radiotherapy treatment planning. However, understanding how the dose-distribution to a structure is related to outcome is confounded by co-morbidities and combinations of treatments as well as incomplete and inconsistent data. One approach to this challenge is Machine Learning. Machine learning describes models which learn from examples of a specific data type without *a priori* information about the relationship between the data.
When both input variables and the corresponding outcome data are available, this known as supervised learning. Once the relationship has been inferred it is possible to make prediction for previously unseen cases.
The published literature on the use of machine learning approaches to model dose-volume effects utilise different algorithms. Two commonly used supervised learning approaches are Artificial Neural Networks and Support Vector Machines.
Artificial Neural Networks (ANN) are a (simplified) mathematical analogy of learning in the brain. An ANN is trained by presenting example datasets to the network. Input variables are propagated through a network of interconnected nodes and compared to the known outcome. The weights of the connections between the nodes are altered iteratively so that the outcome is predicted correctly from the input data.
Support vector machines (SVM) are used for dichotomised outcomes e.g. toxicity/no toxicity. Separation between the two possible classes is achieved by translating the input variables in to a high-dimensional feature space where a boundary is derived to maximise the separation between the classes.
An important consideration when developing a machine learning-based model is how to represent the input data. This issue is not unique to machine learning and is also relevant to conventional statistical approaches. When trying to predict radiation-induced toxicity the dose distribution to relevant structures need to be included. Generally this is achieved by using summary measures such maximum dose and mean dose to the structure. The dose-volume histogram can be reduced to a summary measure such as Equivalent Uniform Dose (EUD). Often sequential variables describing the volume of the structure receiving a specified dose eg V5, V10, V15 etc are included.
A more detailed approach is to include a spatial description of the dose. These dosimetric features will be combined with clinical information and information regarding other therapies such as chemotherapy.
A successful model will be able to make predictions for previously unseen data. Cross validation, where models are built on subsets of available data and tested and validated on independent samples, can ensure the ability of a model to generalise. The effect of each variable on the ability of a model to make accurate predictions can be assessed with methods such as "leave one out" which as suggested repeats the process without a variable and assess the effect.
This presentation will provide an overview of published literature on the modelling of dose-volume effects using machine learning. A worked example of both ANN and SVM approaches to predict acute toxicity following head and neck radiotherapy will be used to demonstrate methodology. The results will also be compared to a conventional multivariable analysis.
Relatively little has been published on the use of machine learning approaches to the modelling of dose-volume effects. However, they provide a complementary alternative to conventional statistical techniques. Consequently there is potential to further our understanding of the relationship between the dose distribution to a normal structure and corresponding radiation-induced toxicity.

SP-0397
Including clinical (and genetic) covariates in NTCP models
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It is well known that the risk of radio-induced toxicity increases when higher doses and larger volumes are involved in the irradiation and, in the last years, some consistent results have been published on the possible estimation of normal tissue complication probability (NTCP) for a number of organs-at-risk. The widespread method used for such calculations is based on a sigmoid dose-response curve coupled to reduction of the whole dose-volume histogram into one parameter (such as the equivalent uniform dose).
NTCP models with their prediction based only on dosimetric variables can be used in treatment planning and can act as a baseline reference.
On the other hand, it is becoming clearer that radiation-related side effects are also correlated to a number of patient-related factors. With the advent of newer radiotherapy technologies, which allow steep gradients and minimization of doses to normal tissues, there is an increased interest in understanding clinical/genetic risk factors that might enhance patient radio-sensitivity and to develop NTCP models which might include these variables in order to achieve better normal tissue complication predictions.
Some recently published studies have shown that current NTCP models can be improved by incorporating clinical risk factors into model formulation. Overview of published results will be presented.
A further important step is the inclusion of molecular/genetic predictors into NTCP models. This issue is still at a very primitive stage and should be elucidated because, given the same set of clinical/dosimetric factors, patient-to patient variability in normal tissue response to radiation has been widely recognized in clinical practice, suggesting that this phenomenon might be, at least in part, genetically driven.
In this presentation data on molecular/genetic markers influencing radio-induced toxicity are presented, together with the first findings supporting the hypothesis that a genetically determined dose–response relationship is possible and could be used to predict the probability of side effects associated with radiotherapy and serve as a rational basis for individualized radiation dose prescriptions.
The future lies in these multi-factorial prediction models: a great effort has to be done to collect reliable detailed prospective data for the development of NTCP models with the inclusion of predisposing clinical/geneticfeatures for normal tissues involved in radiotherapy.

SP-0398
An image-based approach to investigate sensitive tissues related to trismus following head and neck radiotherapy
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Trismus, which results in difficulty, restriction or pain when opening the mouth (CTCAE), is a common complication in head and neck cancer patients following radiotherapy and leads to degradation in quality of life. There are few studies that have addressed radiation induced trismus. However, the main cause remains poorly understood. Studies have attributed trismus to the irradiation of a range of organs at risk (OAR) such as the mastication muscles, the temporomandibular joint (TMJ), and pterygoid plate among others.