STUDY

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Consumable Material Waste and Workflow Efficiency Comparison Between Multi-use Syringeless and Single-use Syringe-Based Injectors in Computed Tomography

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Study Type:
Single-institution, observational cross-sectional study design

Study Objective:
This study evaluates the potential time and material waste (ICM, plastic, saline, and total) saved using a multi-use syringeless injector (MUSI) compared to a single-use syringe-based injector (SUSI).

Outcome Parameter:
- Time saving
- Iodinated contrast medium (ICM) waste
- Plastic waste
- Saline waste
- Total waste

Material and Methods:

CT Contrast Injectors and CT Scanners
SUSI: A piston based, single-use syringe-based injector [MEDRAD® Stellant Injector System (Bayer AG, Germany) installed on Optima CT660S/Revolution EVO 32ch, RevE-VO 64ch and Revolution HD 64ch CT scanners (GE Healthcare, Wisconsin, USA)]
MUSI: Peristalsis-based, multi-use syringeless injector [CT Motion™ Contrast Media Injector (Ulrich Medical, Germany) installed on Optima CT660/Revolution EVO 64ch and Discovery CT750HD CT scanners (GE Healthcare, Wisconsin, USA)]

Time Savings Experimental Design
Two independent observers recorded total time spent by technologists completing various tasks required for injector operation over three clinical workdays (totaling 15 hours) from two CT scanners.

Routine SUSI tasks included removing contrast and saline syringes from packaging, inserting syringes onto injector, and placing or removing tubing from the patient and injector.
Routine MUSI tasks included spiking a 500 mL contrast bottle and docking or undocking contrast to the injector, removing saline syringes from packing and inserting onto injector, and placing and removing tubing from the patient and injector.
In total, time spent at the injector was measured for 10 studies employing the SUSI and 19 using the MUSI. Time spent at the terminal was also recorded.
CT technologists (n=15) were surveyed on their experience with either injector system using a questionnaire. The survey was administered 1 month into MUSI integration into clinical workflow.

Waste Model Design*
Total waste was modeled according to the equation:

$$W_{total} = W_{contrast} + W_{saline} + W_{plastic}$$

For the SUSI and MUSI injector each:

$$W_{SUSI} = \sum_{1}^{N_{mr}} \{ (\sum^{N_{mr}} F_{contrast}) \times P_{iohexol} + N_{mr} \times V_{SUSI} \times P_{saline} + F_{weight} + N_{mr} \times W_{100Saline} + N_{mr} \times W_{ptpack} \}$$

$$W_{MUSI} = \sum_{1}^{N_{weeks}} \{ F_{MUSI} + N_{perweek} \times V_{lines} \times P_{saline} + V_{pumptubing} \times r_{Saline} \times 7 + \left(1000 - 50 \times \frac{N_{perweek}}{7} \right) \times P_{saline} \times 7 + F_{spike} + N_{perweek} \times W_{lines} + W_{pumptubing}$$

For further information and explanation of variables refer to full-text study.

* This mathematical model has been recreated from Toia et al.

Results:

Objective Time Savings Analysis

On average CT technologists spent 63.6 seconds less in the scan room with MUSI compared to the SUSI. On average CT technologists spent 23.1 seconds longer per exam interacting with the MUSI CT injector terminal compared to the SUSI terminal. Thus, on average spend 40.5 seconds less per exam using MUSI.

Subjective Time/ Waste Savings Analysis (Questionnaire)

The evidence for technologists favoring MUSI in time saving was not statistically significant. Nonetheless, technologists needed less time with MUSI in 66%. In 7% less time with SUSI, and in 27% equal time with either injector.

Plastic waste generation with MUSI was in 93% less and in 7% similar to SUSI according to interviewed CT technologists. Contrast waste generation with MUSI was in 93% less and in 7% greater than SUSI according to interviewed CT technologists.

Technologists rated MUSI work efficiency, user-friendliness, and overall satisfaction (strongly or somewhat improved) higher than SUSI.

Waste Saving Estimated through Mathematical Model

Over a 16-week window, the SUSI model estimated 31.3 L (44.1 kg) of ICM waste, 43.3 L (43.3 kg) of saline waste, 467.7 kg plastic waste, and 555.0 kg total waste by weight.

The MUSI model estimated 0.0 L of ICM waste, 52.5 L (52.5 kg) of saline waste, 71.9 kg plastic waste, and 124.4 kg total waste by weight.

In the same period, MUSI waste equated to a 100% reduction in ICM waste, a 21.1% increase in saline waste, an 84.6% reduction in plastic waste, and a 77.6% reduction in total waste by weight relative to SUSI.

Authors' Conclusion:

The author states that this study is in line with others on this topic and supports the evidence that MUSI may reduce pharmaceutical and plastic waste.

MUSI resulted in a 100%, 84.6%, and 77.6% estimated reduction in ICM, plastic, and total waste respectively and a 21.1% increase in saline waste as compared to SUSI. At the observed institution, the estimated potential cost savings over a 16-week period amounted to $7200 for plastic waste and $32 iodine waste removal respectively.

The study showed that CT technologists spend 40.5 seconds less time per patient using MUSI, despite spending 23.1 seconds longer with the terminal.

Considering that a typical scanner in our fleet scans approximately 30 patients on a weekday, this would equate to a 101.3-minute time saving per scanner over a 5-day workweek.

These data correlated with the CT technologist survey results in which responders rated work efficiency, user-friendliness, and overall satisfaction higher with the MUSI system compared to SUSI.

Limitations of the Publication:

- Discrepancy between included studies (10 for SUSI vs. 19 for MUSI) which was mainly due to limited observer availability at off-campus outpatient clinics during the workday.
- The reported overall 21.1% increase in saline waste with MUSI may be corrupted, since it was likely attributable to the CT technologists spiking a bag of saline (typically 1000mL bags instead of two 30mL vials for SUSI) in advance for any potential contrast studies. Some bags may have reached their expiration window and required discarding.
- The potential cause of technologist increased time with the MUSI terminal was the needed learning how to use a completely new software interface.
- Since the study is an observational pilot study at a single institution, the reported waste savings may not reflect potential waste generation or savings at other hospitals.
- The sample selection included only a subset of CT scanners thus, it may not fully grasp potential workflow changes for emergency and inpatient settings.
- The waste models for SUSI assume a site had access to vials of contrast in multiple volumes. Sites may only have access to a single volume (e.g., 50 or 100 mL). In general, waste will be higher for sites with only a single volume of contrast agent container.
- The study did not account for large-volume ICM bottle swaps with MUSI. While this is likely a trivial time addition to an overall workday, our actual time savings may be slightly longer than reported.
- Waste savings are reflective of a mathematical model which extrapolated waste on known ICM volumes per patient and nominal measurements of saline and plastic materials which are not expected to change on a per patient basis.

Key Messages:

- CT technologists spent **40.5 seconds less per exam with MUSI** compared to SUSI.
- **MUSI resulted in a 100%, 84.6%, and 77.6% estimated reduction in ICM, plastic, and total waste respectively (and a 21.1% increase in saline waste as compared to SUSI).**
- Technologists rated **MUSI work efficiency, user-friendliness, and overall satisfaction higher relative to SUSI.**
- **MUSI offers reduced pharmaceutical and plastic waste as well as time savings benefits allowing CT technologists to focus on other clinical tasks.**

General information:
This document contains information on ulrich medical contrast media injectors (hereafter referred to as "device") that may not be approved in a specific country. The user of the respective device is obliged to find out whether the device used by him is legally approved in his country and/or whether there are any legal requirements or restrictions for its use and to what extent.
The user must ensure that the current versions of the complete product materials provided as the overall documentation for the device are available and taken into account. The necessary product materials are: Instructions for use.
This document is a carefully prepared summary of the above-mentioned study. Nevertheless, we cannot completely rule out errors in this document.

This study and its contents refer exclusively to the CT motion USA version.

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