Error Prevention Via Improved Integration of the Bravos HDR and the Aria Oncology Information System

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IMPACT

An automated HDR pre-treatment verification system was designed and clinically implemented, offering robust and efficient treatment process in a high throughput and time constrained HDR brachytherapy practice.

Critical checks include:
- Plan/Prescription compliance
- Plan approvals
- Plan scheduling

Advisory checks include:
- Verification of documents' approvals.

General applicability:
Hardware is vendor agnostic
Software is customizable

INTRODUCTION

HDR brachytherapy procedures are usually time constrained with planning and safety checks performed immediately preceding delivery, often intraoperatively. Additionally, planning systems can be integrated with oncology information systems (OIS) or standalone systems, with plan-checking and treatment preparation processes dependent on specific systems and clinical workflows. The combination of variability in workflow and resources used, and the time constraints may result in mistreatment. Further, integration of HDR afterloader and OISs, if used, if often incomplete. We describe custom hardware/software interlock system that prevents HDR treatment standardized requirement are met.

METHODS AND MATERIALS

A customer-supplied dual relay was connected to the interlock key switch (IKS, designed for afterloaders sharing a vault with other machines) to assert an IKS interlock preventing treatment. The relay is controlled by a Raspberry Pi 4 running a node webserver that passes open/closed signals to the relay based on software generated messages. Software checks that are not part of the vendor HDR-OIS integration include 1. critical checks such as compliance of plans to prescriptions: Dose/Fx, number of Fx, existence of only one 'approved' plan, and 2. advisory checks that comprise of various document approvals.

Figure captions:

Hardware Interlock (top right)
Software application (bottom left)
Report generated for the clinical record (right)

RESULTS

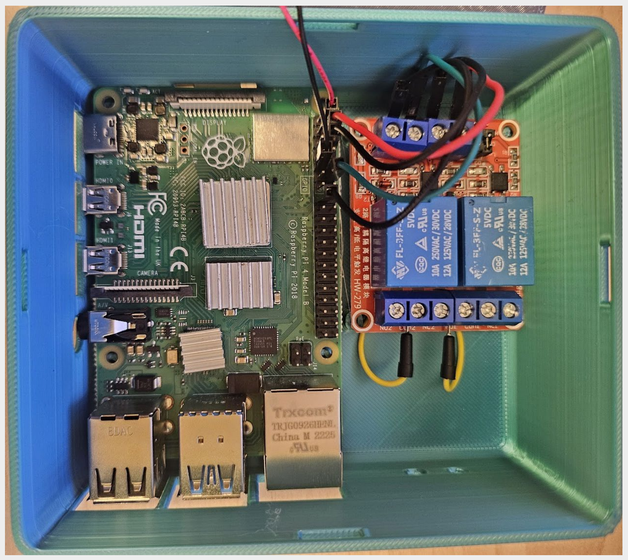
The developed interlock system was successfully established in multiple treatment vaults. The application automatically performs multiple safety checks for the modded-up patient prior to treatment delivery, enable/disables treatment if checks pass/fail, triggers the interlock upon completion of patient treatment, and exports a treatment QA report to the OIS. Software bypass can be set for QA and service tasks.

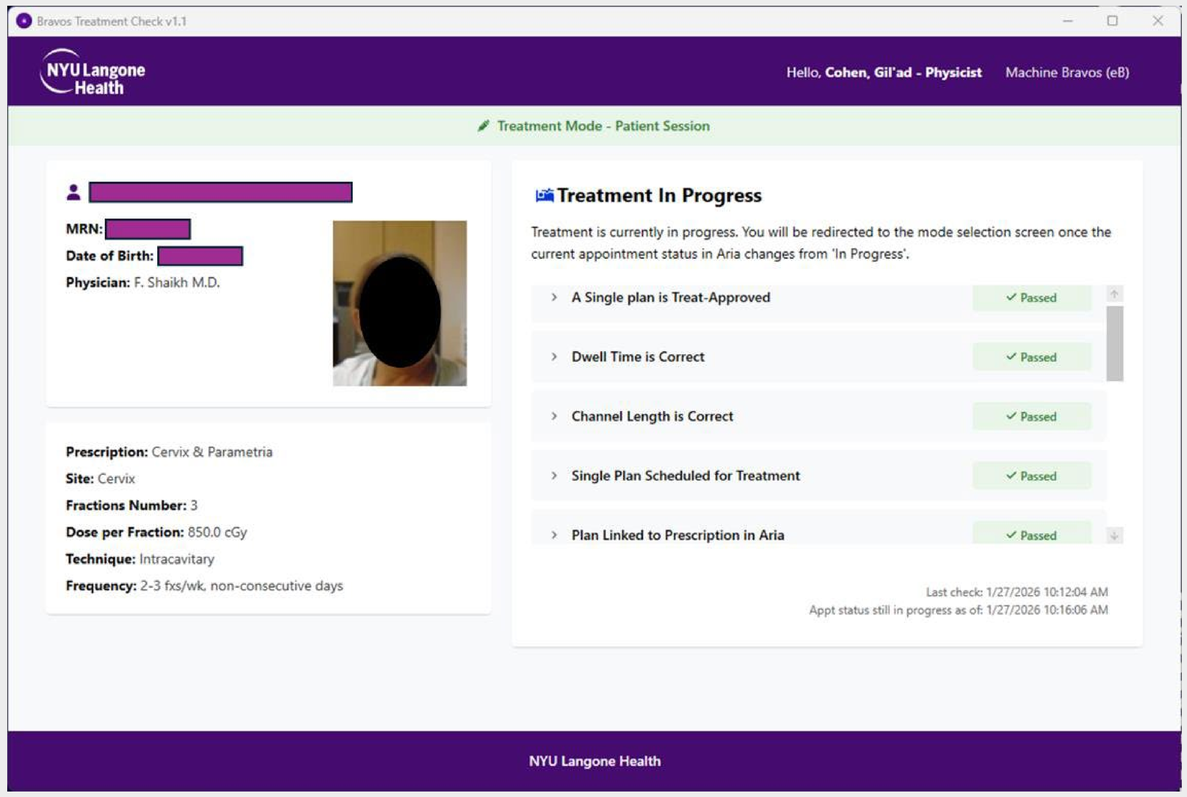
DISCUSSION

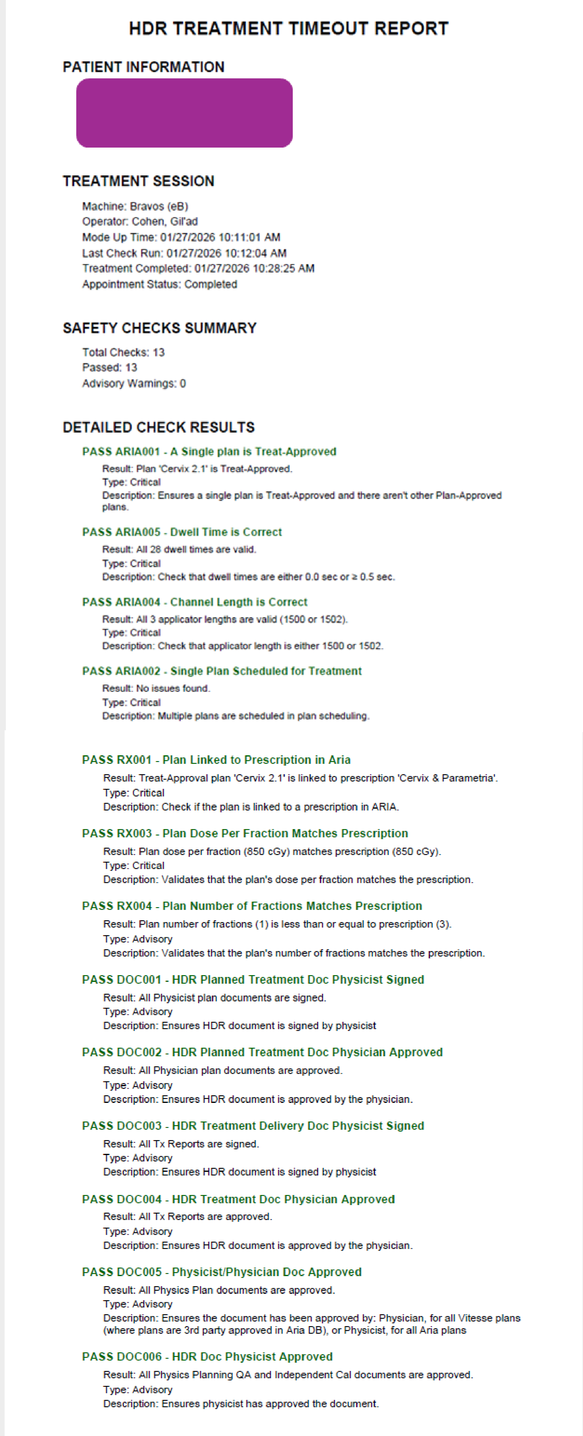
Integration of HDR unit with traditional OISs is currently lacking. Further, manual checks of prescription compliance, inconsistencies in plan scheduling, document approvals, as well as checks of system specific parameters can be automated to improve treatment process robustness, efficiency, and prevent treatment errors.
The system implemented in our clinic initiates a hard stop for critical failures. Non-critical failures (such as certain document approvals) result in an advisory warning that can be either corrected or over-ridden by the AU and AMP (electronic signature required).

CONCLUSIONS

A custom hardware interlock for HDR treatment was developed to implement critical safety checks. The software is customizable and the hardware is vendor agnostic and can be connected in series to various vendor hardware interlocks.







HDR TREATMENT TIMEOUT REPORT

PATIENT INFORMATION

TREATMENT SESSION

Machine: Bravos (eB)
Operator: Cohen, Gil'ad
Mode Up Time: 01/27/2026 10:11:01 AM
Last Check Run: 01/27/2026 10:12:04 AM
Treatment Completed: 01/27/2026 10:28:25 AM
Appointment Status: Completed

SAFETY CHECKS SUMMARY

Total Checks: 13
Passed: 13
Advisory Warnings: 0

DETAILED CHECK RESULTS

PASS ARIA001 - A Single plan is Treat-Approved
Result: Plan 'Cervix 2.1' is Treat-Approved.
Type: Critical
Description: Ensures a single plan is Treat-Approved and there aren't other Plan-Approved plans.

PASS ARIA005 - Dwell Time is Correct
Result: All 28 dwell times are valid.
Type: Critical
Description: Check that dwell times are either 0.0 sec or ≥ 0.5 sec.

PASS ARIA004 - Channel Length is Correct
Result: All 3 applicator lengths are valid (1500 or 1502).
Type: Critical
Description: Check that applicator length is either 1500 or 1502.

PASS ARIA002 - Single Plan Scheduled for Treatment
Result: No issues found.
Type: Critical
Description: Multiple plans are scheduled in plan scheduling.

PASS RX001 - Plan Linked to Prescription in Aria
Result: Treat-Approval plan 'Cervix 2.1' is linked to prescription 'Cervix & Parametria'.
Type: Critical
Description: Check if the plan is linked to a prescription in ARIA.

PASS RX003 - Plan Dose Per Fraction Matches Prescription
Result: Plan dose per fraction (850 cGy) matches prescription (850 cGy).
Type: Critical
Description: Validates that the plan's dose per fraction matches the prescription.

PASS RX004 - Plan Number of Fractions Matches Prescription
Result: Plan number of fractions (1) is less than or equal to prescription (3).
Type: Advisory
Description: Validates that the plan's number of fractions matches the prescription.

PASS DOC001 - HDR Planned Treatment Doc Physicist Signed
Result: All Physicist plan documents are signed.
Type: Advisory
Description: Ensures HDR document is signed by physicist

PASS DOC002 - HDR Planned Treatment Doc Physician Approved
Result: All Physician plan documents are approved.
Type: Advisory
Description: Ensures HDR document is approved by the physician.

PASS DOC003 - HDR Treatment Delivery Doc Physicist Signed
Result: All Tx Reports are signed.
Type: Advisory
Description: Ensures HDR document is signed by physicist

PASS DOC004 - HDR Treatment Doc Physician Approved
Result: All Tx Reports are approved.
Type: Advisory
Description: Ensures HDR document is approved by the physician.

PASS DOC005 - Physicist/Physician Doc Approved
Result: All Physics Plan documents are approved.
Type: Advisory
Description: Ensures the document has been approved by: Physician, for all Vitesse plans (where plans are 3rd party approved in Aria DB), or Physicist, for all Aria plans

PASS DOC006 - HDR Doc Physicist Approved
Result: All Physics Planning QA and Independent Cal documents are approved.
Type: Advisory
Description: Ensures physicist has approved the document.

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