Planning And Delivering HDR Accelerated Partial Breast Irradiation TREATMENTS

Acceptance Testing For HDR Planning, Remote Afterloader And APBI Applicators

Angelina Bacala, PhD

OUTLINE

- Short description of the high dose rate (HDR) brachytherapy for Accelerated Partial Breast Irradiation (APBI)
- Introduction to Oncentra planning system and acceptance procedures for a new source
- The applicators: Savi, Contours, ML Mammosite and acceptance testing
- A preview of the remoteafterloader

HDR BRACHYTHERAPY FOR APBI

- APBI
  - An approach that treats only the lumpectomy bed plus a 1-2 cm margin[1]
  - A decreased dose to normal tissue
  - Tumor size < 3 cm[1]
  - Patient selection criteria, table 1[2]

Table 1[2]

American Brachytherapy Society (ABS) acceptable criteria for partial breast irradiation

Criteria	
Age	≥ 50 years old
Size	≤ 3 cm
Histology	All invasive subtypes and DCIS
Estrogen receptor	Positive/negative
Surgical margins	Negative
Lymphovascular space invasion	Not present
Nodal status	Negative

Fraction, target volumes, and acceptance criteria

- Fractionation: the most common 34 Gy in 10 fractions twice a day (BID) for interstitial and intracavity[3]
- Dose limitations for normal tissues: uninvolved normal breast, ideally <60% of the whole breast reference volume should receive ≥ 50% of the prescribed dose[3]
- PTV-eval is the breast tissue volume bounded by the uniform expansion of the balloon/cavity radius in all dimensions less the balloon/cavity volume
- Dose volume histogram (DVH) analysis of target coverage will confirm ≥90% of prescribed dose covering ≥90% of the PTV-eval

Fractionation, target volumes, and acceptance criteria[3]

- (%PTV-eval coverage) - [(vol trapped air/vol PTV-eval) x 100] =≥ 90%
- At least 95% of the PTV-eval receiving 90% of the prescribed dose
- The volume of air/fluid trapped in PTV-eval < 10%
- V150 ≤ 50 cc
- V200 ≤ 20 cc
- Skin ≤ 100 % of the prescribed dose

ONCENTRA PLANNING SYSTEM AND ACCEPTANCE PROCEDURES

Import[4] 

- Location of DICOM import files received by OTP Dicomserver: C:\OTP_DATA \DICOM\INCOMING

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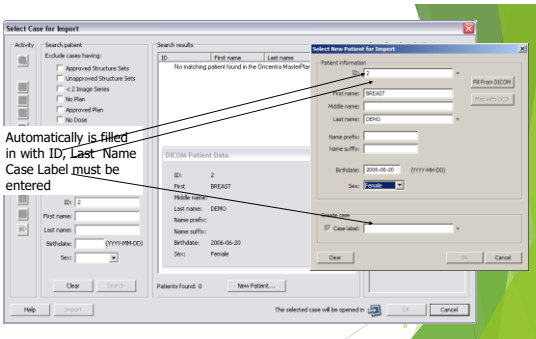

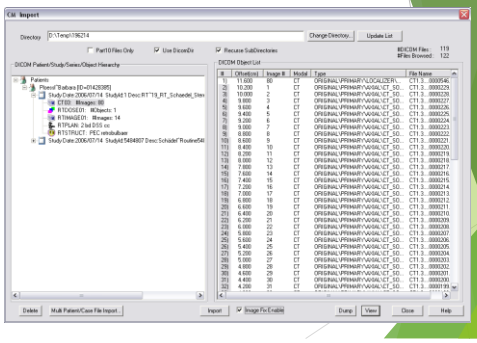

- **Brachy planning activity**[4]
  - Source definition: select a Nucletron remote afterloading system with a specific calibrated radioactive source for HDR brachytherapy
  - Catheter reconstruction: reconstruct the catheters using the acquired images (manually or automatically)
  - Activation of source dwell positions: define which source dwell positions in the catheters are activated for treatment (manually or automatically)
  - Defining points: for reporting and normalization on patient, applicator or dose points

- Dose normalization: set the reference isodose line with a selected normalization method
- Dose optimization: optimize the homogeneity and shape of the target dose distribution while sparing normal tissue
- Dose prescription: assign an absolute dose (cGy) to a relative dose (%), typically 100%
- Plan evaluation: calculate and evaluate DVHs, review planar isodose distributions, review 3D reconstructed doses
- Plan reporting: treatment printout
- Plan exporting: the treatment plan can be exported to another treatment planning system or to afterloader

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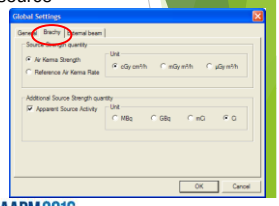
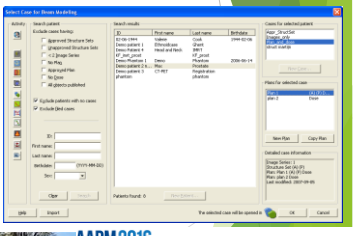
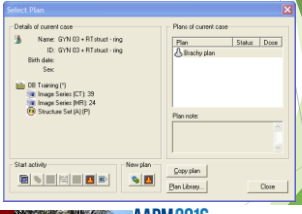
- **Preparing the system**[4]
  - Defining the afterloader and source: Before making a treatment plan, the Radiation Data Storage (RDStore) tool is used to define the treatment machine (afterloader and source
  - Global system settings for brachy:



- **New plan**[4]
  - Can be created opening the BP activity
  - Or using the Search View

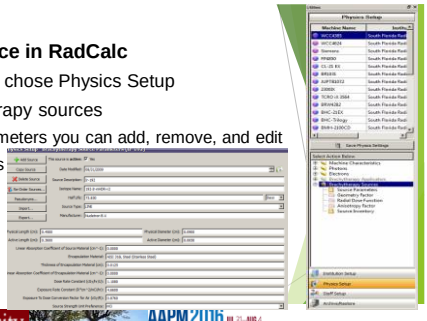


- **New plan**[4]
  - Clicking “select plan” in the portal menu (or F7)
  - You ca also copy a plan

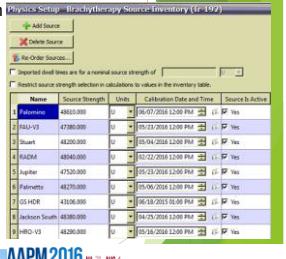


- **Verifying import and export of images**
  - Attend the scanning process, evaluate the images and the patient's positioning
  - Import the images and compare with the CT scanner's images and the measurements the therapist took at the scanning time
- **Dose calculation**
  - The best is using a secondary dose calculation by: developing your own dose calculation spreadsheet or using a 3rd party software like MUcheck, Radcalc, and others

- **Entering the source in RadCalc**
  - Go in utilities and chose Physics Setup
  - Select Brachytherapy sources
    - In Source Parameters you can add, remove, and edit source parameters



- In Source Inventory you can add, remove, and enter the source strength and the date of calibration

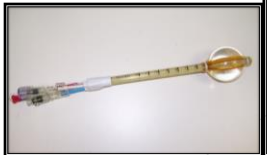


APPLICATORS USED FOR THE APBI TREATMENTS

- Multi Lumen Mammosite (MLM)
  - Balloon filled with water and contrast
  - 4 catheters, one central and 3 around

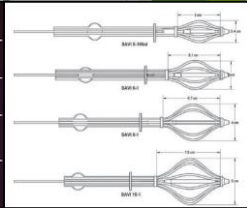
APPLICATORS USED FOR THE APBI TREATMENTS

- Contura
  - Balloon filled with water and contrast
  - 5 catheters, one central and 4 around



APPLICATORS USED FOR THE APBI TREATMENTS

- Savi
  - Wisk like wires
  - Multiple sizes

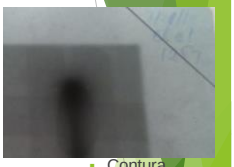


Before use verifications

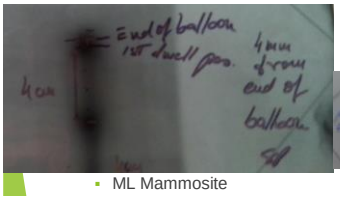
- Diameter when balloon filled or Savi expanded
- Treating length
- Measure distance to first dwell position

Before use verifications

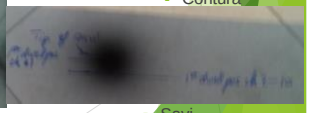
- Locate the first dwell position



- Contura



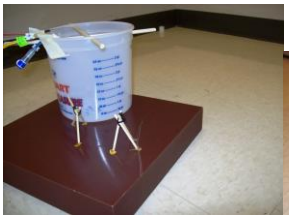
- ML Mammosite



- Savi

Before use verifications

- Measure the delivered dose



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Planning for APBI using Savi, Contura and ML Mammosite applicators

Silvia Pella, PhD, DABR

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OUTLINE

- Short description of the high dose rate (HDR) brachytherapy dose calculation
- Importing Ct scans
- Catheters reconstruction
- Enter prescription
- Planning
- Evaluating the plan
- Exporting the plan

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- Goal: achieve a dose distribution that will treat the PTV without exceeding normal tissue tolerances
- Parameters needed
  - Source type
  - Source length
  - Number of source positions
  - Spacing
  - Dwell times in each position

HDR BRACHYTHERAPY DOSE CALCULATION

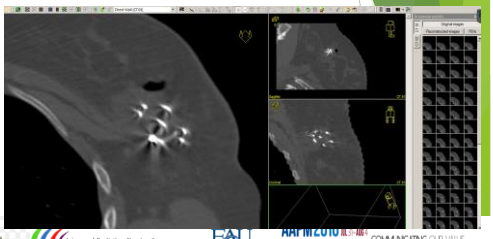
- Dose calculation
  - TG 43 algorithm
  - Two-dimensional (2D) dose-rate equation

$$D_r(r,\theta) = S_k \cdot \Gamma \cdot G(r,\theta) \cdot g(r) \cdot F(r,\theta)$$

  - S_k = air kerma strength (1U= 1μGy m^2 h^{-1})
  - Γ = dose rate constant (cGy h^{-1} U^{-1})
  - G (r,θ) = geometry factor
  - g (r) = radial dose function
  - F (r, θ) = anisotropy function

IMPORTING THE IMAGES

- Using the method described in the previous presentation we import the patient's scans

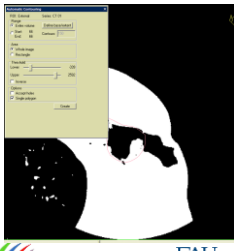


IMPORTING THE IMAGES

- Enlarge the upper corner image and chose Point selection tab to make the images perpendicular to contour the Cavity/balloon - CTV.

Structures segmentation

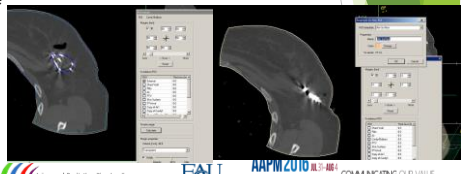
- Generate the External structure using the automatic contouring feature



Structures segmentation

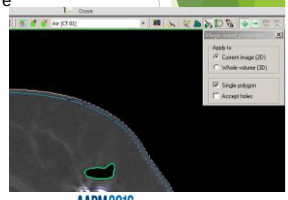
- Skin:
  - Shrink the External structure with 2 mm and generate a new structure – help
  - Extend the cavity with 40-50 mm electing to avoid the External and help structures this will give you

the skin structure



Structures segmentation

- Air: use the Magic Wand feature to fill the air space
  - Then subtract the cavity's volume from the air without creating a new structure

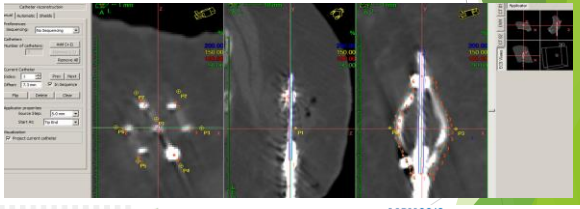


Structures segmentation

- Ribs: using Magic wand and choosing the proper contrast
- Chest wall: contour the chest wall in all the slices that will contain the PTV
- PTV: expand the CTV with 10 mm avoiding the skin surface and the chest wall and keeping a distance of 1 mm between the PTV's wall and the two other structures

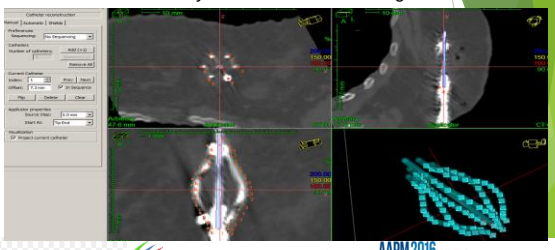
Catheters reconstruction

- Being in the ECS view identify the catheter positions and numbers and enter a point for easy recognition for each of them



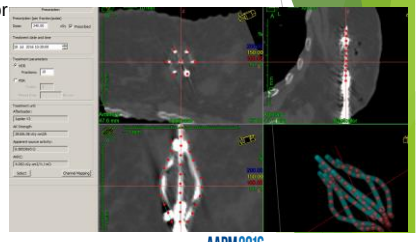
Catheters reconstruction

- Once reconstructed verify them and enter the lengths and the offset.



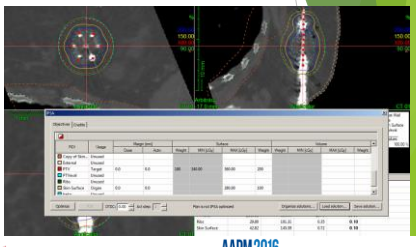
Entering the prescription

- Check that you have the physician's prescription and enter the prescription. Check for the correct source



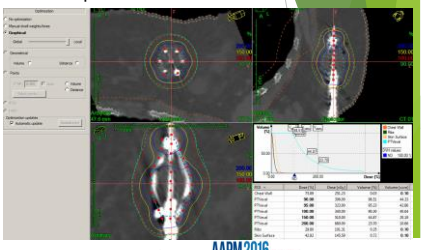
Optimization

- Using IPSA you can optimize automatically



Optimization

- Or you can perform a manual optimization

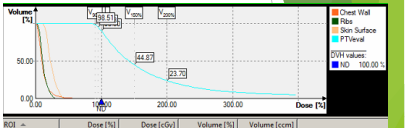


Optimization

- Or you can use the normalization function using points placed on the PTV

Evaluating the plan

- Dose volume histogram (DVH)
  - Generate and use to analyze the quality of the plan



ROI	Dose [%]	Dose [cGy]	Volume [%]	Volume [ccm]
Chest Wall	73.89	251.23	0.03	**0.10**
PTVeval	**90.00**	306.00	98.51	44.23
PTVeval	**95.00**	323.00	95.23	42.86
PTVeval	**100.00**	340.00	90.30	40.64
PTVeval	**150.00**	510.00	44.87	20.19
PTVeval	**200.00**	680.00	23.70	10.66
Ribs	29.80	101.31	0.35	**0.10**
Skin Surface	42.82	145.59	0.72	**0.10**

Evaluating the plan

- Use the B39 criteria

	Volume (cc)		Distance (mm)	Diameter (mm)
PTV_{EVAL}	79.65	Skin (min)	2.8	
Cavity	52.15	Ribs (min)	2.5	47.1
	Cc	%*	Goal	Accept
Air	2.86	3.59%	≤ 10 % of PTV_{EVAL}	≤ 10 % of PTV_{EVAL}
Max Skin Dose	0.1	98.59	≤ 125 %	≤ 145%
Max Rib Dose	0.1	80.96	≤ 125 %	≤ 145%
$PTV_{EVAL}V_{90}$	77.26	93.41%	≥ 95 %	≥ 90 %
$PTV_{EVAL}V_{95}$	74.88	90.42%	--	--
$PTV_{EVAL}V_{100}$	71.77	86.52%	--	--
$PTV_{EVAL}V_{150}$	30.23	--	≤ 50cc	≤ 50cc
$PTV_{EVAL}V_{200}$	12.65	--	≤ 10cc OR ≤ 20cc SAVI	≤ 10cc OR ≤ 20cc SAVI

* % coverage reported reflects the air volume subtracted as per B-39

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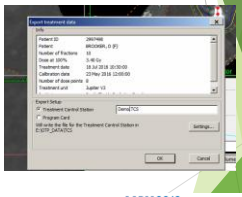
Exporting the plan

- Once the physician approved the plan and a second physicist verified it, approve the plan and export to TCS



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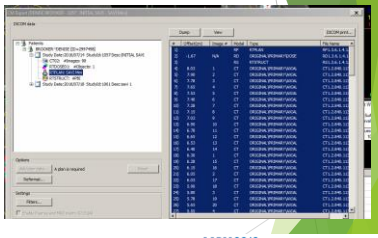
Exporting the plan

- Export to Radcalc for a second hand verification
- Export only the plan



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Printing the documents

- Print
  - The treatment plan
  - DVH
  - Isodose distribution in 2D and 3D
  - The Radcalc verifications
  - Merge all the documents and upload them in the patient's chart

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Thank you!

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Treatment delivery and quality management procedures (QMP)

Madhu Chilukuri, PhD, DABR

USA University of South Alabama Mitchell Cancer Institute Comprehensive Oncology Healthcare & Research | AAPM 2016 COMMUNICATING OUR VALUE IMPROVING OUR FUTURE

OUTLINE

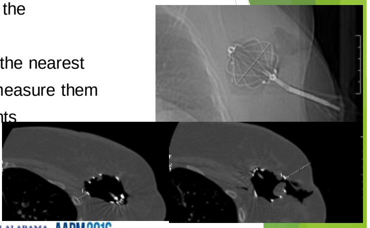
- Short description of the high dose rate (HDR) brachytherapy QA
- The morning QA
- Import the plan
- Verify the new scan
- Connect the patient and deliver treatment
- End of treatment
- Exporting the plan

First QA

- Patient at the first scan (the one used for planning)
  - Mark the skin in line with the catheter on top it the exterior tube
  - Measure the distance between the skin and the key inserted around the tube to keep the Savi in a fix position
  - Document the setup for reproducibility

First QA

- Patient at the first scan (the one used for planning)
  - On the scout image measure the diameter of the cavity/balloon
  - On the images taken identify the nearest distance to the skin and ribs, measure them and document the measurements



The morning of treatment QA

- Before treatment delivery
- Interlocks
- Check the emergency kit

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Boca Raton Cancer Center
Daily HDR QA Checklist

Item/System Tested	Monday	Tuesday	Wednesday	Thursday	Friday
Calibrated Survey meter					Y
Emergency kit in room-(100 cc syringe, wire cutters, suture removal kit, forceps, tool to unlock prostate template, Savi expansion tool**)					Y
Applicators/Transfer tubes (visual inspection)					Y
Patient viewing system-cameras					Y
Intercom-(must test two-way communication)					Y
Console indication lamps					Y
Console audible alarm					Y
Console printer					Y
Indexing ring interlock					Y
Transfer tube connected					Y
Treatment interrupt-console					Y
Emergency stop-console					Y
Door indicator warning light					Y
Door interlock					Y
Secondary Radiation monitor - in room					Y
Secondary Radiation monitor - console					Y
Source position indicators - console					Y
Backup-timer - console					Y
Source position accuracy (± 1 mm)					Y
Performed by:					[illegible]
Physics:					[illegible]
Date:					7/22/2016

*All unsatisfactory items must be corrected prior to performing patient treatments.
**Savi expansion tool MUST be placed prior to hooking the trasfer tubes. The tool in the emergency is a spare in the event that the patient does not have one.

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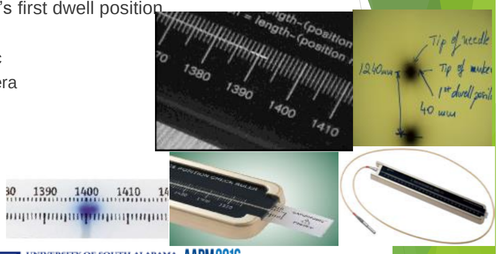
The morning of treatment QA

- Check source's first dwell position
  - Films
  - GafChromic
  - Video camera



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The morning of treatment QA

- Survey the remote afterloader and the room

- Check the in-room radiation monitor

Quality management program

1. Written directive
2. Patient Identification
3. Treatment Plan Verification
4. Pre-treatment safety checks
5. Treatment delivery
6. Post-treatment safety checks
7. Source replacement and Calibration
8. Documentation
9. Supervision
10. Medical events
11. Periodic review

QMP report

- A good report should document the following

1. Written directive
2. Source and source strength
3. Technique
4. Step size, dose delivered, total # of dwell positions
5. Individual and total dwell times
6. Reference position
7. Isodose distributions, DVH statistics
8. Independent validation of dose and calculations
9. Pre and post treatment radiation survey

When do we perform QA?

- Every source change
- Every day of treating
- Monthly
- Annual

Policy and procedures

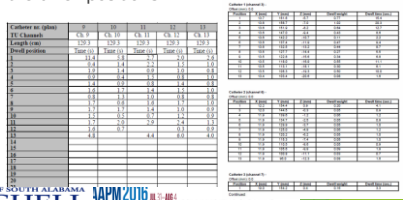
- Well assigned roles
- Clear instructions for each team member
- Follow protocols
- Physician present at all times

Transfer tubes acceptance

- Different lengths
- Visual inspection for mechanical integrity
- Store to keep integrity
- Measure length as received
- Test connection
- Test transfer of source

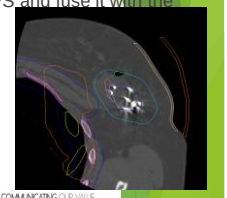
Import the plan

- Import the plan and verify the printed from the treatment console dwell times and positions with the imported ones
- Verify the connectors and the dwell positions
- Verify the correct activity



Verify the new scan of the 1st fraction and the subsequent ones

- Verify the new scan with the initial one for each fraction
- For the first treatment import the scan in the TPS and fuse it with the planning CT.
- Evaluate the change and the eventual need for re-planning. Plan went from 98% coverage to 86%



Connect the patient and deliver the treatment

- Survey the patient before and after the treatment
- Check transfer tubes before engaging in treatment delivery

End of treatment

- Survey the patient and the remote afterloader
- Disconnect the transfer tubes
- Document the treatment in the patient's chart

Emergency procedures and manual

- Establish emergency procedures
  - USNRC and TG-59 recommends
  - Users *shall* learn and periodically retrain to operate the devices and to respond properly to emergencies
  - Written emergency procedures describing actions to be taken, including surgical intervention, should the source not return to the shielded container at the conclusion of treatment.
  - Appropriate staff and equipment available in support of these procedures.

Emergency procedures and manual

- Emergency instructions and manuals
  - Operator's manual
    - Function of the console
    - How to program a treatment
    - Check the time factor
    - Emergencies procedures
  - List of authorized users (posted)
  - List of names with phone # for emergencies (posted)
  - List of error messages

Major emergencies

- Source retraction failure
- Patient medical emergency
- Total computer failure, etc.
- Involve operator, radiation oncologist, the physicist.

Minor emergencies

- Loose source guide tube connector,
- Vault door not properly closed
- Kink in the tube
- Ring not locked, etc.
- Easy recovery actions that allowing treatment to resume

Main goal for emergency procedures

- Reduce the radiation dose to the patient by retracting the source from the patient as soon as possible
- Minimize the radiation exposure to personnel performing the source retraction

Why errors?

- Individual mistakes, lapses in judgment, or device malfunctions
- Transient malfunction of a device (afterloader, applicator, or planning system)
- Failure of a team member to follow established policies
- Making a mistake while following policies
- Relying on policies and procedures which are inadequate

Why errors?

- Failure to follow procedures may be caused by
  - Inadequate training, inadequate supervision, or excessive time pressure.
- Making mistakes while following policies is often a consequence of
  - Inadequate documentation or training
  - Poor intra team communication

Why errors?

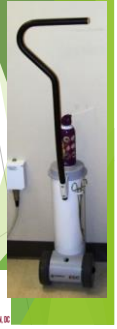
- Poorly designed treatment-planning and remote-afterloader interfaces,
- An inexperienced or incompetent team member
- Suboptimal working conditions, or
- Excessive time pressure.

Routine emergency equipment

- At the console outside the room:
  - Sign-"Danger-Open Radiation Source-Keep Out!"
  - Geiger–Muller meter ~0.1–100 mR/h range!
  - Ionization survey meter ~1–1000 mR/h range!
- Inside the room:
  - Emergency Container
  - Forceps
  - Kelly surgical clamps
  - High quality flashlight and fresh spare batteries
  - Suture removal kit
  - Suture kit

Routine emergency equipment

- Emergency container
  - Mobile
  - Large and deep enough



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2. The American Brachytherapy Society consensus statement for accelerated partial breast irradiation, C. Shah, F. Vicini, D.F. Wazer, D. Arthur, R.E. Patel, Brachytherapy 12 (2013) 267-277
3. NSABP B-39
4. Oncentra user manual

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Hope your HDRs are uneventful and of a very high quality

Thank you

??? Questions ???