Optimizing sterilization logistics

Prof. dr. J.J. van de Klundert
Chair department of Health Care Management
Erasmus Medical Center
vandeklundert@bmg.eur.nl
Dutch perspective on current developments/improvements
Orbis Medical Center: hospital of the 21\textsuperscript{th} century
CSSD of the 21\textsuperscript{th} century?

- Reduction of required m\textsuperscript{2} in precious space close to operating theatres: 
  sterilization in a remote location (≠ outsourced)

- Reduction of capital invested in sterile equipment (standardization,…..)

- Reduction of working extra hours (logistic planning)

- Reduction of rush orders (logistic planning)

Ohh yes……and without compromising the 100 % service level
The logistics of the sterilization process
The ‘ist’ situation (in 2005): **ignorant slave model**

![Diagram](image)

Fig. 1 Rudimentary design for sterile logistics and subsequent improvements

Start of the day situation
With the surgeon as master: Surgeon oriented logistics....
The ignorant slave model (cont.)

Fig. 1 Rudimentary design for sterile logistics and subsequent improvements
## Drawbacks

- Storage of all possible sterile materials in center of hospital, where space is scarcest (as opposed to remote storage)

- Work at CSSD stops only when all used materials is sterilized – regardless of what is needed the next day

- No standardization $\rightarrow$ high inventory, requiring much space

- High working capital requirements (material only used for one surgery type)
Patient oriented logistics: the service provider

Start of the day situation

Fig. 1 Rudimentary design for sterile logistics and subsequent improvements
Operating Theater Schedule

Monday 19 November

8:00  Patient Z - Hernia Operation (Operating Room 1)
9:00  
10:00 Patient Z - Hernia Operation (Operating Room 1)
11:00 Patient X - Hernia Surgery (Operating Room 1)
12:00 
13:00 Patient Q - TAAA
14:00 
15:00 

4 items
Patient oriented logistics

Fig. 1  Rudimentary design for sterile logistics and subsequent improvements

Start of the day situation

Safety stock
Causes of unplanned use

- Emergency surgery
- Complications
- Instruments defect
- Instruments get desterilized
- Nets are incomplete

....
Which model is better?

Don’t compromise service levels: (shortage probability less 0.0001)

→ Better means lower cost

- Cost of $m^2$,
- Cost of capital invested in sterile instruments,
- Cost of transportation,
- Cost of over hours,
- Cost of sterilization,
Benchmark: an unrealistic ‘ideal’ scenario: completely elective, no unplanned use, no safety stock

Improvement of ideal over ignorant service provider: 42%

(on data using Lap. Chol., Cataract, TAAA)
Simulation of 4 non ideal but realistic service provider models (which take unplanned use and safety stock into account)

0. Ignorant slave: 100

1. Ignorant service provider: Have enough safety stock in the OT sterile storage to last for an entire week 82.1

2. Anticipating service provider: Replenish during week in anticipation of expected unplanned use 62.4

3. Informed service provider: Track the unplanned use (e.g. using RFID) and replenish it while replenishing planned use (as under 1) 60.4

Cost of IT not included

1. Intelligent service provider: Track the unplanned use and replenish as under (2) 58.2

2. Ideal: 57.2
Decisions made

CSSD was outplaced not outsourced

Negotiations with other hospitals (and health service providers) on going

Estimated savings by Orbis:

- +/- 500,000 in yearly operating costs
- +/- 500,000 reduction in capital employed

On a national scale this is 100 million!
Optimization of the net composition

Example:

Operation type A requires \{forceps, tenaculum, scissors\}
Operation type B requires \{scalpel, tenaculum, scissors\}
Operation type C requires \{skin staple, scissors\}

→ 1 net per operation type:
  - A: \{forceps, tenaculum, scissors\}
  - B: \{scalpel, tenaculum, scissors\}
  - C: \{skin staple, scissors\}

→ 1 net fits all:
A, B, C: \{forceps, scalpel, skin staple, tenaculum, scissors\}
Net Composition: ‘Clever alternatives’

→ Combine A and B, C separate
  A,B: \{forceps, scalpel, tenaculum, scissors\}
  C: \{skin staple, scissors\}

→ 1 base net, 3 separate add-ons
  A: \{forceps\} \{tenaculum, scissors\}
  B: \{scalpel\} \{tenaculum, scissors\}
  C: \{skin staple\} \{tenaculum, scissors\}
Mathematical formulation (Glorie et al. 2007)

\[
\min \sum_{l \in L} \sum_{k \in K} \sum_{i \in I} a_i \cdot w_{ik} \cdot Z_{kl} + \sum_{k \in K} \sum_{i \in I} c_1 \cdot Z_{kl} + \sum_{j \in J} \sum_{k \in K} c_2 \cdot Y_{jk} 
\]

(3.1)

s.t. \( \sum_{k \in K} Y_{jk} \cdot w_{ik} \geq d_{ij} \) \hspace{1cm} \forall (i \in I, j \in J)

(3.2)

\[
\sum_{j \in J} Y_{jk} \leq \sum_{i \in I} Z_{kl} 
\]

(3.3)

\[
\sum_{k \in K} Z_{kl} \leq r_K 
\]

(3.4)

\[
Z_{kl} \leq Z_k 
\]

(3.5)

\[
\sum_{k \in K} Z_{kl} \leq 1 
\]

(3.6)

\[
Y_{jk} \in \mathbb{N} \hspace{1cm} \forall (j \in J, k \in K)
\]

\[
Z_{kl}, Z_k \in \{0,1\} \hspace{1cm} \forall (k \in K, l \in L)
\]
Closing remarks

Sterilization processes are of increasing interest for hospitals because of safety/risk mngmt, and because of cost.

Sterilization management is becoming more complex, and increasingly knowledge intensive.

You have an exciting future, with valuable logistic optimization opportunity.

Thanks for the invitation!