Application of “A3 Thinking” to Operational Improvements in Radiation Oncology

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Abstract

The grand challenge for most healthcare organizations is to develop systems that deliver value to every patient. The purpose of our talk is to demonstrate how we have systematically been incorporating quality and safety improvement initiatives using Plan-Do-Study-Act (PDSA) thinking supported by Toyota’s “A3” tool into our academic radiation oncology clinic at the University of North Carolina (UNC). We herein quantify the impact of these A3 initiatives on prospectively collected, clinically meaningful, metrics. The data from key quality and safety improvement initiatives are presented. In summary, we show that improvement initiatives can be successfully implemented using A3 thinking approach in an academic radiation oncology department to yield measurable improvements in operations resulting in improvement in patient safety culture.

Keywords
A3 thinking, PDSA, lean, Toyota production system, patient safety culture, radiation oncology

1. Introduction

There is increasing focus on the need to better prepare healthcare workforce for quality and cost improvements [1]. Healthcare experts speculate that long-term organizational effectiveness depends on improvement strategies based on the Plan-Do-Study-Act (PDSA) cycle [2, 3]. However, the literature shows that spearheading improvements using the PDSA cycle is challenging and difficult, because it requires coordination and agreement among many stakeholders, each holding a set of critical information needed for effective problem resolution [4, 5]. Therefore, despite the enormous potential of PDSA cycles for process improvement, little is known about implementation characteristics of PDSA based-programs that make them effective when used with multidisciplinary teams in the healthcare industry.

Thus, this study demonstrates how quality and safety improvement initiatives have been systematically incorporated into the academic radiation oncology clinic at the University of North Carolina (UNC) using Plan-Do-Study-Act (PDSA) thinking supported by Toyota’s “A3” tool. The department of Radiation Oncology at UNC hospitals is located in the new North Carolina Cancer Hospital. This $200 million, 7-story cancer center, with 315,000 square feet, was opened in August 2009. It is a state-of-the-art building and provides comprehensive, multi-disciplinary care for patients with cancer. The data from key quality and safety improvement initiatives yielding measurable improvements in patient safety culture is presented.

2. Background Information

As a problem solving method used by Toyota, the term “A3” is derived from the paper size used for the report, which is the metric equivalent to 11”x17” paper. The A3 tool consists of four stages that the investigator must go through to get from ‘problem faced’ to ‘problem solved’. In summary, at each stage the investigator performs the following activities:

- **Stage 1: Plan (P)** to improve your operations by identifying the problems and ideas for solving these problems.
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- Stage 2: **Do (D)** changes that are designed to solve the problems on a small or experimental scale.
- Stage 3: **Study (S)** whether the experimental changes are achieving the desired result or not.
- Stage 4: **Act (A)** to implement changes on a larger scale if the experiment is successful.

If the experiment was not successful, the investigator skips the Act (A) stage and goes back to the Plan (P) stage to come up with some new ideas for solving the problem and the goes through the cycle again. That is, the iterative process, what makes A3 thinking robust, and that is the reason why it was chosen to use in the department.

A3s serve as an interface between different stakeholders to analyze and solve problems. They do not necessarily contain sufficient details to be understandable by all stakeholders, yet they serve as point of mediation and negotiation around the analyzed problem. The A3 tool used is shown in Figure 1 [6].

![Figure 1](image_url)

**Figure 1:** A3 Form Developed for UNC by NCSU Industrial Extension Service

Front line employees make up the vast majority of the workforce and know their work the best. Therefore, they have the best opportunity to improve it. The A3 is relatively a simple tool that can enhance the PDSA-based improvement cycles. This creates a cultural shift towards grassroots improvements and ownership. Perhaps, this is best represented by a quote from Mr. Eiji Toyota [7]:

“One of the features of the Japanese workers is that they use their brains as well as their hands. Our workers provide 1.5 million suggestions a year, and 95 percent of them are put to practical use. There is an almost tangible concern for improvement in the air at Toyota.”

Very often the success of A3s depends on relationships between individuals involved in problem solving. Researchers studying applications of A3s for problem solving in healthcare found that A3s help: 1) establish a common language and meaningful indicators to analyze and measure progress on problem solving, 2) provide mechanisms for linking process issues with human behaviors and decision making, and 3) supply a platform for analyzing underlying cultural aspects of quality and patient safety issues [8].

**2.1 A3 Program at UNC Radiation Oncology**

The grand challenge of the A3 program at UNC radiation oncology is to manage the growing knowledge of process improvement and ensure that radiation oncology professionals have the competencies needed to analyze and improve their care delivery processes. This is operationalized by using a ‘Lean’ methodology approach to process
improvement with an embedded A3 program to improve quality and safety (Figure 2). These programs are run and supported by the multidisciplinary Quality and Safety Committee lead by a physician champion. The committee meets weekly to a) discuss process performance, b) identify targets for improvement, c) review ‘Good Catches’ (near miss reports), d) approve A3s, and e) plan for future ‘Kaizens’ (continues improvement efforts). The improvement goal is to define standard work and produce reliable outcomes via their constant use.

Figure 2: Lean methodology approach to process improvement in the UNC Department of Radiation Oncology

The A3 program is run by a program manager who is an experienced system improvement professional (Industrial and Systems Engineer). There are several facets to the role of managing A3s (Figure 3): training (sec 3.1.1), ongoing coaching (sec 3.1.2), approval process and implementation (3.1.3), sustainability (sec. 3.1.4), visual management (sec. 3.1.5), and rewords/recognition (sec. 3.1.6).

Figure 3: A3 management in UNC Department of Radiation Oncology

In section 3, using the six facets of the A3 program, a mixed-methods approach for data collection and analysis is presented in order to highlight the key results yielding measurable improvements in operations improvement and patient safety culture.
3. Methods

3.1 Training
A one hour A3 training was developed by the A3 program manager. The goal is to train all the employees in the department, including administration staff, nurses, physicists, therapists, providers and researchers. Every new employee is trained as they come into the department. Data was collected on cumulative percent of trained employees.

3.1.2 Coaching
Anyone can start an A3, which are located throughout the department, readily accessible at each employee work area. Employees are encouraged to begin A3s and come to the A3 program manager for assistance or coaching during any part of the A3. The A3 owners are also encouraged to collaborate with their fellow employees and stakeholders to ensure they understand all facets of the problem and develop robust countermeasures that have group consensus. Stakeholders are required to sign the A3 as written agreements to the proposed changes.

Sometimes A3 topics are farther reaching than the employee’s (A3 owner) area of work. In this case, they can request that a multidisciplinary team meet to develop countermeasures. The A3 program manager can facilitate a brief meeting or a half to full day ‘Kaizen Event’ to work out the improvements. Then the A3 owner presents the countermeasures and implementation plan to the Quality and Safety Committee.

A3s are kept by the owner and continuously updated until they are implemented. Once implemented, the A3s are stored in paper format with the program manager. These are available for reference by anyone in the department at any time. Data is collected on coaching hours and number of Kaizen events.

3.1.3 Approval Process and Implementation
The Quality and Safety Committee is the governing body for approving and supporting A3 efforts. Once an employee has done their own research and completed the first half of the A3 (problem description through root cause analysis) they are welcome to come to the committee for assistance and guidance. After filing out the second half of the A3, they are required to present the countermeasures and implementation plan to the committee for approval, before implementation. Data is collected on number of approved A3s, discontinued A3s, number of staff submitting A3s, number of staff with multiple A3 submissions, and number of Kaizen events originating from A3s.

3.1.4 Sustainability
A3s that are implemented go into the sustainability portion of the program. These A3s are monitored for effectiveness over a three month time period. The program manager has 30, 60 and 90 day check-ins with the A3 owner to get an update on status. If the A3 was related to a specific tangible process or area, the Quality and Safety Committee goes on periodic ‘Gemba’ (go and see) walks to see the new process. The A3 owner presents their process to the committee. Data is collected on 30, 60, 90 day sustainability of implemented improvements. Subjective opinion-based data on threats to A3 sustainability is also collected.

3.1.5 Visual Management
Visual management displays are present throughout the department. The A3 boards keep vital information flowing between the Quality and Safety Committee and employees, as well as between individuals, and departments. They facilitate open communication and information sharing within the department. Pictorial data regarding the design and information features of the visual board was collected.

3.1.6 Rewards and Recognition
Employees are recognized and rewarded for participating in the A3 program. New A3s are highlighted at the monthly departmental Quality Assurance meeting. Those highlights are also posted on the visual management board. For each A3 that is implemented, the area in which the A3 owner belongs (i.e., nursing, physics, administrative, etc.) gets $100 in their “bank” to use towards improving quality and safety. Data was collected on number of implemented A3s per professional group (i.e., nursing, physics, administrative, etc.).
3.2 Link between A3 program and culture of patient safety
Agency for Healthcare Research and Quality (AHRQ) defines the safety culture of an organization as the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s health and safety management [9]. Creating a patient safety culture is a critical component of any type of continuous quality improvement program in healthcare settings. Outside of healthcare, a strong safety culture is noted as a critical underpinning in other high reliability organizations [10-13]. AHRQ has an assessment tool that measures the patient safety culture for hospitals, nursing homes, ambulatory outpatient medical offices, and pharmacies. The AHRQ patient safety survey measures 12 dimensions of patient safety culture. The institution routinely administers this survey every 18 months for all outpatient clinics. Survey results from 2009, 2011, and 2013 are compared to examine trends in three dimensions, namely 1) organizational learning, 2) overall perceptions of patient safety and quality, and 3) office process and standardization to evaluate the cultural impact associated with the aforementioned A3 program.

4. Results
The A3 program has been in effect from June 2012 to January 2014 and has been successful in the department. Sections 4.1.1 to 4.2 present overview of results regarding training (sec. 4.1.1), coaching (sec. 4.1.2), approval process and implementation (4.1.3), sustainability (sec. 4.1.4), visual management (sec. 4.1.5), and rewards/recognition (sec. 4.1.6). In section 4.2, results are presented from AHRQ patient safety survey.

4.1 Training
All employees underwent the 1 hour training. They were given a hard copy of the training material along with instructions for a step by step procedure on how to go through the A3 process, start to sustainability (see Appendix A).

4.1.2 Coaching
Program manager spent approximately 48 hours on individual coaching. Staff came willingly to get assistance on developing their A3s from the program manager. The majority of staff came with their A3 partially filled out. Many times they need assistance with the problem analysis (root cause analysis) and follow-up portions of the A3. The more experienced staff are with the A3 process, the less coaching they need. One nurse completed several A3s (with coaching) and then became a coach herself for her fellow nurses.

Fifteen Kaizen Event days were held between 2009 and 2013. This allowed stakeholders from different group to collaborate, understand the complexity of the processes, open lines of communication, and build a team atmosphere.

4.1.3 Approval process and implementation
Table 1 presents a summary of A3 improvements in the department. Overall, 32 A3s were approved from which:
- 22 have been successfully implemented
- 8 are still in progress
- 2 were piloted and then discontinued
- 21 different staff members in all of the different department areas owned them
- 6 different employees owned more than one
- 3 Kaizen events originated via A3s

<table>
<thead>
<tr>
<th>A3 Title</th>
<th>Description and Results</th>
</tr>
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<tbody>
<tr>
<td>Automatic Doors</td>
<td>Installed automatic doors for improved patient transport</td>
</tr>
<tr>
<td>Cyber Knife Protocols</td>
<td>Developed standard protocols for different types of Cyber Knife patients</td>
</tr>
<tr>
<td>Recovery Room</td>
<td>Standardized operations in recovery room</td>
</tr>
<tr>
<td>CT Simulator Phone</td>
<td>Implemented new scheduling phone for simulator</td>
</tr>
<tr>
<td>Quick Rx</td>
<td>Improved information flow for patient prescriptions</td>
</tr>
<tr>
<td>OP-IP Protocols</td>
<td>Improved process for inpatient to outpatient transition while on treatment</td>
</tr>
<tr>
<td>Consent and creatinine levels</td>
<td>Developed a standard procedure for consent, creatinine and IVs</td>
</tr>
<tr>
<td>CT Imaging for protocol patients</td>
<td>Improved notification of protocol patients and protocol guidelines</td>
</tr>
<tr>
<td>3Ps</td>
<td>Implemented safety barrier to screen for pregnancy, pacemaker, or prior radiation for 100% of patients</td>
</tr>
<tr>
<td>Nurse Carts</td>
<td>Standardized and implemented Kanban system for restocking nursing cars</td>
</tr>
<tr>
<td>New Patient Orientation</td>
<td>Revamped new patient orientation materials</td>
</tr>
<tr>
<td>Clean utility room</td>
<td>5S of clean utility room</td>
</tr>
<tr>
<td>Pyxis scanner swap</td>
<td>Improved location of pyxis and scanner in clinic</td>
</tr>
<tr>
<td>Overhead paging</td>
<td>Decreased overhead paging by ~70%</td>
</tr>
<tr>
<td>Problems with Queuing</td>
<td>Reduced treatment delays due to unknown patient location by ~50%</td>
</tr>
<tr>
<td>Cyber Knife phone</td>
<td>Improved communication by installing new phone</td>
</tr>
<tr>
<td>Charge nurse role</td>
<td>Improved utilization of charge nurse role</td>
</tr>
<tr>
<td>Dept phone calls</td>
<td>Decreased misrouted phone calls by 85%</td>
</tr>
<tr>
<td>Late RN communication</td>
<td>Improved communication of late nurse transition</td>
</tr>
<tr>
<td>Sterilization for utility room</td>
<td>Improved sterilization safety in utility room</td>
</tr>
<tr>
<td>Organize utility room</td>
<td>Improved organization of utility room</td>
</tr>
<tr>
<td>IP consult requests</td>
<td>Improved process for inpatient consult requests</td>
</tr>
</tbody>
</table>

| Miscommunication of Sim orders | Improve communication between MDs and therapists to reduce omissions |
| Clinic exam rooms 2.0 | Implement phase 2 of exam room improvements |
| Pre-Auth process | Improve pre-authorization process to reduce claim denials |
| Late Tx patients | Improve safety and efficiency of late treatments |
| Skin Contours | Improve skin contours for software |
| DIBH process | Increase number of successful deep inspiration breath hold treatments |
| Financial Counselor | Improve flow and communication with financial counselor |
| Emergent afterhours treatment | Develop standard process for emergent afterhours treatments |

<table>
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<tr>
<th>Approved and in progress</th>
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| Chemo-Rad Coordination | Improve communications between radiation oncology and infusion |
|-------------------------|
| Ordering Labs | Decrease non-value added nursing time for lab orders |

An example of a completed A3 is shown below.

Figure 4: Problems with Queuing A3
4.1.4 Sustainability
All of the A3s that were implemented (22 A3s) were successfully sustained via the 30, 60 and 90 day check points.

Few potential threats to sustainability efforts were uncovered, especially while learning from the two A3s that were piloted and then discontinued. One was lack of stakeholder buy-in from the inception of the A3, even though all stakeholders had agreed to move forward. This lack of buy-in caused disagreement on the root causes of the problem and proposed countermeasures. However, there are benefits that originated from this discontinued A3. It improved the standard operations of the A3 program to increase stakeholder involvement and consensus by requiring all stakeholders to agree to proposed changes by physically signing the A3 form summarizing the improvement efforts.

Another incompletely implemented A3 was due to lack of sustained adherence to the implementation plan because the countermeasures included a different department (outside of radiation oncology) that did not behave consistently. In the end, although discontinued, this increased communication between the two different departments.

Another barrier for the program is that it is hard to get physicians and residents (who are in effect more senior in the department hierarchy) to do A3s. Front line staff are more willing to complete them (nurses and radiation therapist) who deliver the actual treatment.

4.1.5 Visual Management
A visual management board of the A3 program was implemented in the central department conference room. This provides any employee with an instant update of the status of the A3 program. The board is composed of six different components: recently implemented A3s, total earnings of reward money, sustainability of previous implementations, running list of completed A3s, recently approved and in progress and recent or planned Kaizen Events.

![Figure 5: A3 Visual Management Board](image)

4.1.6 Rewards and Recognition
Figure 6 presents total budget dollars that each area earned for quality and safety improvements. This translates directly to the number of A3 owners who have successfully implemented an A3. To spend the dollars on quality and safety improvements, all ideas have to be approved by the committee. For example, the nurses implemented several
A3s, earned $800 and installed a monitor in the nurse’s workroom, so they could better monitor their patient flow. The A3s that were implemented, piloted and then discontinues also received the $100 reward.

Figure 6: Rewards for Implemented A3s to Use for Improvement

4.2 Link between A3 program and culture of patient safety
Figure 7 shows the AHRQ patient safety culture survey results in the department for 2009, 2011 and 2013. Percentages of positive responses in the selected three dimensions (i.e., organizational learning, overall perception of patient safety and quality, and office process and standardization) of patient safety culture appear to have increased from 2009 to 2013 (ANOVA; p<0.01). Since the surveys are anonymous and there were some staffing changes during this time, it is unclear to what degree the same groups of people were represented in the survey.

Figure 7: AHRQ Patient Safety Survey Results

As evidence by the survey data, the implementation of the A3 program has positive affect on the quality and safety of the department. Department staff feel that the majority of the A3s completed have improved the department in one way or another. Generally the A3 thinking creates a positive communication platform where staff to feel comfortable discussing sensitive issues, without pointing fingers.
4. Conclusion

The department of radiation oncology has successfully implemented A3 thinking into the healthcare setting. Using A3 thinking is a valuable and effective way to engage front line employees in improving their work. The improvements achieved through A3s decrease inefficiencies, increase communication, improve quality and standard work and, in most cases, promote teamwork and staff engagement. Employees have had high satisfaction with the results gained from leading and participating on A3s. A3 thinking gives front line staff a fairly simple but tangible way to guide them through fixing something that was frustrating to them or their patients. They can also use it as a tool to meet a goal.

Implementing this A3 program was not “fast or easy”. It took a long time to get staff buy-in and involvement in A3s. Up to this point, only 20% of staff in the department have led an A3 effort. There were some early adopters, who have done multiple A3s, but the majority of people have not. It is a slowly evolving process.

Goals are currently being set for the A3 program for the upcoming year. Several of the goals are as follows:

- Improve sustainability outcomes and sustainability reporting structure
- Create structure for phase 2 of an A3: PDSA
- Increase capacity for coaches and champions to support A3 owners
- Create a coaching guide book for increasing A3 quality and capacity
- Expand A3 program to other departments outside of radiation oncology

In the NC Cancer Hospital, A3s are also successfully being used as project management tools and structure for kaizen events.

Acknowledgements

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References

Appendix A: A3 Owner Instructions

A3 Owner Instructions

UNC Department of Radiation Oncology

1. □ Get a blank A3: Blank A3s are located in the Library (Basement Level) or Clinic Workroom (wall between MD and RN areas)
2. □ Begin filling out A3: Use pencil. If you get confused or lost, re-read the descriptions next to the different sections. Feel free to sketch it out and reprint it on a new fresh A3.
3. □ Initiate collection of baseline data (you must have some quantification on y+ A3).
4. □ (Optional) Come to A3 office hours for help or coaching
   • Mondays: 1-3pm
   • Wednesdays: 12-1pm:
   • Wednesdays: 1-3pm
5. □ (Optional) Come to Quality and Safety Committee for advice or guidance
   • Wednesdays: 9:45am-11am
6. Meet with stakeholders to discuss problem analysis, countermeasures and implementation plan. Have stakeholders sign the back of A3 as proof of consensus.

NOTE: You do not need to fill out complete A3 before moving forward. You may need to have meetings with other stakeholders to decide on countermeasures. Including stakeholders is vital to success.

7. □ Present A3 to your Manager to get approval to move forward
8. □ Present A3 at QA Committee Meeting: Your manager may invite you to present A3 for approval at the QA Committee Meeting (Wednesdays 9:45am-11am). Hold on to your A3 paper. QA Operations Committee will: 1) Approve as is to move forward; 2) Approve with edits to move forward; 3) Not Approve
9. □ Update A3 as necessary throughout improvement process and meet with stakeholders. Get signatures of other stakeholders on back of A3, to demonstrate you have buy in.
10. □ Complete your Implementation Plan actions that are listed on your A3. If implementations or countermeasures change, update the A3 to reflect the plan.
11. □ Ensure your A3 has quantification of improvements. They can be rough estimates, but must be something quantifiable to demonstrate value of improvement.
12. □ Submit completed and updated A3. Your A3 will be kept on file for departmental records.

NOTE: If your A3 is approved, implemented, your group will get $100 in the “bank” to use towards improvements in your work areas. Example: Buy a new monitor to make workflow more efficient, bring in a guest speaker to talk about safety in your area, etc.

13. □ Conduct follow-up as listed in your A3. Example: Track the number of patients who have a missed Q that delays the treatment machines over the next 3 months, because countermeasures were implemented to reduce the number of missed Qs.

14. □ Expect to report out on countermeasure status and follow-up measures at 30, 60, 90 days. You will be contacted to report the status of your A3. You may be asked to lead a Gemba walk (where the QA Committee comes to see the work place) related to your A3. Example: A nurse would host the QA Committee on a brief tour of the clean utility room where she implemented countermeasure from an A3.