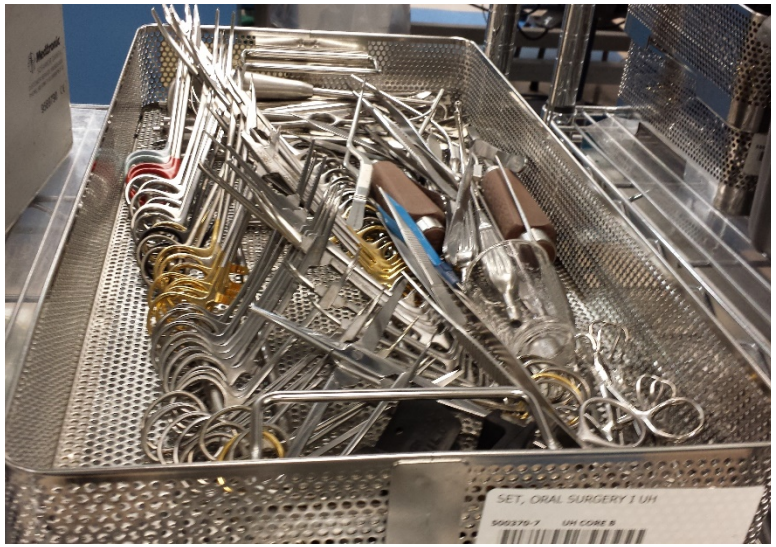
Improving Surgical Instrument Reprocessing at the University of Michigan Health System (UMHS)

Daniel Hazlett



Our Collaborators

UM Center for Healthcare Engineering and Patient Safety (CHEPS)

- James P. Bagian MD PE, Amy Cohn PhD, Joseph DeRosier PE CSP
- Nina Scheinberg, Sarah Bach, Jared Kott, Rama Mwenesi

University of Michigan Health System (UMHS)

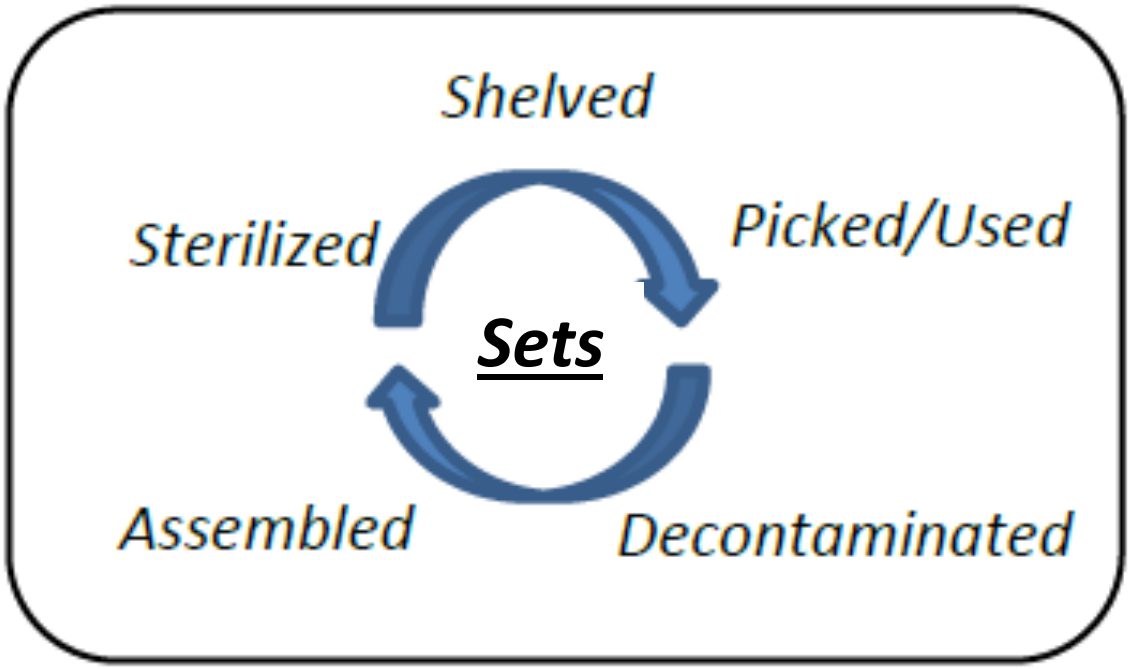
- Shawn Murphy, Director of University Hospital OR and PACU
- Julia Jackson, Manager of Central Sterile Processing and Distribution (CSPD)
- Frank Krupansky, Director of Material Services
- Elvie Casper, Neurosurgery Service Lead

Outline

- Background
- Problem statement
- Improving the instrument reprocessing operation
- Optimizing how surgical instrument sets are defined
- Questions

Background

- Reusable surgical instruments must be reprocessed between cases
- Instruments are kept in predefined ***instrument sets***



Problem Statement

Frequent problems with instruments reprocessing:

- Unavailable Items/sets
- Improperly cleaned items (bioburden and debris)
- Poorly-functioning items

Problems related to instrument sets

- Redundant items (e.g. differing only by vendor or preference)
- Inefficiently defined sets → including items that are not needed for case

Problem Statement

Goal: *To have all items required for the proper care of the patient available at the time of surgery, properly cleaned and sterilized, and in working condition – while ensuring the efficient use of resources.*

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1) High quality reprocessing operation

Problem Statement

Goal: *To have all items required for the proper care of the patient available at the time of surgery, properly cleaned and sterilized, and in working condition – while ensuring the efficient use of resources.*

Two aspects to this goal:

1) High quality reprocessing operation
2) Efficiently defined surgical sets

Two-Fold Approach

Partnered with ***Neurosurgery*** as a pilot department for change

1) Investigate the current ***instrument reprocessing operation***, identify root causes of problems and implement countermeasures.
2) Analyze how the ***instrument set definitions*** impact the downstream operation and explore ways to improve this decision.

mproving the Reprocessing Operation

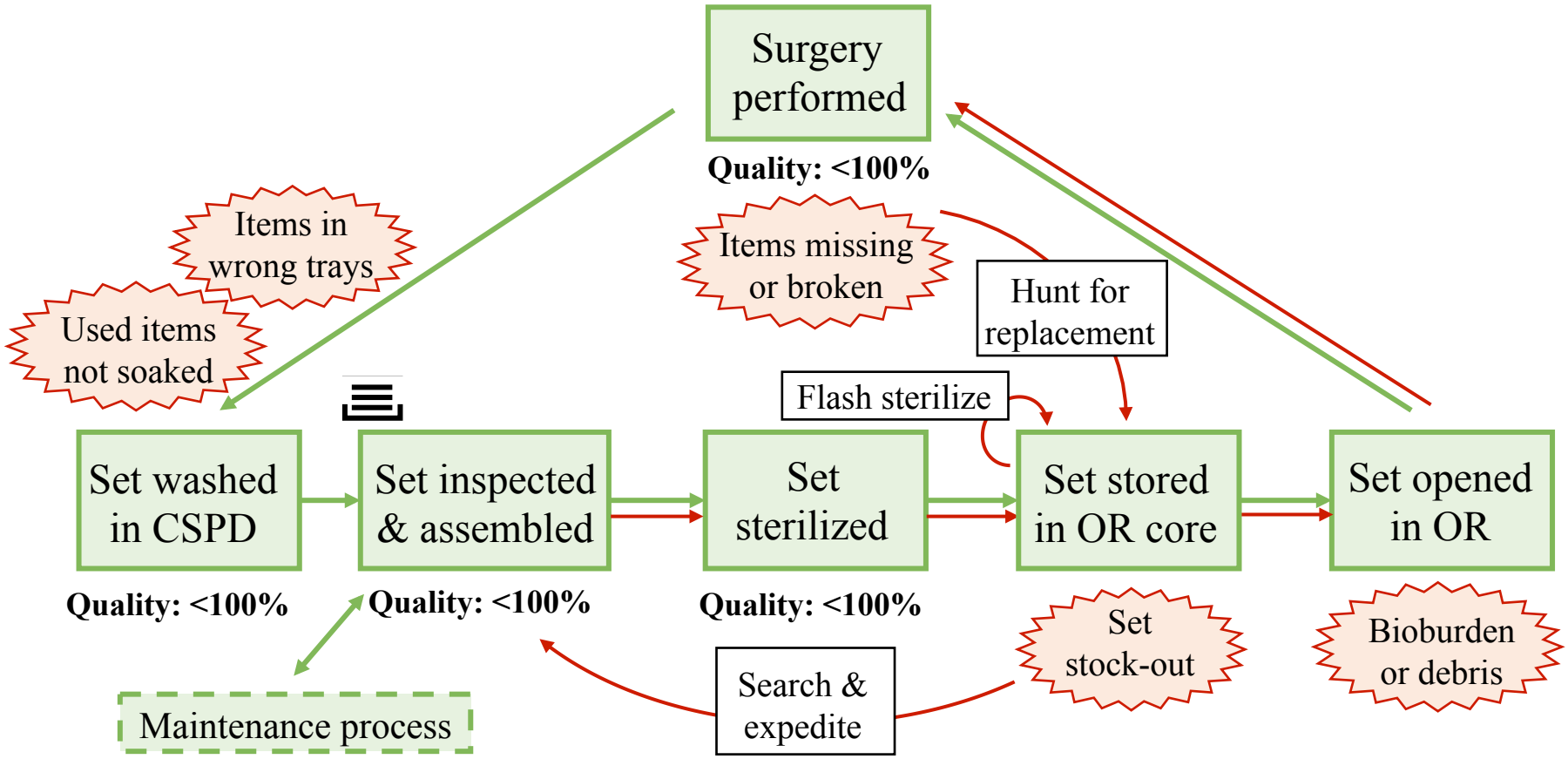
Observations and interviews with staff throughout process

- Instrument techs, perioperative techs, OR nurses and Surgeons
- Neurosurgery, OR and CSPD management

General Observations

- Often communication is poor between OR and CSPD
- Typically, staff understand their part of the process well, but not the whole
- OR staff reported that sets seem to “get lost” in the reprocessing operation
- Often the process for responding to problems is hectic or unclear

mproving the Reprocessing Operation



mproving the Reprocessing Operation

Opportunity: Bioburden Events and "Hard-to-clean" items

- Involved a relatively small number of items
- Often caused by problematic design features (e.g. small channels or grooves)

Countermeasures

1) Identifying items that are prone to bioburden, documenting reason
2) Creating a standard process for mitigating risk of bioburden events
   - Change in cleaning/sterilization procedure?
   - Alternative that is easier to clean?
   - Disposable or recyclable alternative?

mproving the Reprocessing Operation

Opportunity: Managing Item Nomenclature

- Formal vs. common name
- Currently IT system only includes formal name
- Different departments refer to the same item by different common names

Countermeasures

1) Documenting common names
2) Proposing IT changes to include both formal and common names
3) Creating common name reference materials for CSPD staff

Optimizing How Sets are Defined

Two Primary Questions

1) Are all items in the inventory necessary?
2) What is the optimal way to define sets?

Optimizing How Sets are Defined

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1) **Are all items in the inventory necessary?**
2) What is the optimal way to define sets?

- ~3,800 distinct items among 340 Neurosurgery sets for 11 surgeons
- "Functionally Equivalent" items?
  - Differing only by Vendor, non-clinical preference?
- Requires much input from Surgeons → major obstacle
- Surgeons largely feel that all items in the sets are required

Optimizing How Sets are Defined

Two Primary Questions

1) Are all items in the inventory necessary?
2) **What is the optimal way to define sets?**

- Can't store and process all ~3,800 item types individually → Define sets
- Can't deliver all 3,800 item types to every surgery
- Trade-off: generalizing sets vs. customizing sets

Optimizing How Sets are Defined

Benefits of generalizing?

- Simplifies inventory management
- Increases consistency (e.g. more easily locating sets or items within sets)
- Saves storage space
- Reduces time OR nurses spend opening sets before cases

Benefits of customizing?

- Avoids needlessly contaminating items → unnecessary workload
- Saves space in the OR
- Reduces time OR nurses spend counting

Optimizing How Sets are Defined

Competing Objectives

- OR administration → Minimize cost
- Neurosurgery → Minimize delays / Inconveniences
- CSPD → Minimize reprocessing workload

Dependencies

- ↓ reprocessing workload → ↑ process outcomes and/or ↓ cost

Optimizing How Sets are Defined

Heuristic approaches

- **Basic sets:** items required for a majority of cases
- **Specialty/Supplement sets:** items required less for specific type of cases
- **Provider Specific sets:** items requested by specific surgeons
- **Implant or Vendor sets:** sets created by outside vendor for implant cases

Integer programming approaches

- Clear decision variables and parameters
- Many competing objectives, many difficult to quantify
- No single decision maker

Model Formulation

imple Problem: Decide how to consolidate all items from S current set definitions nto T new set definitions, to minimize excess items. (T<S)

$$Min \ \sum i\in I\uparrow \sum s\in S\uparrow \sum t\in T\uparrow c\downarrow is \ e\downarrow is \ y\downarrow st$$

$$s.t.$$

$$(1) \ \sum t\in T\uparrow y\downarrow st = 1 \ \forall \ s\in S$$

$$(2) \ d\downarrow is \ y\downarrow st + e\downarrow is = x\downarrow it \ \forall \ i\in I, s\in S, t\in T$$

$$(3) \ x\downarrow it \ , \ e\downarrow is \in Z\uparrow * \ , y\downarrow st \in (0,1)$$

Optimizing How Sets are Defined

Possible Extensions

- Consider alternative objectives (i.e. min cost, min probability of stock out)
- Incorporate inventory decisions
- Items in current sets vs. items currently used

Limitations

- Item use information difficult to collect
- Problem potentially intractable → consider focusing on 1-2 physicians
- Multiple decision makers with competing interests
- Effect of poor quality in reprocessing operation

Acknowledgements

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CHEPS and the HEPS Master's Program

- **CHEPS:** The Center for Healthcare Engineering and Patient Safety
- **HEPS:** Industrial and Operations Engineering (IOE) Master's Concentration in Healthcare Engineering and Patient Safety offered by CHEPS
- CHEPS and HEPS offer unique multidisciplinary teams from engineering, medicine, public health, nursing, and more collaborating with healthcare professionals to better provide and care for patients
- For more information, contact Amy Cohn at amycohn@umich.edu or visit the CHEPS website at: https://www.cheps.engin.umich.edu

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Questions?

Model Formulation

Consider the problem of how to consolidate S current set definitions into T new set definitions, to minimize excess items. (T<S)

Assumptions

- *Each current sets must be contained in some new set that "replaces" it*
- *There is some cost associated with excess instruments*

Sets

I: *set of all instrument types*

S: *set of all current set definitions*

T: *set of all new set definitions*

Model Formulation

Decision Variables

x_{it}: *the number of items of type i in new set t* $\forall\ i \in I, t \in T$

y_{st}: 1 *if set s is "replaced" by new set t*, 0 *otherwise* $\forall\ s \in S, t \in T$

e_{is}: *excess of item type i in the set* replacing *current set S* $\forall\ s \in S, t \in T$

a_{ist}: *an artificial variable* (*used in constraints*) $\forall\ s \in S, t \in T$

Parameters

d_{is}: *the number of items of type i in current set s* $\forall\ i \in I, s \in S$

c_{is}: *unit cost of excess of item i relative to set s* $\forall\ i \in I, s \in S$

Model Formulation

$$Min \ \sum_{i \in I} \sum_{s \in S} c_{is} e_{is}$$

$$s.t.$$

$$(1) \ \sum_{t \in T} y_{st} = 1 \ \forall \ s \in S$$

$$(2) \ d_{is} y_{st} + e_{is} + a_{ist} = x_{it} \ \forall \ i \in I, s \in S, t \in T$$

$$(3) \ M(1 - y_{st}) \geq a_{ist} \ \forall \ i \in I, s \in S, t \in T$$

$$(4) \ x_{it}, e_{is}, a_{ist} \in Z^{*}$$

$$(5) \ y_{st} \in (0,1)$$