original reports Implementing an Electronic Data Capture System to Improve Clinical Workflow in a Large Academic Radiation Oncology Practice

abstract

Purpose To describe the feasibility and benefits of implementing a custom radiation oncology electronic data capture (EDC) system in a large academic radiation oncology practice.

Patients and Methods A Web-based point-and-click EDC known as Brocade was internally developed and implemented systemwide in 2016. Brocade captures key data elements, such as stage, histology, and patient and treatment characteristics; links this information to radiation dose data extracted from the record and verify system; and creates clinical notes that are automatically exported to the hospital electronic health record. We report the number of unique radiation episodes captured by Brocade in its first full year of implementation and describe the notes generated, toxicities captured, compliance with staging and quality assurance, and time of day in which documentation occurred with Brocade versus our prior human transcription system.

Results A median of 756 radiation episodes per month was captured for a total of 9,283 unique episodes captured in the first full year of implementation. The most common notes were for on-treatment visits (29,913) and simulations (13,220). Stage was captured for 92.2% of Brocade episodes (8,513 of 9,236) versus 29.7% of courses pre-Brocade (3,025 of 10,170; $P < .001$). Quality assurance was documented for 96.3% of completed courses (7,601 of 7,892). The most common grade ≥ 1 toxicities were pain (10,031), fatigue (7,490), and dermatitis (6,172). Brocade implementation was associated with a reduction in off-hours documentation and increase in the proportion of documentation created between 8:00 and 12:00.

Conclusion Brocade is a reliable Web-based EDC tool that improves clinical documentation without detracting from clinical workflow. Moreover, Brocade has the advantage of capturing data in a structured manner that facilitates real-time analytics and outcome reporting.

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INTRODUCTION

Radiation oncology has a structured, predictable workflow from consult to treatment delivery to follow-up, but the tools to support the documentation of this workflow by using existing commercial electronic health records (EHRs) are limited and confer limited interoperability.¹ For example, radiation oncologists frequently must access at least two discrete systems—the radiation oncology–specific record and verify system and the general clinical EHR—to conduct the routine day-to-day work of on-treatment patient management and documentation. The duplication of work and lack of interoperability between systems results in the aggregation of lost time and frustration.² To compound these issues,

EHR implementation can lead to unexpected loss of provider free time as a result of a shift of note writing to after hours,³ no measurable decrease on documentation time,⁴ and a general loss in productivity.⁵ These limitations could worsen with the rising use of EHRs nationwide as a result of financial incentives⁶ and prioritization at a policy level.⁷

Web-based electronic data capture (EDC) systems have become a mainstay of randomized clinical trials as a means of collecting information in a structured format to allow for database storage, patient status tracking, real-time reporting, and outcome analysis.^{8,9} By limiting the amount of unstructured text through drop-down lists and radio buttons, the EDC can streamline

the collection of the highest quality data necessary for each patient encounter documented in the EHR. However, the integration of an EDC into standard clinical workflows remains challenging, with the Oncospace Consortium¹⁰ being one of the few success stories within the practice of oncology.

In 2013, The University of Texas MD Anderson Cancer Center Department of Radiation Oncology evaluated its documentation patterns and identified many gaps including (1) redundant work required to create multiple similar documents needed to support various aspects of the radiotherapy treatment course, (2) failure to document stage consistently, (3) failure to collect radiation toxicity data prospectively, and (4) inability to monitor the prospective quality assurance program electronically. After scanning the radiation EHR market, we concluded that no commercially available products would fill all these gaps. As a result, we opted to create and implement an EDC system that we named Brocade.

Brocade established a Web interface that links clinical details to a specific course of radiation treatment by drawing data elements from a radiation oncology-specific EHR with user-entered fields to generate structured notes populated into a clinical EHR. Initially, Brocade was limited to patients with breast cancer but was quickly adopted for all disease sites treated in the radiation oncology department given overall user satisfaction, reduction in clinical documentation time, and ease of data analysis.¹¹ This article describes the feasibility of implementing Brocade in our large academic practice and the gains made in filling the gaps.

PATIENTS AND METHODS

Overview

The information management systems at The University of Texas MD Anderson Cancer Center can be divided into general clinical EHR (Epic, Verona, WI) and a radiation oncology-specific record and verify oncology information system (MOSAIQ; Elekta, Stockholm, Sweden). In 2013, an information technology development team embedded within the Department of Radiation Oncology was tasked with developing and implementing a Web-based EDC system, subsequently named Brocade, to act as an intermediary

between the general clinical EHR and MOSAIQ as a means of consolidating clinical information, reducing redundancy, and improving completeness of documentation. Before Brocade implementation, tumor stage and histology could be entered into MOSAIQ, but compliance with this data entry could not be easily enforced or monitored. Similarly, we had no means of electronically monitoring quality assurance review (ie, chart rounds) or collecting acute toxicity data.

In early 2014, Brocade was initially deployed on the breast radiation oncology service. Brocade provides a user-friendly point-and-click Web interface that eliminates the need for extensive typing or dictation. Structured, disease site-specific elements are captured through adaptive forms that respond to user input to capture specific data elements relevant to the clinical scenario. For example, for a patient with breast cancer treated with neoadjuvant chemotherapy, questions about the initial clinical stage and work-up appear. In contrast, if the patient was treated initially with surgery, only questions about the pathologic stage and findings appear.

During its initial development stages, a generic Brocade template was available that still relied heavily on free-text input. However, custom, disease site-specific structured templates gradually were created in partnership with clinicians and developers to eliminate as much free-text input as possible. National standards were used whenever possible to establish note templates. For example, Brocade integrates the National Cancer Institute Common Terminology Criteria for Adverse Events (version 4.0; CTCAE)¹² into on-treatment visit notes. Each disease site-specific page was designed to display contextualized, relevant data elements logically and hide extraneous information (eg, dyspnea toxicity and grading is displayed for thoracic patients but not genitourinary patients).

Three disease sites—breast, GI, and head and neck—had customized templates at the time of our Epic go live in March 2016. Subsequently, disease site-specific pathways for genitourinary, hematologic, and thoracic malignancies were launched in October 2016; gynecologic malignancies in March 2017; melanoma, sarcoma, and pediatrics in May 2017; and CNS malignancies in October 2017. All data elements are stored in a Structured Query Language database. Data security includes secure socket layer

network encryption and logging of health information accession by users.

Statistical Analysis

For this analysis, we focused on the first complete year in which Brocade was used throughout our department from March 2016 through February 2017. To establish feasibility, we report the number of unique episodes of radiation therapy registered in Brocade per month during this time window. To establish reduction in redundant work (gap 1), we report the number and type of notes generated by Brocade during this time window. Because each Brocade note relies on key data elements (eg, stage, surgery, narrative history) that are documented only once per episode and automatically incorporates the radiation prescription and delivered dose pulled directly from the MOSAIQ data tables, each note thus represents a reduction in redundant documentation compared with our departmental standard in 2014. To establish capture of tumor stage (gap 2), we used Pearson's χ^2 test to compare completeness of stage data in the first year of Brocade versus completeness of stage data using MOSAIQ in the year before implementing Brocade. To establish capture of acute toxicity (gap 3), we characterized the frequency and type of acute toxicities collected through Brocade during this time window. To characterize our quality assurance program (gap 4), we characterized the number of discrete quality assurance reviews and their outcomes for patients who completed a radiation course during this time window. As additional evidence to support feasibility, we determined time of day when Brocade notes were generated and qualitatively compared this with the time of day when dictations were completed before the launch of Brocade. A formal test of statistical significance was not applied to this comparison because the units being compared were not equivalent (ie, cumulative dictation time by hour of the day for dictation v hour of the day at which a note was generated for Brocade).

RESULTS

Overview of Brocade Workflow and Implementation

Figure 1 shows the following stepwise clinical workflow as a result of implementing Brocade:

1. The patient is first registered in MOSAIQ, which allows for the creation of a radiation treatment course with associated prescription, dose fractionation, simulation schedule, appointment times, and general demographic information.
2. A patient episode is created in Brocade and linked to the corresponding diagnosis and treatment course in MOSAIQ (Appendix Fig A1). For each episode, a disease site-specific EDC form is completed in Brocade that captures structured data elements, including clinical and/or pathologic staging by the American Joint Committee on Cancer seventh edition, disease-specific risk factors, tumor characteristics, chemotherapy history, and surgical history. In the event that two different diagnoses will be treated during one radiation episode (eg, synchronous bilateral breast cancer), each diagnosis may be registered separately within the episode to allow for capture of structured data elements for each diagnosis.
3. Brocade uses the EDC data to generate a clinical vignette that is edited and approved by the clinician and then carried into subsequent note templates to provide a basic oncologic history.
4. Brocade then allows users to access an interface to provide note templates for documenting simulation setups (Appendix Fig A2), treatment planning, quality assurance review (eg, chart rounds), on-treatment visits, and the radiation treatment summary. Each note template is disease site specific and uses an EDC approach to capture structured data, which are presented within a narrative-style text document that is sent to Epic through a Health Level Seven interface and signed through the Epic transcription interface. The on-treatment visit note captures subjective and objective toxicities on the basis of CTCAE and supportive care treatments. The radiation treatment summary (Appendix Fig A3) automatically summarizes and catalogs maximal toxicities during radiation (imported from the weekly on-treatment visit notes) in addition to details about the radiation course abstracted from the MOSAIQ dose data tables through a Structured Query Language server query.

Fig 1. Clinical workflow steps that integrate MOSAIQ, Epic, and Brocade. AJCC, American Joint Committee on Cancer.

During the course of its existence, Brocade uptime has exceeded 99% and has not caused any significant delays in clinic workflow. Compliance with use of Brocade essentially has been 100% because Brocade offers the most efficient pathway to note creation within our current EHR structure.

Feasibility: Unique Episodes of Radiation Registered in Brocade

From March 2016 through February 2017, a total of 9,238 unique episodes of radiation therapy were registered in Brocade. The median number of patient registrations per month was 756, which peaked at 1,095 in October 2016 (Fig 2). This peak corresponded with a change in Brocade to enforce a business rule that new courses of radiation require the creation of a new treatment episode.

Gap 1: Addressing Redundant Documentation

From March 2016 to February 2017, a total of 67,754 notes were created by Brocade and sent

to the hospital EHR (Epic), which represents an average of 7.3 notes per episode. Figure 3 shows the number and type of Brocade notes generated during this interval. Weekly on-treatment visit and simulation notes accounted for the majority of generated notes at 29,913 and 13,220, respectively. The total notes per month steadily increased since March 2016, peaking in August 2016 at 6,195 (Fig 2).

Gap 2: Capturing Stage

Before implementation of Brocade, entry of cancer stage in MOSAIQ was possible but optional, and our retrospective evaluation of staging compliance in the year before implementing Brocade indicated that 29.7% of treatment episodes (3,025 of 10,170) had stage documented in a structured manner. Subsequent to implementation of Brocade, structured cancer stage was captured in 92.2% of treatment episodes (8,513 of 9,238; $P < .001$). After the implementation of Brocade, the primary patients without a documented stage were those with unstaged cancers, such as primary CNS malignancies.

Fig 2. Trend of total notes generated and total patients registered in Brocade.

Gap 3: Capturing Acute Toxicity

A total of 33,396 acute toxicities were documented across the 9,238 episodes of care during this time interval. Figure 4 shows the top 10 most common grade ≥ 1 toxicities documented through Brocade during weekly on-treatment visits. Pain, fatigue, and dermatitis comprised the majority of toxicities (10,031, 7,490, and 6,172 events, respectively). Pain can be further subdivided into breast pain (11.8% [1,184 of 10,031]), esophagitis (11.3% [1,135 of 10,031]), dysphagia (10.9% [1,095 of 10,031]), headache (7.4% [746 of 10,031]), shoulder arthralgia (2.5% [253 of 10,031]), mucositis (1.59% [159 of 10,031]),

dermatitis pain (0.74% [74 of 10,031]), cystitis (0.15% [15 of 10,031]), and not otherwise specified (53.5% [5,370 of 10,031]).

Gap 4: Electronically Monitoring Quality Assurance

Of the 9,238 episodes, 7,892 were completed by February 2017 and documented with a radiation treatment summary. Of these completed episodes, 7,601 had at least one quality assurance note prospectively generated, which indicates that the plan was reviewed and discussed by at least two other radiation oncologists. This translates into a quality assurance documentation rate of 96.3% (7,601 of 7,892). Brocade collected the following data on outcomes of quality assurance review: 88.6% of plans were approved (n = 6,732), 7.1% were approved with discussion about potential issues (n = 538), 3.6% required a minor revision of limited clinical relevance (n = 276), and 0.7% required a more significant revision that could be clinically relevant (n = 55).

Fig 3. Quantity and type of notes generated in Brocade over the course of 1 year.

Additional Feasibility Data

Figure 5 shows a normalized histogram that compares the hourly distribution of clinician time spent while creating clinical documentation. From March 1, 2015, to February 29, 2016 (pre-Brocade), traditional medical transcription services were used to create clinical documentation. From March 1, 2016, to February 28, 2017 (and ongoing), Brocade was used to create clinical documentation. Figure 6 shows a summary of these data as the percentage of

Fig 4. Top 10 most-common grade ≥ 1 toxicities documented with the use of Brocade during weekly on-treatment visits.

documentation accomplished per three distinct time blocks: morning (8:00 to 12:00), afternoon (12:00 to 5:00), and after hours (5:00 to 8:00). The majority of documentation (50%) using Brocade occurred during the morning compared with traditional dictation (44%). After-hours documentation was also more common with traditional dictation compared with Brocade, accounting for approximately 6% versus 3% of documentation, respectively.

DISCUSSION

In 2014, the existing commercially available products did not support our large academic

department's need for a highly reliable charting system that would support efficient documentation and structured data collection while facilitating our quality assurance program. In response, we designed Brocade, an EDC tool embedded within the radiation oncology workflow. Through this custom-designed tool, we were able to enhance clinical efficiency and reduce redundant effort in duplicative documentation. We also were able to create a highly reliable system for capturing stage (92%), acute radiation toxicity, and outcomes of the quality assurance plan review (documented in 96% of patients with a treatment summary). Thus, Brocade successfully met its goals and stands as a

Fig 5. Normalized histogram that compares hourly distribution of clinician time spent while creating clinical documentation.

unique success story in an era of rising adoption of EHRs that frequently run the risk of serving as mere data dumping grounds for routine clinical care.^{2,6,7,13}

Brocade minimizes free-text entry through the use of structured data elements, which thereby allow the capture of structured clinical information as a by-product of routine care. Information broken down into smaller, structured pieces can be stored in a logical manner to allow for assembly into clinical notes and future prospective outcome analysis. With respect to the latter, this step is the first in empowering a learning health system for radiation oncology, akin to the ASCO CancerLinQ.¹⁴ Systems like this rely heavily on data processing that can only be accomplished by machines if the information is easily interpretable through structured data elements. By capturing these essential data elements, Brocade lays the foundation for future inputs into a predictive analytics platform. In the absence of such structured data, entities such as CancerLinQ and Flatiron Health (New York, NY)¹⁵ have resorted to using a combination of technology and trained abstractionists to review the medical record and code structured covariables and outcomes from the charts of patients with cancer. This approach not only is labor intensive and expensive but also fails to capture data elements that may not be routinely captured by unstructured documentation, such as dermatitis grade and severity, fibrosis, and certain key cosmetic or functional outcomes. In contrast, by incorporating disease site-specific CTCAE toxicities with their accompanying definitions, Brocade lends itself to accurate, efficient, and cost-effective real-time capture of all major and relevant radiation-associated acute toxicities by the treating radiation oncologist. Before Brocade, our department did not have a reliable method

to capture toxicities for on-treatment weekly visits or treatment summaries; therefore, the improvement Brocade engenders has enabled the establishment of a novel safety monitoring and quality improvement system. Brocade also has added value to the safety culture through a robust quality assurance workflow because at least 96% of treatment plans are verified by at least two other radiation oncologists and the discussion or proposed changes can be tracked. Moreover, Brocade has allowed for the quality assurance workflow to be standardized across five practices from the main campus to all satellite facilities, which thereby facilitates monitoring across a large geographic distribution.

However, capture of structured data elements within routine clinical workflows should not degrade clinical efficiency. Although upfront effort is required in Brocade to capture discrete data during the creation of a new treatment episode, the ability to reference this information and automatically pull it into subsequent notes actually improves clinical efficiency. Findings from the current manuscript build on our prior study, illustrating that the adoption of Brocade is associated with a shift of clinical work to more-normal work hours and away from late-night work.¹¹ In addition, the system has improved overall completeness of documentation, such as staging, while maintaining a robust stream of patients as evidenced by the number of treatment episodes registered and notes generated.

Moreover, the burden of documentation can be spread across team members because anyone with Brocade access, within the scope of federal and state regulations, may assist in generating clinical notes. The most meaningful clinical information can be captured by someone who is unfamiliar with a particular service, such as a rotating resident physician or advanced practice provider, and is immensely helpful when an attending physician is covering clinic for a physician on leave. These efficiencies are enabled by the considerable time and effort invested in generating the standardized disease site-specific templates to reconcile the most important data elements for each disease site, requiring input and expertise from clinicians and developers working hand in hand. Finally, one of the most appealing features is the Web-based interface that can be integrated with essentially any clinical or radiation oncology-specific EHR. Brocade

Fig 6. Percentage of documentation accomplished in the morning, afternoon, and after hours by traditional dictation versus Brocade over the course of 1 year.

is a proof of concept that integrates the record and verify system of radiation oncology/physics with essential charting requirements that can communicate with a major clinical EHR. As such, Brocade could be implemented readily at most private or academic radiation oncology practices without significant changes to the existing EHR, upfront financial costs, or disruption in clinical workflow. At the very least, the development of Brocade can serve as a roadmap for other institutions that seek to develop

custom solutions to these complex charting and workflow issues. Future work will focus on improving clinical workflow, including the ability to generate follow-up notes as well as using the current data elements as inputs for big data initiatives and predictive analytics.

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ASCO's conflict of interest policy, please refer to www.asco.org/rwc or ascopubs.org/jco/site/ifc.

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No relationship to disclose

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Patents, Royalties, Other Intellectual Property: Through employer, equity interest in Oncora Medical as part of a partnership agreement

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REFERENCES

1. Pan HY, Mazur LM, Martin NE, et al: Radiation oncology health information technology: Is it working for or against us? *Int J Radiat Oncol Biol Phys* 98:259-262, 2017
2. Shen X, Dicker AP, Doyle L, et al: Pilot study of meaningful use of electronic health records in radiation oncology. *J Oncol Pract* 8:219-223, 2012
3. McDonald CJ, Callaghan FM, Weissman A, et al: Use of internist's free time by ambulatory care electronic medical record systems. *JAMA Intern Med* 174:1860-1863, 2014
4. Poissant L, Pereira J, Tamblyn R, et al: The impact of electronic health records on time efficiency of physicians and nurses: A systematic review. *J Am Med Inform Assoc* 12:505-516, 2005

5. Jones SS, Heaton PS, Rudin RS, et al: Unraveling the IT productivity paradox--Lessons for health care. *N Engl J Med* 366:2243-2245, 2012
6. Blumenthal D: Stimulating the adoption of health information technology. *N Engl J Med* 360:1477-1479, 2009
7. Kohn LT, Corrigan J, Donaldson MS: *To Err Is Human: Building a Safer Health System*. Washington, DC, National Academies, 2000
8. Litchfield J, Freeman J, Schou H, et al: Is the future for clinical trials internet-based? A cluster randomized clinical trial. *Clin Trials* 2:72-79, 2005
9. El Emam K, Jonker E, Sampson M, et al: The use of electronic data capture tools in clinical trials: Web-survey of 259 Canadian trials. *J Med Internet Res* 11:e8, 2009
10. McNutt T, Wong J, Purdy R, et al: OncoSpace: A new paradigm for clinical research and decision support in radiation oncology. Amsterdam, the Netherlands, May 31-June 3, 2010
11. Pan HY, Shaitelman SF, Perkins GH, et al: Implementing a real-time electronic data capture system to improve clinical documentation in radiation oncology. *J Am Coll Radiol* 13:401-407, 2016
12. National Cancer Institute: Common Terminology Criteria for Adverse Events (CTCAE) Version 4.0. https://www.eortc.be/services/doc/ctc/CTCAE_4.03_2010-06-14_QuickReference_5x7.pdf
13. Hsiao CJ, Hing E: Use and characteristics of electronic health record systems among office-based physician practices: United States, 2001-2013. *NCHS Data Brief* (143):1-8, 2014
14. Sledge GW, Hudis CA, Swain SM, et al: ASCO's approach to a learning health care system in oncology. *J Oncol Pract* 9:145-148, 2013
15. Liede A, Hernandez RK, Roth M, et al: Validation of International Classification of Diseases coding for bone metastases in electronic health records using technology-enabled abstraction. *Clin Epidemiol* 7:441-448, 2015

Cancer ROADS Brocade

Schedule Registration Event Manager Worklists QA

MRN: Gender: DOB:

Protocol:

Episode Registration History Cancel New Episode

Date	Episode	Service	Pathway	Diagnosis	Form	ICD-10/9	Description	
9-8-2017	1	Thoracic	Generic	1	Generic	C34.11	Malignant neoplasm of upper lobe, right bronchus or lung	Copy Registration
4-5-2018	2	Head & Neck	Generic	1	Generic	C79.31	Secondary malignant neoplasm of brain	Copy Registration

Registration Date:

Service:

Pathway: ☒ Generic ☐ Other

Episode Details

Treatment Intent: ☐ Curative ☒ Palliative ☐ Benign

Palliative Options: ☐ Whole Brain ☐ Brain Met ☐ Bone Met ☐ Cord Compression ☐ Intrathoracic Symptoms

☐ Other

Patient History

Electronic Medical Devices: ☐ Yes ☐ No

Radiation History

Was there prior radiation treatment not reflected in MOSAIQ? ☐ Yes ☐ No

Prior Radiation Treatment at MD Anderson

Course	Region	Modality	Start Date	Last Date	Dose	Fractions	Total Dose
1	R lung/med	x06			150 cGy	30/30	4500/4500 cGy

MOSAIQ Diagnosis

Date	ICD-10/9	Diagnosis
☐	C79.31	Secondary malignant neoplasm of brain
☐	C34.11	Malignant neoplasm of upper lobe, right bronchus or lung

Treatment Detail

Current Disease: ☐ First Diagnosis ☐ Stage IV ☐ Recurrent

Modality: ☐ External Beam ☐ SBRT ☐ SRS ☐ Hypofx IMRT ☐ Brachytherapy

Laterality: ☐ Left ☐ Right ☐ Bilateral ☐ Midline ☐ Not Paired ☐ N/A

Common Histology: ☐ adenocarcinoma ☐ invasive ductal carcinoma ☐ large cell carcinoma ☐ neuroendocrine carcinoma

☐ small cell carcinoma ☐ squamous cell carcinoma ☐ Hodgkin lymphoma ☐ melanoma

☐ acute lymphoblastic leukemia ☐ acute myelogenous leukemia ☐ non-Hodgkin lymphoma, NOS ☐ sarcoma, NOS

☐ Other

Current Treatment Course

Concurrent Chemotherapy: ☐ Yes ☐ No

[Build Patient History](#)

Fig A1. Brocade patient registration template for a generic palliative care patient. DOB, date of birth; Hypofx IMRT, hypofractionated intensity-modulated radiation therapy; ICD 10/9, International Classification of Diseases, Tenth or Ninth Revision; med, mediastinum; Met, metastasis; MRN, medical record number; N/A, not available; NOS, not otherwise specified; QA, quality assurance; R, right; SBRT, stereotactic body radiation therapy; SRS, stereotactic radiation surgery.

Cancer

ROADS Brocade

Schedule

Registration

Event Manager

Worklists

QA

MRN:

Gender:

DOB:

Protocol:

Clinician / Transcriber Details

Clinician

MD

Transcriber

MD

MOSAiq Prescription

Diagnosis	Course	Site Name	Technique	Modality	Fractions	Dose	Total Dose
☐ 1 - Right Malignant neoplasm of upper lobe, right bronchus or lung <i>P: 4D CT SIM, IMRT QA, STP, SPC C: Daily kv, bi-weekly CBCT (CBCT first day pls), 6hr tft</i>	1	R lung/med	VMAT	x06	30	150.00 cGy	4500.00 cGy
☐ Secondary malignant neoplasm of brain <i>P: CT sim, aquaplast mask C: Weekly kv imaging</i>	1	Whole brain	opposed laterals	x06	10	300.00 cGy	3000.00 cGy

Simulation Type

Simulation ...

04-05-2018

SIM Type

☐ Initial
 ☐ Boost
 ☐ Replanning
 ☐ Verification
 ☐ Clinical
 ☐ Initial block check
 ☐ Boost block check
 ☐ Electron block check
 ☐ Brachytherapy
 ☐ other
 Enter comment...

Performance Scale

Scale

☐ ECOG
 ☐ Karnofsky (patient age >= 16-years)

Simulation Details

Attending physically present	☐ yes	☐ no
Consents	☐ present in chart	☐ pending
Pregnancy status	☐ N/A	☐ documented in consent
	☐ other	<input type="text"/> Enter comment...
Timeout performed	☐ yes	☐ no
Simulator	☐ CT simulator	☐ treatment machine
	☐ other	<input type="text"/> Enter comment...
Body position	☐ supine	☐ prone
	☐ other	<input type="text"/> Enter comment...
Arm position	☐ abducted	☐ akimbo
	☐ other	<input type="text"/> Enter comment...
Arm laterality	☐ left	☐ right
	☐ other	<input type="text"/> Enter comment...
Radiopaque markers	☐ none	☐ surgical scars
	☐ other	<input type="text"/> Enter comment...
Marked Isocenter	<input type="text"/> Enter Detail...	
Custom immobilization	☐ upper Vac-Lok	☐ lower Vac-Lok
	☐ other	<input type="text"/> Enter comment...
Non-custom immobilization	☐ wing board	☐ MedTec device
	☐ other	<input type="text"/> Enter comment...
Breath hold	☐ breath hold	☐ 4DCT
Custom blocking	☐ yes	☐ no
Avoidance Structures	☐ eye	☐ pharynx
	☐ kidney	☐ rectum
	☐ cauda equina	☐ sacral nerve roots
	☐ none	<input type="text"/> Enter comment...
Custom electron cutout	☐ yes	☐ no
Planned modality	☐ 2D	☐ 3D
	☐ SBRT	☐ HypoFX IMRT
Tolerance of simulation	☐ well	☐ problem as follows:
	☐ other	<input type="text"/> Enter comment...
Patient status	☐ outpatient	☐ inpatient

Create Sim Note

Fig A2. Brocade simulation note template. CBCT, cone beam computed tomography; CT, computed tomography; D, dimensional; DOB, date of birth; ECOG, Eastern Cooperative Oncology Group; HypoFX, hypofractionated; IMRT, intensity-modulated radiation therapy; MRN, medical record number; N/A, not applicable; QA, quality assurance; SBRT, stereotactic body radiation therapy; SIM, simulation; SPC, special physics consult; STP, special treatment procedure; VMAT, volumetric-modulated arc therapy.

Cancer
ROADS
Brocade
Schedule
Registration
Event Manager
Worklists
QA

MRN:
Gender:
DOB:

Protocol:

Clinician / Transcriber Details

Clinician
MD
Transcriber
MD

MOSAIQ Dose Site Summary

Course	Site Name	Start Date	Last Date	Elapsed Days	Fractions	Dose	Total Dose	Modality	Technique
1	BOT/bilat neck			44	33/33	210 cGy	6930/6930 cGy	x06	IMRT
1	SCV			27	20/20	200 cGy	4000/4000 cGy	x06	AP
1	SCV MLB			7	5/5	200 cGy	1000/1000 cGy	x06	AP
1	midnk boost PA			7	5/5	200 cGy	1000/1000 cGy	x15	PA
1	lt midnk e boost			3	3/3	200 cGy	600/600 cGy	e09	LAO
1	rt midnk 9e			3	3/3	200 cGy	600/600 cGy	e09	rao
1	Rt E MNB2			1	1/1	200 cGy	200/200 cGy	e09	rao

Major Toxicities

The patient experienced the following maximal toxicities:

Maximal Toxicities
- Dermatitis: Grade 2
- Pain: Grade 2

Comments
Enter Comment...

Major Side-Effects & Interventions

Response
☐ none/no additional
☐ dehydration requiring IV fluids
☐ hospitalization(s)
☐ pain requiring narcotic pain medications
☐ malnutrition requiring feeding tube placement
☐ treatment breaks
☐ skin desquamation requiring topical treatments
☐ ER visit(s)

Comments
Enter comment...

Follow-Up Plan

Follow-Up
☐ return to Radiation Oncology in 00 month(s)
☐ follow-up with the following physicians: Physicians:
☐ follow-up per the Continuity of Care Pathway
☐ discharge to primary service
☐ patient declines further follow-up
☐ follow-up per protocol: Protocol(s):

Comments
Enter comment...

Create Summary Note

Fig A3. Brocade treatment summary template. 9e, 9 MeV electron; AP, anterior-posterior; bilat, bilateral; BOT, base of tongue; DOB, data of birth; e, electron; ER, emergency room; IMRT, intensity-modulated radiation therapy; IV, intravenous; LAO, left anterior oblique; lt, left; midnk, midneck; MLB, modified lateral beam; MNB2, midneck boost 2; MRN, medical record number; PA, posterior-anterior; QA, quality assurance; rao, right anterior oblique; rt, right; SCV, supraclavicular.