

Summary

Surgical Instrument Tray Optimization Process at a University Hospital: A Comprehensive Overview

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Background

Healthcare costs have risen significantly in Denmark and globally, with operating rooms (ORs) being major contributors due to high material and supply usage. Surgical instrument trays, often overloaded with unused tools, represent a key area for cost and efficiency improvements.¹⁻³ Based on a comprehensive inventory analysis revealing a high proportion of worn-out instruments - with functionality ranging from 28% to 74% across specialties - a hospital-wide optimization initiative was undertaken at Aarhus University Hospital, Denmark's largest university hospital.⁴ The initiative aimed to reduce tray complexity, improve resource utilization, and enhance quality of care, with optimization efforts focused on instruments for open surgery to streamline scope, reduce complexity, and control costs.

Objectives

The study aimed to:

- Reduce the number of instruments and tray types
- Consolidate or separate trays based on surgical needs
- Introduce modular trays for specific procedures
- Standardize commonly used instruments across specialties

Setting and Scope

The initiative involved:

- 74 operating rooms across 12 surgical specialties

- 1340 instrument trays selected for optimization
- Focus on open surgery instruments only
- Collaboration between surgeons, OR nurses, logistics experts, and instrument manufacturers

Design and Methodology

A structured, interdisciplinary workshop approach was used, involving:

1. Holistic Review: All tray types were assessed for overlap and redundancy
2. Reduction: Instruments used less than once every 4–5 surgeries were removed unless needed for emergencies
3. Consolidation/Separation: Trays were merged or split based on procedure specificity
4. Modularization: Specialty modules were created (e.g., breast reconstruction, bariatric surgery)
5. Standardization: Common instruments were unified across departments (e.g., reducing forceps types from 43 to 26)

Data was collected over a 12-week period, both before and after optimization, and compared, including:

- Number of tray types
- Total number of trays
- Instruments per tray type
- Total number of instruments

Statistical analysis was performed using t-tests, with significance set at $p < 0.05$.

Key Results

The optimization yielded the following results:

- The number of tray types was reduced from 258 to 215 (17% reduction, $p = 0.01$)
- The total number of trays slightly increased from 1,318 to 1,357 (1%, not significant)
- The number of instruments per tray was reduced from 30 to 24 on average (18% reduction, $p = 0.0002$)
- The total number of instruments was reduced from 43,073 to 36,687 (16% reduction, $p < 0.0001$)

Specialty-specific changes included:

- Obstetrics and Gynecology reduced tray types by 33%
- Plastic surgery reduced instruments per tray by 42%
- Orthopedic surgery eliminated trauma trays and redesigned for large/small bone surgeries

Discussion

The discussion section provides reflection on the outcomes of the surgical instrument tray optimization process conducted at Aarhus University Hospital. It emphasizes the complexity of tray design and the multifaceted nature of optimization across diverse surgical specialties.

Key Findings and Comparisons with Existing Literature

A statistically significant average reduction of 18% in instruments per tray was achieved, with specialty-specific variations ranging from 3% in Obstetrics and Gynecology to 42% in Plastic Surgery. These results, while substantial, are somewhat lower than those reported in previous studies:

- Farrelly et al. reported a 34% average reduction in instruments per tray in a pediatric surgical setting.¹
- Dekonenko et al. found reductions ranging from 40% to 70% in pediatric surgical cases.⁵

The authors note that their broader hospital-wide approach, which included consolidation, separation, modularization, and standardization, may explain the more moderate reductions compared to department-specific studies.

Complexity of Tray Design and Optimization Approaches

Instrument tray design is inherently complex, and no universal method guarantees optimal outcomes. A scoping review by dos Santos et al. identified various strategies for tray rationalization, including: Expert analysis, Lean methodologies, Mathematical modeling, Key-driver programs and Value stream mapping.³

The Aarhus study integrated several of these approaches through an interdisciplinary, iterative design process, involving surgeons, OR nurses, and logistics experts.

Interpreting Instrument Reductions

The authors argue that total instrument count is a more valid metric than instruments per tray, due to the structural changes in tray design. For example, some trays were eliminated entirely (e.g., 16 tray types in Orthopedics), while others were modularized or split.

Although the study did not include laparoscopic instruments, the authors considered whether an increase in laparoscopic procedures might explain the reduction in open-surgery instruments. However, they concluded that this was unlikely.

Operational Efficiency and Patient Safety

The reduction in instruments is expected to improve OR preparation and setup time, instrument handling during surgery and pre-cleaning time in the OR. Supporting evidence of this includes:

- Farrokhi et al. (2015) reported a 37% reduction in setup time for minimally invasive spine surgery.⁶
- Crosby et al. (2020) found reductions of 26–37% in setup time and 58–66% in tray assembly time.⁷

Moreover, fewer instruments may reduce the risk of errors in handing incorrect tools to surgeons, enhancing patient safety.⁸

Limitations in Impact on OR Scheduling

While time savings of 5–15 minutes per surgery are possible, the authors caution that this may not be sufficient to add extra surgeries to the daily schedule. Factors such as surgeon efficiency, team communication and cooperation and patient health status, are likely to have a greater influence on overall OR effectiveness than instrument setup time alone.⁸⁻¹⁰

Potential Trade-offs and Unanswered Questions

The study raises important questions about unintended consequences.

Has the reduction in tray instruments led to increased use of single-use instruments or individually packaged reusable instruments?

What is the impact on resource consumption in the Central Sterile Supply Department (CSSD), such as water, energy, and labor?

Unfortunately, the authors did not have data to explore these trends, highlighting the need for further research.

Conclusion

The Aarhus University Hospital initiative demonstrates that a structured, interdisciplinary approach can successfully optimize surgical instrument trays across all specialties. The process led to significant reductions in tray complexity and instrument count, with potential benefits for efficiency, cost savings, and patient safety.

The study recommends using total instrument count as a more accurate metric than instruments per tray.

However, the full impact on CSSD workload and OR scheduling remains to be validated through future research.

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