



Harnessing AI for Sustainable Radiation Oncology: Transforming Brachytherapy Waste Management

KE LICHTER,¹ GS SILVA,¹ C PHOUNG,¹ J LIU,¹ L NI,¹ A SMITH,¹ HJ SHIN,¹ I HSU¹

¹University of California San Francisco, Department of Radiation Oncology



University of California
San Francisco

BACKGROUND & AIMS

- The **U.S. healthcare sector** contributes $\approx 10\%$ of national GHG emissions; operating rooms account for up to **30% of hospital waste** and **60% of supply spend**^{1,2}
- **Regulated medical waste (RMW)**—blood- or fluid-contaminated items—generates 2-3 \times more CO₂-e kg⁻¹ and costs 8-10 \times more kg⁻¹ to process than municipal solid waste.²
- Brachytherapy suites are highly consumable-intensive yet run on tight turn-around times, making them ideal laboratories for **AI-assisted, point-of-care waste optimisation**.^{3,4}

Hypothesis: A computer-vision platform can **rapidly characterize waste streams, flag mis-sorted items in real-time, and feed back actionable data** to clinicians, thereby reducing RMW, cost, and carbon footprint without workflow disruption.

AIMS

- Quantify baseline waste generation and composition for HDR brachytherapy cases.
- Deploy an AI / machine-learning (ML) audit platform (Zabble) to:
 - Cut manual audit time
 - Minimize mis-segregation of RMW
 - Decrease overall waste volume and associated CO₂-eq
- Create a **Brachytherapy Waste Audit Toolkit** enabling replication across centers

References

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MATERIALS & METHODS

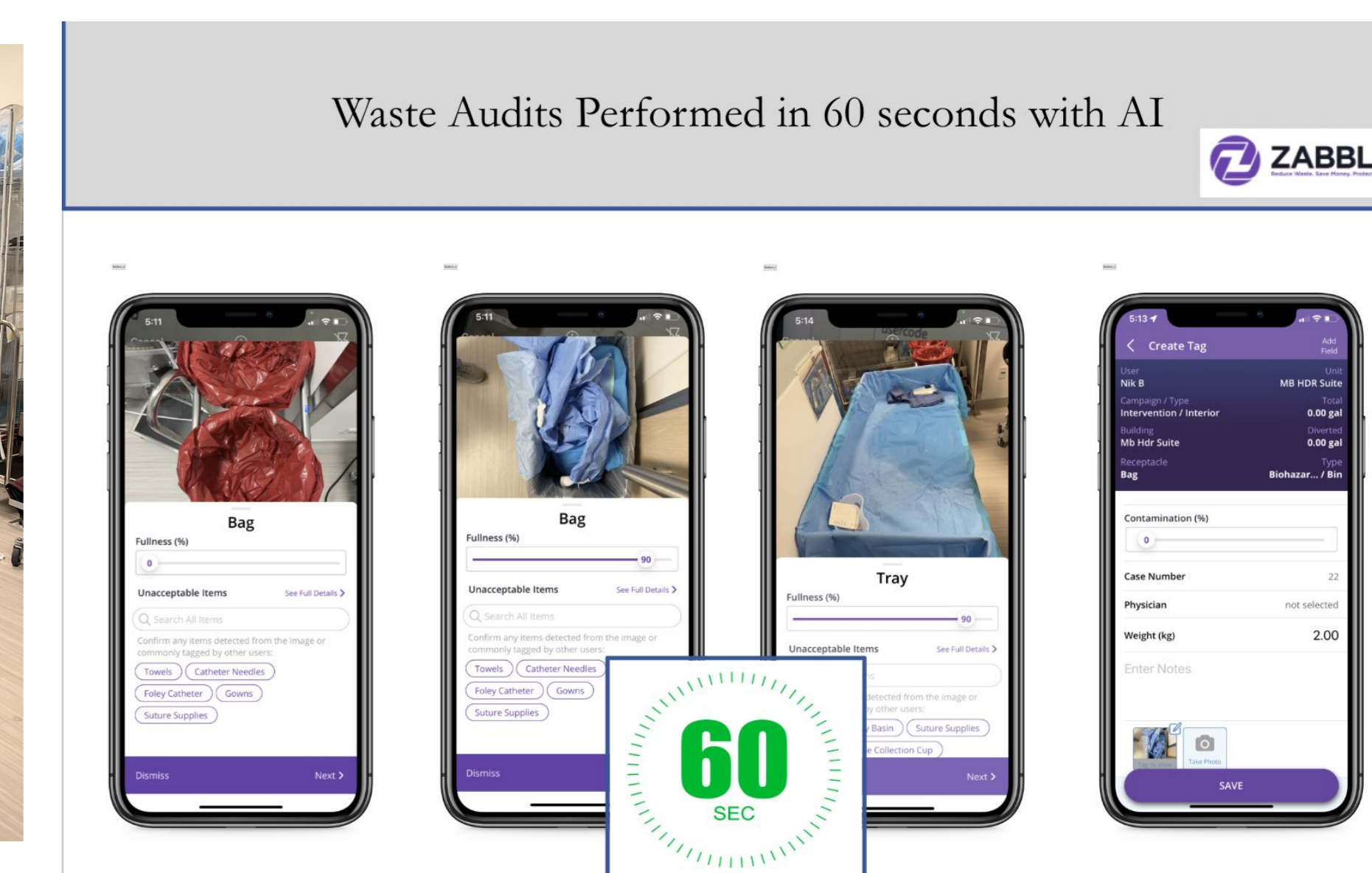
3-month baseline audit + 6-month intervention

- **Baseline audit:** 20 consecutive HDR cases
 - Waste weighed & categorized in sterile core immediately post-procedure
 - 1,126 individual items logged (mass, material, disposition)
- **AI-enabled intervention:**
 - Personal cellular phone camera + embedded ML model classifying items on the fly
 - Real-time alerts for mis-sorted RMW (on-screen + audio cue)
 - Weekly dashboards to staff; 15-min in-service focused on top three error modes
 - Continuous data capture feeding into a dynamic waste-segregation decision tree

RESULTS

Metric	Baseline	AI Intervention	Δ (% or absolute)
Manual audit time	4.5 min /case	0.7 min /case	- 87 %
Total waste volume	14.0 kg (IQR 12.4-15.9)	11.2 kg (IQR 10.3-12.7)	- 20 %
RMW fraction of total	44 %	11 %	- 75 %
RMW mass	6.16 kg /case (SD 0.65)	1.15 kg /case (SD 0.40)	- 5.0 kg
RMW cost	\$6.72 /case	\$1.15 /case	- \$5.57 /case
Est. CO ₂ -e (incineration)	12.3 kg CO ₂ -e /case	2.3 kg CO₂-e /case	- 10.0 kg

RESULTS



SUMMARY/CONCLUSION

- **AI-driven audit shrank RMW by 75%, landfill waste by 20%, and auditing labor by 87%.**
- Cost and carbon savings accrue directly, but **secondary gains**—staff engagement, data-driven supply optimization, and culture change—may prove even more valuable.
- The open-access **NorCal Brachytherapy Waste Audit Toolkit** (QR code) provides step-by-step guidance, standard data sheets, and benchmark dashboards to **catalyze multi-institutional QI collaboratives** across the ASTRO community.
- Future work: life-cycle modelling of single-use vs re-processable applicators, and integration of AI alerts into the electronic peri-operative record for automated sustainability reporting.⁵

