The Role of Checklists on Improving Safety in Radiation Oncology

Luis E. Fong de los Santos, Ph.D.
Learning Objectives

• Understand the role of checklists as a safety management tool
• Recognize the importance of the organization and department culture on checklists success
• Describe the checklists development and implementation process
• Review the standard components and format of safety checklists
Airline Industry

Number of people flying per year (Globally)

3.1 billion

Fatalities per year:

692

http://aviation-safety.net/

Medical Industry

Number of people visiting a medical facility per year (USA)

1.24 billion

Fatalities from Preventable Medical Mistakes per year

200,000 to 450,000

October 2008 — Prostate Glands Misidentified

Five prostate cancer patients were treated incorrectly after a faulty ultrasound machine misidentified the glands.

June 2008 — Therapist Mistakes Treatment on Alternate Days

A 63-year-old woman was to undergo two different treatments on alternate days — one to the upper lung and the other to the mediastinum — an area in the chest. But because of a therapist mistake, the patient received the treatment to the upper lung every alternate day. The patient’s treatment year was underdosed by 50 percent — increasing the odds that cancer would recur — because a doctor implanted radioactive seeds in the wrong location.

December 2007 — Radioactive Seeds Implanted in Wrong Location

A patient’s prostate cancer was underdosed by 50 percent — increasing the odds that cancer would recur — because a doctor implanted radioactive seeds in the wrong location. The radiation, which was supposed to enter the cancerous tissue, entered a healthy tissue. The facility lacked a written policy for verifying data entry.

November 2005 — Therapist Errors Result in Radiation Overdose

A female patient with laryngeal cancer received a 47 percent overdose after a therapist left out the wedges, which modify the beam, for eight treatments. A device that measures radiation produced an unexpected reading, but the therapist did not inform the physicist or the physician. The facility lacked a written policy for verifying data entry.

September 2005 — Temporary Workers Overdose Patient

A patient with breast cancer received a 50 percent overdose for 10 treatments because a wedge was mistakenly left out. The medical physicist failed to perform the first weekly chart check. The hospital reported that it had a staffing issue at the time of the vent and that temporary workers did not have the same training or competency checks as the permanent staff.

Tirapazamine, Cisplatin, and Radiation Versus Cisplatin and Radiation for Advanced Squamous Cell Carcinoma of the Head and Neck (TROG 02.02, HeadSTART): A Phase III Trial of the Trans-Tasman Radiation Oncology Group

Critical Impact of Radiotherapy Protocol Compliance and Quality in the Treatment of Advanced Head and Neck Cancer: Results From TROG 02.02


Quality and Outcomes

Percent Surviving

Time Since End of RT (years)

Compliant ab initio
Made compliant
No major TCP impact
Major TCP impact

P < .001

Peters et al. JCO, 28(18), 2996, 2010
Checklists - Background

• Checklists have been extensively validated in non-medical and medical fields for many years, and have proven to be an effective tool in error management and a key instrument in reducing the risk of costly mistakes and improving overall outcomes.
Checklists - Background

  – Reducing hospital-acquired infection rates by 70%.

  – Improved compliance with standards of care by 65% and reduced surgical mortality by nearly 50%.

• What about **Radiation Oncology**?
<table>
<thead>
<tr>
<th>Suzanne Evans, MD</th>
<th>Luis E. Fong de los Santos, PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/26/2012-12/31/2014 Member - (nonvoting)</td>
<td>6/26/2012-12/31/2014 Task Group Chair -</td>
</tr>
<tr>
<td>Eric C. Ford, PhD</td>
<td>James E. Gaiser, PhD</td>
</tr>
<tr>
<td>6/26/2012-12/31/2014 Member -</td>
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<tr>
<td>Sandra E. Hayden, MA</td>
<td>Kristina E. Huffman, MMSc</td>
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<tr>
<td>6/26/2012-12/31/2014 Member - (nonvoting)</td>
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<tr>
<td>Jennifer Lynn Johnson, MS</td>
<td>James G. Mechakos, PhD</td>
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</tbody>
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**TG-230 / MPPG-4**

The Development, Implementation, Use and Maintenance of Safety Checklists

**Start: 6/26/2012**

Peter J. Pronovost, MD, PhD (Consultant)
Human Tasks and Error

• Tasks requiring schematic behavior, in other words done “on autopilot”
  – Error Type: Slips or Omissions. They are associated with lapses of concentration, distractions, exhaustion or burnout

• Tasks requiring attentional behavior, which need a predefined active plan and problem-solving skills
  – Error Type: Mistakes. Often occurring due to lack of experience, poor training, poor judgment or misunderstanding a situation
Role of Checklists in Error Management

- Basic memory guides those tasks that are easily forgotten; allowing the team to concentrate on tasks that require full attention (Gawande 2009)

- Checklists function as a supporting interface among individuals, and between individuals and their environment (Patient Safety Primers: Checklists)
Sociocultural Component of Checklists

• The mistake of the “simple checklist” story is in the assumption that a technical solution (checklist) can solve an adaptive (sociocultural) problem.”

(Bosk et al. 2009)
Hazard Mitigation Effectiveness

- Forcing Functions and Constraints
- Automation and Computerization
- Simplification and Standardization
- Reminders and Checklists
- Policies and Procedures
- Training and Education

Institute for Safe Medical Practices, Vaida et al. 1999
Forcing Function
Checklists

Before induction of anaesthesia
(with at least nurse and anaesthetist)

Has the patient confirmed his/her identity, site, procedure, and consent?
- Yes

Is the site marked?
- Yes
- Not applicable

Is the anaesthesia machine and medication check complete?
- Yes

Is the pulse oximeter on the patient and functioning?
- Yes

Does the patient have a:

Known allergy?
- No
- Yes

Difficult airway or aspiration risk?
- No
- Yes, and equipment/assistance available

Risk of >500ml blood loss (7ml/kg in children)?
- No
- Yes, and two IVs/central access and fluids planned

- Motivation
- Perception
- Interpretation
- Discipline
- Fatigue
- Distraction
- Compliance
- Mood
- Cooperation
- Etc.
Checklist in Airline Industry

Checklists
+
Crew Resource Management (CRM)

CRM focuses on:
interpersonal communication,
leadership, and
decision making
Checklist in Medical Industry

Checklists + Safety Culture

Factors of Safety Culture (Pidgeon and O'Leary):

• Commitment of upper level management to safety
• Shared attitudes towards safety and hazards
• Flexible norms and rules to deal with hazardous situations
• Organizational learning
Checklists – Where do I start?

• Find areas or processes with:
  – The strongest evidence on quality improvement and safety
  – Have the highest clinical impact
  – Have the lowest barriers for implementation and utilization

• Selection process should concentrate on:
  – Tasks that are critical, often missed and overlooked
  – Tasks that can potentially put the patient at the highest risk for harm if not done or done incorrectly

• Note: Poor selection or ambiguity on the checklist goal, role or tasks will most likely lead to failure on the checklist intervention
Achievable Goals for Checklists

- Compliance improvement of clinical protocols, procedures and processes
- Reduction of near-misses in critical clinical processes
- Enhancement of communication and team dynamic
- Improve practice standardization
- Streamline workflow
Checklist Development and Implementation Process

1. Clinical Need and Evidence-Based Best Practices
2. Designing Phase: Content and Format Definition
3. Validation and Pilot Phase
4. Pre-Clinical Implementation Training
5. Outcomes and Performance Evaluation
6. Maintenance and Continuous Improvement

TG-230 – in progress
Simple versus Complex Environments and Processes

Single physicist practice with one linac and developing a checklist for setting water tank

- Multidisciplinary group developing a checklist for a specialized procedure
  - Examples: SBRT, SRS, Brachytherapy.

- Large practice developing a checklist for pre-treatment physics plan check

NCC-AAPM SPRING Meeting
Gather the Team

- Team approach should be used throughout all the phases of development, implementation and maintenance of a specific checklist
Human Factors Engineering (HFE)

- HFE uses knowledge about human characteristics, both capabilities and limitations that are relevant during any designing process and aims to optimize the interactions among people, machines, procedures, systems and environments.

- Checklist design recommendations can be classified into three main areas:
  - Physical Characteristics
  - Content
  - Workflow, Layout and Format

“We cannot change the human condition, but we can change the conditions under which humans work.” - James Reason
HFE - Poor vs Good Design

Poor Designed:

(a) Use of “pre” may look similar to “post”. Before and After are less likely to be confused
(b) Vague question; unknown what a check here would mean
(c) Boxes are low contrast. Far removed from the action they refer to
(d) Lack of whitespace & use of caps decreases readability
(e) Listed actions not clearly separated
(f) Creates undue load on memory, both in keeping the current checklist in mind while looking at another page and in the lengthy wording: “CHECKLIST PAGE c-112”

**A CHECKLIST FOR CHECKLISTS**

<table>
<thead>
<tr>
<th>Development</th>
<th>Drafting</th>
<th>Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you have clear, concise objectives for your checklist?</td>
<td>Does the Checklist:</td>
<td>Have you:</td>
</tr>
<tr>
<td>Is each item:</td>
<td>- Utilize natural breaks in workflow (pause points)?</td>
<td>- Trialed the checklist with front line users (either in a real or simulated situation)?</td>
</tr>
<tr>
<td>- A critical safety step and in great danger of being missed?</td>
<td>- Use simple sentence structure and basic language?</td>
<td>- Modified the checklist in response to repeated trials?</td>
</tr>
<tr>
<td>- Not adequately checked by other mechanisms?</td>
<td>- Have a title that reflects its objectives?</td>
<td>Does the checklist:</td>
</tr>
<tr>
<td>- Actionable, with a specific response required for each item?</td>
<td>- Have a simple, uncluttered, and logical format?</td>
<td>- Fit the flow of work?</td>
</tr>
<tr>
<td>- Designed to be read aloud as a verbal check?</td>
<td>- Fit on one page?</td>
<td>- Detect errors at a time when they can still be corrected?</td>
</tr>
<tr>
<td>- One that can be affected by the use of a checklist?</td>
<td>- Minimize the use of color?</td>
<td>- Can the checklist be completed in a reasonably brief period of time?</td>
</tr>
<tr>
<td>Have you considered:</td>
<td>Is the font:</td>
<td>- Have you made plans for future review and revision of the checklist?</td>
</tr>
<tr>
<td>- Adding items that will improve communication among team members?</td>
<td>- Sans serif?</td>
<td></td>
</tr>
<tr>
<td>- Involving all members of the team in the checklist creation process?</td>
<td>- Upper and lower case text?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Large enough to be read easily?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Dark on a light background?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Are there fewer than 10 items per pause point?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Is the date of creation (or revision) clearly marked?</td>
<td></td>
</tr>
</tbody>
</table>

Atul Gawande’s website Project Check (http://www.projectcheck.org/checklist-for-checklists.html)
Surgical Safety Checklist

Before induction of anaesthesia
(with at least nurse and anaesthetist)

- Has the patient confirmed his/her identity, site, procedure, and consent?
  - Yes
  - No
  - Not applicable

- Is the site marked?
  - Yes
  - No
  - Not applicable

- Is the anaesthesia machine and medication check complete?
  - Yes
  - No
  - Not applicable

- Is the pulse oximeter on the patient and functioning?
  - Yes
  - No

- Does the patient have a:
  - Known allergy?
    - No
    - Yes
  - Difficult airway or aspiration risk?
    - No
    - Yes, and equipment/assistance available
  - Risk of >500ml blood loss (7ml/kg in children)?
    - No
    - Yes, and two IVs/central access and fluids planned

Before skin incision
(with nurse, anaesthetist and surgeon)

- Confirm all team members have introduced themselves by name and role.
- Confirm the patient’s name, procedure, and where the incision will be made.
- Has antibiotic prophylaxis been given within the last 60 minutes?
  - Yes
  - No
  - Not applicable

Anticipated Critical Events

To Surgeon:
- What are the critical or non-routine steps?
- How long will the case take?
- What is the anticipated blood loss?

To Anaesthetist:
- Are there any patient-specific concerns?

To Nursing Team:
- Has sterility (including indicator results) been confirmed?
- Are there equipment issues or any concerns?

Is essential imaging displayed?
- Yes
- No
- Not applicable

Before patient leaves operating room
(with nurse, anaesthetist and surgeon)

Nurse Verbally Confirms:
- The name of the procedure
- Completion of instrument, sponge and needle counts
- Specimen labelling (read specimen labels aloud, including patient name)
- Whether there are any equipment problems to be addressed

To Surgeon, Anaesthetist and Nurse:
- What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.

Revised 1 / 2009 © WHO, 2009
3 Bradycardia – Unstable
HR < 50 bpm and asymptomatic; hypotension, acutely altered mental status, shock, ischemic chest discomfort, acute heart failure

START
1. Call for help and a code cart  
   - Ask: “Who will be the crisis manager?”
2. Turn FiO₂ to 100%  
   - Verify oxygenation/ventilation
3. Give atropine
4. Stop surgical stimulation (if laparoscopy, desaturate)
5. If atropine ineffective:  
   - Start epinephrine or dopamine infusion  
   - or  
   - Start transcatheter pacing
6. Consider...  
   - Turning off volatile anesthetics if patient remains unstable
   - Calling for expert consultation (e.g., Electrophysiologists)
   - Assessing for drug-induced causes (e.g., betas blockers, calcium channel blockers, digoxin)
   - Calling for cardiology consultation if myocardial infarction suspected (e.g., ECG changes)

DRUG DOSES and treatments
- **Atropine:** 0.5 mg IV, may repeat up to 3 mg total
- **Epinephrine:** 2 – 10 mcg/min IV  
  - or  
  - **Dopamine:** 2 – 10 mcg/kg/min IV

OVERDOSE treatments
- Beta-blocker: Glucagon: 2 – 4 mg IV push
- Calcium channel blocker: Calcium chloride: 1 g IV
- Digoxin: Digoxin Immune Fab. Consult pharmacy for patient-specific dosing

TRANSVERSE Pacing instructions
1. Place pacing electrodes front and back
2. Connect 3-lead ECG to the patient
3. Turn monitor/defibrillator to PACER mode
4. Set PACER RATE (ppm) to 80/min.  
   (Adjust based on clinical response once pacing is established)
5. Increase to 60 mA of PACER OUTPUT until electrical capture (pacer spikes aligned with QRS complex)
6. Set final milliamperes 10 mA above initial capture level
7. Confirm effective capture  
   - Electrocardiogram (ECG) tracing
   - Mechanically: palpate femoral pulse (compare pulse unreliable)

Critical CHANGES
If PEA develops, Go to > CHILLS 4

DURING RESSUSCITATION
- Airway: Assess and secure
- Circulation:  
  - Confirm adequate IV or IO access
  - Consider IV fluid administration
### TP Smart Planning Checklist

**Patient Name:** TEST  
**Patient MRN:** 00000000

<table>
<thead>
<tr>
<th>Demographic Information:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment Category:</strong></td>
<td>Plan</td>
</tr>
<tr>
<td><strong>Treatment Machine:</strong></td>
<td>444</td>
</tr>
<tr>
<td><strong>Planning Technique:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Beam Modifiers:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>IGRT/Motion Monitoring:</strong></td>
<td>2D OBI</td>
</tr>
<tr>
<td><strong>Respiratory Monitoring:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Patient/Plan Specific:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Site:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Immobilization Type:</strong></td>
<td>Body Stereo Cradle IV</td>
</tr>
</tbody>
</table>

- **Modality:** 6X
- **Calc / TBI**
- **DMLC**
- **Blocks**
- **3D OBI**
- **Spoiler**
- **Prev Treatment**
- **Iso Shift**
- **Couch Kicks**
- **H&N w/ LAN**
- **Thorax**

---

Group at Memorial Sloan-Kettering Cancer Center
Same Clinical Process – Different Groups

<table>
<thead>
<tr>
<th>Physics Checklist: Weekly QA of Chart</th>
<th>Medical Physics Treatment Planning Weekly Chart Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescription signed in Diagnoses and Interventions (D&amp;I) in MOSAIQ</td>
<td>Prescription complete and consistent</td>
</tr>
<tr>
<td>Treatment fields scheduled correctly and match in D&amp;I</td>
<td>Plan consistent to prescription</td>
</tr>
<tr>
<td>CBCT scheduled correctly (if applicable)</td>
<td>Plan QA complete</td>
</tr>
<tr>
<td>Weekly SSD checks performed and correct</td>
<td>Treatment parameters verified</td>
</tr>
<tr>
<td>Check notes</td>
<td>Bolus verified</td>
</tr>
<tr>
<td>Complete chart check module</td>
<td>Compensators and field modifiers verified</td>
</tr>
</tbody>
</table>

For new-start cases only:
- Case presented at QA rounds
- Attending ordered CBCT (if applicable)
- Attending ordered weekly physics check
- Diode measurements complete and signed (if applicable)
- IMRT or VMAT QA document complete and signed (if applicable)

- Fractions delivered check
- Fractions remaining check

Further action(s) required: ________________________________

Emphasize the fact that each practice needs to go through their **own** implementation and validation process

Checklists **meet their specific** needs
Checklists and Tracking Deviations

ECLIPSE CHECKS

<table>
<thead>
<tr>
<th>Patient Name:</th>
<th>Plan Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID:</td>
<td></td>
</tr>
</tbody>
</table>

**Eclipse Workspace**

- Confirm that dosimetrist has approved the plan(s).
- Confirm that MD has reviewed plan(s).
- If 4DCT was used, verify that Average CT dataset was used for planning.
- Confirm that planning isocenter matches treatment isocenter.
- Review delineation of targets(s) and organs-at-risk.
- Review locations of reference and ICRU points within BEV.
- Review immobilization contours and couch structure in plan.
- Evaluate treatment of CT artifacts.
- Review any other HU overrides.
- Review bolus utilization.
- Review plan parameters (isocenter location, energy, angles, MLC arrangement, MU, and MU limits).
- Verify that non-coplanar beams enter patient within region encompassed by CT scan.
- Verify that post beams have angle = 180.1° for gantry rotation on right side of patient (for HFS).
- Review isodose coverage.
- Review calculation parameters.
- For electron fields, review QA plans and blocks.

Check **Yes** (with an ‘x’) if item has been evaluated/verified.

Check **N/A** (with an ‘x’) if item does not pertain to plan.

If deviations from standard practice are found or if you wish to enter a comment into the Plan Check Log, place a number (for number of deviations for particular check), not a character (such as X) in the Dev box.

# Red Items not checked: 7
# Black Items not checked: 9
# Findings: 0

Courtesy of Kathy L. Kolsky, Ph.D., Mayo Clinic, Rochester, MN
Curious George and the rocket

Illustrations by H. A. Rey

Check List

- 1 Space suit, complete with shoes & gloves
- 1 Space helmet
- 1 Oxygen tank
- 2 Emergency rockets
- 1 Parachute
Successful Checklists

• Effective checklists support human thinking and creativity, allow constructive team member interactions, and facilitate a systematic care delivery.

• Effective checklists require a strong organizational and social infrastructure, as well as the application of well-defined human factor engineering concepts for their success.

• Checklists alone cannot do much; checklists in the appropriate organizational environment can definitely be an exceptional safety management tool.
Acknowledgements

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- Eric C Ford, PhD, University of Washington Medical Center
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