**Patient Safety Abstracts**

**Presentation Number:** 277

**Prospective Dosimetric Data Generation for Every Patient and Fraction to Analyze Results on Radiation Oncology Patient Registries**

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**Purpose/Objective(s):** With the increasing need of evidence-based medicine, radiation oncology registries (ROR) are becoming a very useful tool to analyze patient outcome and complications outside academic randomized clinical trials. The dosimetric information used in ROR in general consists of information obtained from treatment planning that is a snapshot taken before treatment starts. Therefore, in order to try to understand the dosimetry correlation for a particular patient outcome result, it is desirable to have daily dosimetric information derived during the actual treatment. In our network of radiotherapy clinics distributed over multiple states, over 2,300 treatment fractions are delivered daily. Such a tool to analyze patient dosimetry is already in place in many of the network clinics. The results for more than 50,000 fractions will be presented.

**Materials/Methods:** An automatic dose reconstruction system was put in place to compute the dose on the daily setup CT (when available). Daily contours sets are generated using deformable registration and doses are accumulated to a common frame of reference by warping daily doses to the planning CT using deformation vector fields. A flagging system is in place to trigger actions from dosimetric deviations compared to the treatment plan dose either for each particular fraction or cumulative doses using defined thresholds. A complementary in-vivo dosimetry system is in place to flag possible issues during treatment. The combination of in-vivo dosimetry and dose reconstruction enables detection of deviations relative to planning expectations, and in many cases permits discrimination if the deviations correspond to setup, machine and/or anatomical changes. Dose reconstruction enables magnitude quantification for deviations.

**Results and Conclusions:** More than 50,000 daily fractions (Fx) were prospectively computed and analyzed compared to plan. PTV mean doses deviated more than 10 % for 1.4% of the Fx in abdominal cases, 0.06% for breast, 0.8% for lung and mediastinum, 0.4% for pelvis, 0.6% for prostate, 0% of the head and neck. For sensitive structures: a) in breast cases the flagging rate of D (mean, heart)>20% and D(mean,lung)>15% are 1.4 and 22% respectively; b) in H&N the flagging rate of D (mean, parotid)>15%, D(max,cord)>10%, D(max,lens)>10%, D(max,brainstem)>10% are 14, 2.6, 3.5 and 2.7% respectively; c) in prostate cases the flagging rate of D(mean,rectum)>15% and D(mean,bladder)>15% are 5 and 1.2% respectively. We hypothesize that the generation of this information will allow us to begin to correlate treatment delivery with particular outcomes while comparing techniques or practices used at the different clinics in our network.


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**Presentation Number:** 281

**Reducing Errors in Radiation Treatment Through the Implementation of Electronic Safety Checklists**

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**Purpose/Objective(s):** To implement electronic safety checklists to reduce treatment errors reaching patients.

**Materials/Methods:** IRB approval was obtained and an electronic safety checklist software program was written to interface with Mosaic treatment software. The checklist items were developed by reviewing errors previously reported in our error reporting system. A separate safety checklist was developed for each step in the workflow from CT simulation to radiation start: CT simulation, physician contouring, dosimetrist planning,
physics and radiation therapist check. Each checklist was completed before the plan could progress. The number of reported errors was examined starting from before the development of our department’s error reporting system until after the implementation of the safety checklist program. The severity of errors was graded according to the Radiation Error Scoring System (J Am Coll Radiol 2009;6:45-50). In this system, grade 1 and 2 errors are classified as “near misses”, and grade 3 and 4 errors as those reaching the patient. To assess safety culture, the US Department of Health Hospital Survey on Patient Safety Culture was sent to staff before and after the implementation of the checklist program.

Results: Reported errors increased over time, including after the implementation of the safety checklists. Before implementing the error reporting system an average of 2.2 errors were reported per month (101 errors from 1/2009 - 9/2012). Of these errors, 73% were grade 1, 14% grade 2, 9% grade 3 and 4% grade 4. After implementing the error reporting system in 10/2012 but before implementing the safety checklist program, an average 11.4 errors were reported per month (161 errors from 10/2012 - 11/2013). Of these errors, 157 were grade 1 (97%), 4 were grade 2 (3%) and none were grade 3 or 4. After implementing the checklist program in 12/2013, an average 16.5 errors were reported per month (33 errors from 12/2013 - 1/2014, all grade 1). The only domain of the safety culture survey that was significantly different before and after the implementation of the checklist program was “Staffing”, with a positive response rate of 64% before and 75% during checklist implementation (p=0.04). All the other domains of the survey, including “Overall Perceptions of Patient Safety” were not different (p>0.05).

Conclusions: Implementing our electronic safety checklist was associated with an increase in reported errors. There seemed to be a trend towards reducing the severity of errors (more reported “near misses”, less errors reaching the patient), although more time is needed to determine if the safety checklists actually reduce the number of errors reaching patients. The safety culture of the department, as measured by a validated survey, did not suffer from implementation of a new process and even improved in one domain.


Presentation Number: 280

Lessons From a Prospective Incident Learning System: Focus on Physician-Specific “Errors/Near-Misses” and “Errors” that Reached the Patient


Purpose/Objective(s): Our department has had an incident learning system to gather data on errors and near misses. This study aims to perform a root cause analysis of errors/near-misses related to physician’s actions, and of errors that reached the patient.

Materials/Methods: The Department of Radiation Oncology at the University of North Carolina instituted an incident learning system in June 2012. All members in our department are encouraged to submit errors/near-misses through this electronic system; this includes actual errors that affected the patient, as well as near misses. For each error/near-miss, we use previously defined process maps (i.e. patient care pathways) to assess the root cause of that error/near-miss. We herein report the analyses of the error/near-misses attributed to physician’s workflow, focusing on their root cause, and their clustering along the process maps, as well as errors that actually reached the patient.

Results: From June 2012-January 2014, 457 error/near-misses were reported; 79 (17%) were attributed to physician workflow. Of these, 66/79 (84%) were broadly related to performance/processes and 40/70 (56%) related to communication; with some related to both. A more detailed review of the process maps revealed that the root cause for 31/79 (39%) of the error/near-miss were due to inadequate communication between physicians and simulation therapists and dosimetrist; 6/79 (8%) were related to incorrect/insufficient image segmentations for treatment planning; and 21/79 (27%) could not be readily mapped to the process maps. 12/457 (3%) error/near-misses reached the patient; none of a severity requiring reported to a regulatory body. The root causes of these errors were in medical decision/assessment (1), simulation/imaging process (5), planning and verification (2), treatment delivery (3), and on-treatment verification (1). Identified contributing factors included communications (3), performance (5), high-workload (9). Analysis of the process maps for these 12 errors: 6 crossed informal safety barriers, 1 formal safety barrier, and 5 had no
safety barriers.

**Conclusions:** The majority of error/near-miss attributed to physician workflow are due to performance and communication issues; specifically communication with simulation therapists/dosimetrists. Furthermore our process maps do not adequately recognize the physician’s work, and reflect the inherent complexities of our processes. For the errors that actually reached the patient, review of the process maps demonstrated suboptimal safety barriers in about half of the cases. Modifications to or processes to increase safety barriers have been implemented. A formal reporting and assessment method appears helpful in improving processes to reduce errors.

**Author Disclosure:**  
**B.S. Chera:** A. Employee; University of North Carolina.  
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Do Emergent Treatments Result in More Severe Errors? Analysis of a Large Institutional Near-Miss Incident Learning Database


**Purpose/Objective(s):** Emergent treatments are a vital part of the care for patients with cancer but may be subject to more errors due to the compressed time frame. Little hard data exists, however, to guide safety improvement interventions. The purpose of this study is to examine the patterns of errors in emergent treatments using our large institutional incident reporting system.

**Materials/Methods:** Reports in the incident reporting database from January 2012 to October 2013 were prospectively reviewed by a multidisciplinary team to identify cases relating to emergent treatments or treatments initiated on weekends and holidays. Reports were scored for potential severity on a 0-4 scale where 4 is critical and 0 is none. The total number of emergent treatments during the same time period was obtained from the electronic medical record. Students T test and Fisher exact statistical tests were performed.

**Results:** Over the 21-month period examined, 1292 patients were treated, 190 of them emergently. For the 190 emergent treatments, 71 incident reports were logged (on 55 unique patients). Nineteen out of 71 emergent reports (26%) had a high severity score (>3) versus 14% for all other reports in the database related to non-emergent reports treatments (p<0.001). An example high-severity report is an isocenter shift made in planning that was not communicated to the rest of the treatment team resulting in a wrong isocenter which was subsequently detected on port films. The mean severity score for emergent reports was 1.90 vs 1.48 (p<0.001) for non-emergent reports. Emergent near misses were more likely to have gone on to the next step in the treatment pathway before being caught (p=0.002). Patients who were treated within 24 hours or less of simulation were not found to have higher severity scores compared with those treated after 24 hours (p=0.46). However, starting treatment on a weekend or holiday was associated with higher proportion of critical near misses than emergent patients during the week (37% vs 7.9%, p=0.034).

**Conclusions:** Our results suggest that emergent treatment patients are subject to more high-severity errors, especially when treated on the holidays or weekends. Errors also tend to be caught further downstream of the workflow pathway, possibly due to the compressed timeline. This data and associated error patterns informs ongoing safety improvement. Interventions include formalizing policies and procedures for patients treated emergently or on weekends and holidays and putting safeguards in place specifically for these patients.

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Review of High-Dose-Rate (HDR) Brachytherapy Plan Errors: Effect of Software-Aided Verification on Effectiveness and Efficiency of the Physics Plan Quality Assurance (QA) Process


Purpose/Objective(s): To compare the physics QA process for HDR brachytherapy treatment plans performed by experienced physicists using manual verification (MV) and software-aided verification via custom software (SAV). Both methods were compared in terms of (i) error rate, (ii) time required for verification and (iii) consequences for patient safety.

Materials/Methods: HDR brachytherapy plans treated in a single institution in 2013 were identified. QA of these plans had been performed initially using either SAV or MV. SAV custom software was designed to verify the internal consistency of the plan with the associated documentation, and the conformance with clinical policies. All plans were reanalyzed to identify errors in the QA process. Error rate (number of errors / total number of plans) was measured and statistical significance of SAV vs. MV was evaluated (p < 0.05; Fisher test). Verification time was calculated on all tandem and ring (T&R) plans and statistical significance of SAV vs. MV was evaluated (p < 0.05; Student T-test). All HDR brachytherapy safety events reviewed by our Quality Improvement Committee (QIC) between 2010 and 2013 were identified. The impact of SAV on the underlying errors was assessed.

Results: 377 plans were reviewed (106 SAV, 271 MV): 121 vaginal cylinders (31 SAV, 90 MV), 112 surface applicators (22 SAV, 90 MV), 79 intracavitary applicators (38 SAV, 41 MV), 43 interstitial (9 SAV, 34 MV), and 22 miscellaneous plans (6 SAV, 16 MV). 0 (0%) errors were found in the SAV group, while 13 (4.8%) errors were found in the MV group (p = 0.02): 7 mistyped patient identifiers, 3 plans not software protected against changes, 2 indexer length errors, and 1 plan with incorrect optimization points. No error resulted in a meaningful adverse effect to a patient. For the 72 T&R plans (33 SAV, 39 MV), the mean check time was 20 minutes (range 15 to 28) for SAV while it was 24 minutes (range 13 to 37) for MV (p = 0.008). A total of 12 HDR brachytherapy safety events were identified, 6 related to source handling and shielding, and 6 related to planning and treatments. Of the latter 6 events, 4 were associated with plan verification and could be detected by SAV. For 2 safety events, the underlying error could not be detected by plan verification alone.

Conclusions: When used by an experienced physicist, SAV significantly reduces the number of undetected errors in HDR treatment plans compared to MV. SAV also significantly reduces the time necessary to perform physics verification compared to MV performed by the same staff. Of the 12 HDR related safety events reviewed in our department, 4 (33%) could potentially have been prevented by the introduction of SAV.