

WORKFLOW AUTOMATION STUDY OF OT AND CSSD

Mrs. Neeta Amit Ghugare
CSSD Senior Technician
Wockhardt Hospital, Mumbai Central.
India

Co-Author
Dr. Dhananjay Mankar
Assistant Professor
Tata Institute of Social Sciences Mumbai

Abstract:

Adequate sterile supply plays an essential role in the attempt to reduce the spreading of diseases within the health service. Many instruments and materials used for medical and surgical interventions are very expensive and are designed such that they can be re-used. A high-quality reprocessing cycle is necessary in which the used materials are treated such that, they can be used safely again. Quality and success of Central Sterile Supply Department depends upon customer satisfaction (OT and other user department). Surgical instrument set is needed quickly in the surgical suite and that set is to be delivered complete (no missing instruments). Hospitals are tasked with managing hundreds of pieces of instruments across large facilities. Nursing staff wastes precious minutes searching for instruments, counting instruments pre and post procedure and segregating instruments into correct sets. Surgeries may be delayed because a critical instrument can't be found. Additionally, CSSDs face challenges of uniquely identifying thousands of items to ensure sets are packed correctly without mismatches, instruments are maintained as per manufacturer protocols and processing is done in a time-bound manner so that inventory is quickly available for the next use. Nursing and CSSD staff spend 79 mins/surgery to count instruments at various points in the workflow of instrument management. There are more than 8 times incidences of instruments being incorrectly mixed / misplaced post procedure and 2 incidents of incorrect packing of sets in the study conducted and 5 time unnecessary or for 1-2 instrument set got opened found during study in 14 days.

Automated instrument tracking using Radio Frequency Identification can help improve efficiency and save costs for hospitals, Bulk reading and automatic identification of instruments saves time, item level monitoring improves patient safety and reduces costs and labor. It reduces nurses mental stress and enables them to spend more time caring for patients.

The main purpose of this project is to show how Technology and RFID are key in automatic determination of the possible instrument usage information for automatic surgical workflow recording, minimize problems connected with surgical infection, loss of surgical instruments, types of error and waste of time due to instruments counting and tracking. The result shows how the Technology and RFID can replace manual recording and documentation and how a hospital can drive returns from the investment required in RFID hardware.

Introduction:

As per AORN guidelines Instrument counts protect the patient by reducing the likelihood that an instrument will be retained in the patient, including minimally invasive procedures. Instruments counts are a proactive injury prevention strategy. Retention of surgical instruments accounts for approximately one third of retained item case reports. Case studies demonstrate that many types and sizes of retained instruments have been found, ranging from small clamps to moderately sized hemostats (i.e 6 to 10 inches) to 13 inch long retractors.

Today's medical technology and care of patient associated with infectious diseases, which pose a serious threat to people's health. OT staff and CSSD Technicians routinely feel pressure in their work due to the time sensitive needs of the operating rooms. Instruments are costly, so it is responsibility of OT and CSSD to take care of it. Traceability issue, opening of major instruments set for 2-3 instruments, more time wastage on missing incidents, errors in packing, mismatch of instruments, wet packs, not following SOPs for counting are common problems in OT and CSSD worldwide.

Central Sterile Supply Department at Proposed Hospital 170 instrument sets having around 7200 instruments and 279 separate pack instruments are handled by this department. There are 3 Senior Technicians 7 CSSD Technicians with B.Sc. qualified and 5 attendants works in the department. There are total 8 OTs, and Average 10 cases happens per day so approximate 35-40 sets and around 60-80 separate packs come from OT for reprocessing on daily basis.

CSSD and OT handles variety of instruments and set packs. Many time "OT transaction register" found incomplete, so traceability becomes an issue. Opening of major instruments set for 2-3 instruments, more time wastage on missing incidences, errors in packing, mismatch of instrument, wet packs, CSSD waiting time for signature from OT are major issues. Sometime OT staff could not Count of instruments in set before, after or during surgery and no one wait while receiving the case by CSSD. Not giving importance for transaction. Type 4 Indicators inside the set which indicates the set has gone through the process should document

with patient record which not getting done by OT staff. Unnecessary phone calls for location of instruments. Damaged instruments are not documented on time or sometimes forgotten to record by staff. Many regular sets come in Expiry so not following "First in First out"

REVIEW OF RFID SYSTEM:

What is RFID?

Radio Frequency Identification describes the use of radiofrequency signals to provide automatic identification of items so does not require contact or line of sight to operate and can read several items at a time. It can function under a variety of environmental conditions and provides a high level of data integrity.

- Tag: a Microchip combined with an antenna that has a unique ID
- Antenna : Transmits and receives the signals to and from the tag
- Reader and Transceiver: Transmit RF signals, receives the encoded signal from the tag, decoded the tag's identification and transmits the identification with any other data from the tag to the host computer.
- Middleware: Receives information about the tag and takes context specific actions based on user requirement.

Why RFID tracking system is better than Barcode?

Around 60% of facilities are beginning to embrace comprehensive instrument tracking solutions. Majority of the market penetration has been in the United States and Europe. Barcodes have been the most commonly used method for instrument identification but now trends in IT Adoption in CSSD is replaced with RFID. Barcodes system is the most commonly used type of tracking technology but it is read only one by one and also is difficulty in soiled instrument Handling and fades over time.

RFID Tags: Industry compliance by FDA as safe. Tiny sizes that can fit almost all sizes of instruments. Weight is < 0.5gms. In point of economics it is not a cost, it is an investment

Why RFID?

- To Keep track of Set movements
- To improve Accuracy and efficiency
- For right inventory at the right place
- Improve Accuracy and Efficiency
- To communicate fast and Accurately
- RFID enabled location updates automate tracking sets
- Loaner Management made easy with item images, case details and item details. Track loaner sets from the time they arrive until they are returned to the vendor
- It manages the Repair Bin
- A simple four step process allows to select patient, account for every instrument /Loaner/ dressing material/ swab used during surgery, keep a handy count of materials and track consumption of items. Create Pdf consumption reports for easy patient billing.
- Digitization & Regulatory Compliances
- Comply with the USFDA regulation on Unique Device Identification to track each instrument through the use cycle. India Medical Device Rules 2017 also mandate that by Jan 2022, every medical device should bear a unique ID.

How will it reduce the cost?

Surgical instrument tracking system using RFID is Return of Investment.

- a) Inventory cost: Inventory cost, cost of non-moving inventory, for better vendor and product evaluation during replacements, Reduction in damages due to higher accountability
- b) Processing Costs: Reduction due to opening of unwanted sets (for e.g. To check particular instruments or for lack of proper packing lists, Reduction in stationery/ Printing costs through paperless workflow.
- c) Manpower Costs: Reduction in technician workload due to reduction of unwanted set opening, Reduction in supervisory costs spent on paperwork, finding sets and instruments, Reduction in inventory verification time, Reduction in staff training time for new recruits, Reduction in technician time due to automatic counting, integrated workflow.

Literature review:

Article from FROST and Sullivan: Hospital staff typically spends three or more hours per day on inventory management. Frost and Sullivan research estimates that 20% of the time, staff members are unable to find equipment, leading to additional wasted time and

loss of the instrument itself. Additionally, instruments left inside a patient after surgery can cost a hospital more than \$200,000, including legal defenses, indemnity payment, and the additional surgery needed to remove the instrument. If the clinical staff is unable to find an instrument is located, resulting in lost time in operating Rooms and staff time.

Outside the OR, it is estimated that 20% of hospital supplies, devices, or equipment are lost or misplaced due to inefficient supply chain management, leading to the OR working at about 50% decreased efficiency due to poor equipment flow.

Some hospitals recognize the inefficiencies of this process and choose to use auto identification applications such as barcode scanning, optical recognition, and biometrics to track medical supplies. While more efficient than manual counting, these systems have many disadvantages including being slow and unreliable, requiring line of sight, and depending on human intervention- all reducing hospital return on Investment (ROI).

According to new report by Grand View Research, increasing incidence of surgical instruments being left behind after surgery is the most significant factor anticipated to boost the market growth during the forecast period. Annually in the U.S. around 4500 to 6000 surgical instruments are left in the surgical sites, which results in the need of additional surgery sites, for removal of retained devices from the body. This in turn results in the need for operating instrument tracking products.

HONG KONG, April 02, 2015 – Read-on-metal UHF RFID tags from Xerafy proved their suitability and value for surgical instrument tracking during an 18-month trial at New Rigshospitalet hospital in Copenhagen, Denmark. Tracking surgical instruments with RFID could save the hospital 31,000 hours a year in operating room procedures alone while also improving patient safety and providing additional time saving and infection control benefits during sterilization and other processes.

In 2011, Shimane University Hospital, in Japan, deployed RFID solution to track surgical instruments used on patients through cleaning, sterilization and storage. The Rigshospitalet hospital, in Copenhagen, completed an 18-month trial of RFID technology to track surgical instruments. Both found that item-level monitoring improved patient safety and reduced costs and labour.

Accuracy can also be compromised by incorrect instrument lists, untrained personnel, or time constraints. Hand counting these instruments can affect turn-around time for the operating room, and compromise quality of care.

Accurate medical device tracking also plays a role in accreditation and compliance with government regulations. For instance, to improve patient safety, the Joint Commission (JCAHO) developed the Universal Protocol to avoid wrong site, wrong procedure, and wrong person surgery errors. Part of the protocol includes verifying the items and surgical tools required for the procedure using a standardized list.

With a view to finding out feasibility of using RFID based surgical instruments tracking system at Proposed Hospital, I conducted a study of the current workflow at the hospital. The study was conducted over a period of 14 days in the CSSD department and Operating Theatres of the hospital.

Research Objectives for the Study:

1. To study financial feasibility of adopting RFID based surgical instrument tracking system at the hospital
2. To estimate degree of compliance with established SOP and gaps if any and whether compliance can be improved with use of technology
3. To estimate the current cost of processes, error rates and wastage in processes and whether these can be mitigated through use of technology

Research Methodology

Observation of current place

1. Time & motion study at CSSD in Receiving Area and Assembling area to estimate time taken for counting, matching of sets and instruments and searching of instruments between 18/06/2018 to 30/06/2018 dates.
2. Time and motion study in OT before, during and after the surgical procedure.
3. Audit of compliance rates on SOP for both departments
4. Questionnaires administered to the staff in OT and CSSD to explore awareness about instrument handling procedures and attitudes regarding the same. A total of 30 questionnaires were administered.
5. Study of work volumes through historical data collected at OT and CSSD. This data included “Instrument record register for Missing instruments”, “OT transaction Register”.

- A. Research Objective:** To study financial feasibility of adopting RFID based surgical instrument tracking system at the hospital

Table 1: Shows cost of man hour: Considered average salary for CSSD staff, OT nursing staff and attendant Rs.20,000, Rs. 28,000 and Rs. 8000 respectively.

Assumptions	RS.
Man hour cost for CSSD	Rs. 100
Man hour cost for OT	Rs.120
Man hour cost for CSSD attendant	Rs. 40
Man hour overtime for CSSD attendant	Rs. 35

Table 2: Shows Counting Time Management

On basis of live observation I have calculated counting time per instrument on each station (Pre and post-surgery in OT, Receiving, Packing and Expired sets received for reprocessing)

Total Volume of Surgery done between 18/06/2018 to 30/06/2018 and Total volume of work load came for reprocessing considered (Referred "OT transaction register"). Then how many sets and separate packs get use per surgery calculated.

Station	Total time in seconds)1	Per Surgery 2	Time per surgery in Hours	Man hour cost	OT Cost per Hour	Total Saving
Packing (Used sets)	82,663.20	1,312.11	0.36	100		36.4
Packing (Expired sets)	27,554.40	437.37	0.12	100		12.1
Receiving (by 1 person)	66,704.61	1,058.80	0.29	100		29.4
OT pre & Post surgery	122,502.27	1,944.48	0.54	120	1000	604.9
Total	299,424.48	4,752.77	1.32			682.96

1. Estimated based on workflow study inside CSSD and OT for 14 days during live procedures
2. Per surgery estimates based on Number of surgeries taken place during study period.

Table 3: Shows Documentation time management

Documentation	Per set (min)3	Total time per surgery	Documentation cost per surgery
Transaction (Receiving) register	0.50	1.50	
Packing list printing	1.00	3.00	
Sterilization batch listing	1.50	4.50	
Label writing	0.25	0.75	
Dispatch register	1.00	3.00	
Separate pack entry at receiving and in sterilization batch listing x6 (no. of items comes per case)	0.20	3.00	
Patient record	1.00	1.00	
Outgoing transactions for OT	0.50	1.50	
Total documentation time	6.75	18.25	30.42

3. Based on observations during study period

Table 4 : Shows Total saving per Annum with RFID (Assumed 3000 surgeries per annum)

Breakup of savings:	Per surgery (With RFID)	Per Surgery (Without RFID)	Total savings per annum (RFID)
Counting	682.96	0	2,048,873
Documentation	30.42	30.42	91,250
Total Saving			21,40,123

Conclusion:

Adopting RFID based surgical instrument tracking system at the hospital can save Rs. 21,40,123 on manpower for counting the instruments and documentation.

B. Research Objective: To estimate degree of compliance with established SOP and gaps if any and whether compliance can be improved with use of technology

As per AORN guidelines and SOP of the hospital counts of instruments should be performed

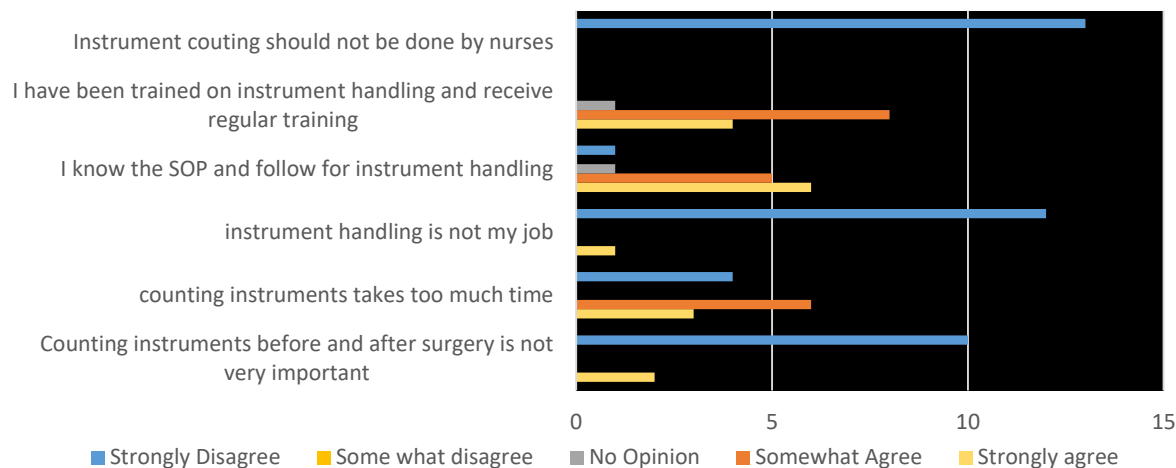
- Before the procedure to establish a base line (i.e. initial count)
- When new instruments are added to the field
- At wound closure or at the end of the procedure
- At the time of permanent relief of either the scrub person or the RN circulator

Table 5: Shows Non-Compliance Rate found at work station during live Observation.

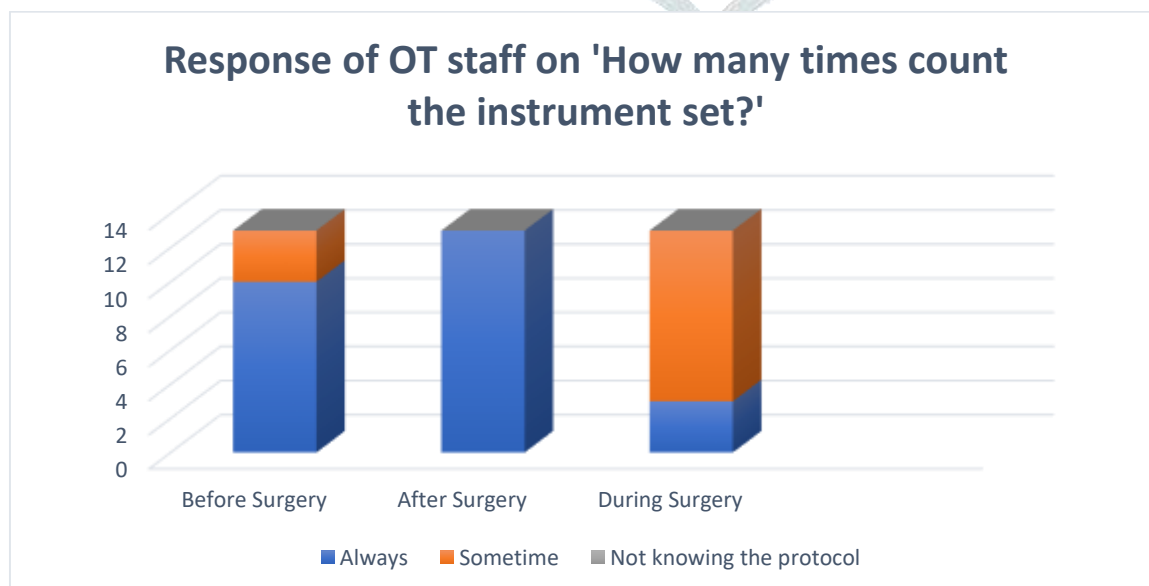
Particulars	Percentage of sets not counted
Before surgery	23%
After surgery	33%
OT Person Not available during receiving the case by CSSD	66%
Incorrect set Pack	1%

In attitudinal administered Questionnaires we got following results from OT staff:

OT response on attitudinal questions on instrument counting



The questionnaires administered regarding 'How many times you count the Instruments set' Following result were shown in response:



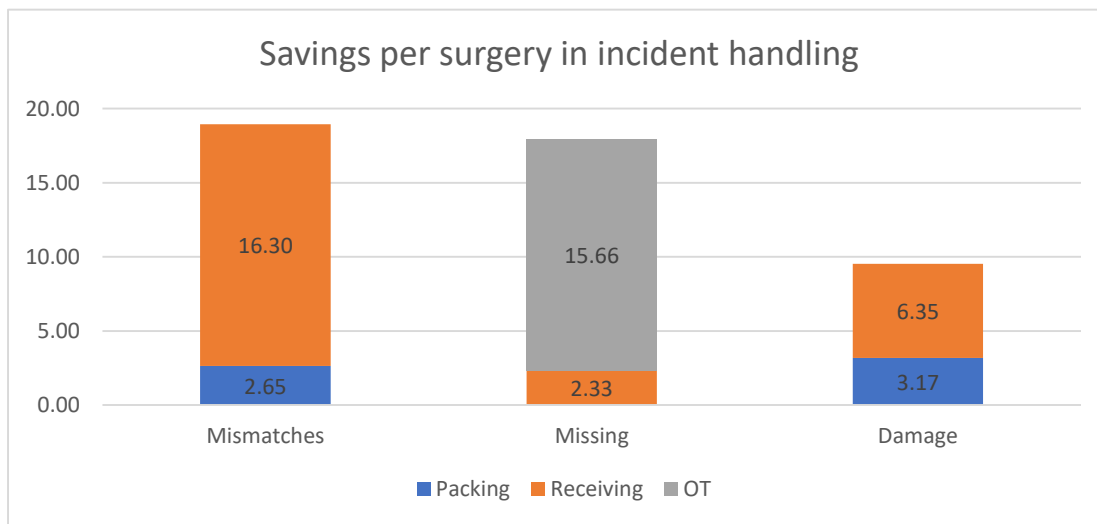
Discussion: OT staff stated that they could not count instrument because many times Surgeons is in hurry for surgery, It is emergency or only one scrub nurse available so not possible so no time get to count the instruments.

Conclusion:

Noncompliance can be improved with use of technology and can also remove the human fatigue, fill staff knowledge gaps and make process faster, easier and make safer for patients.

- C. **Research Objective:** To estimate the current cost of processes, error rates and wastage in processes and whether these can be mitigated through use of technology

Incident Handling



Tables 6: Shows Types of Incidents

Mismatches Incidents

Station	Mismatch probability per surgery	Time to resolve incident in seconds	Time per surgery in Hours	No. of people involved	Man hour rate	OT Cost per hour	Cost per Surgery
Packing	8%	1,200	0.026	1	100	0	2.65
Receiving	11%	1,200	0.037	2	220	0	16.30
OT	0	0	0	0	0	0	0
Total cost of mismatch handling							18.94

Missing Incidents

Station	Missing Probability per surgery	Time to resolve incident in seconds	Time per surgery in hours	No. of people involved	Man hour rate	OT Cost per Hour	Cost per Surgery
Packing	0	1,200	0.000				0.00
Receiving	2%	1,200	0.005	2	220		2.33
OT	3%	1,200	0.011	2	240	1000	15.66
Total cost of missing handling							17.99

OT cost per hour not included in cost calculation.

1. Damages Incidents

Station	Damage	Time to document handle damage (Second)	Time per surgery in hours	No. of people involved	Man hour rate	OT Cost per Hour	Cost per surgery
Packing	2%	7,200	0.032	1	100	0	3.17
Receiving	3%	7,200	0.063	1	100	0	6.35
OT				0	0	0	0
Total cost of damages handling							9.52

Cost Saved per Surgery for incident Handling	46.46
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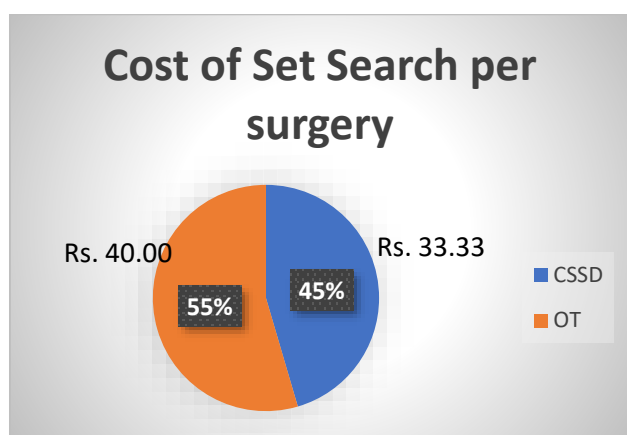


Table 7: Shows Cost per Surgery on incidents handling

Set search per surgery	Time per surgery in seconds	Man hour rate	Cost per surgery
CSSD	1200	100	33.33
OT	1200	120	40.00
Total Time			73.33

Table No.8 shows Set Opened for 1 -2 instruments

Material consumables includes wrapping sheets, silencer towel, Check list, all type of Indicators, R.O. water and Electricity.

No. of sets unnecessarily opened per surgery	Time per set for Receiving, washing and packing in hours	Time per surgery for packing unnecessarily opened sets (hours)	Man hour rate	Man power cost	Material consumables cost of reprocessing per set	Material cost per unnecessary set opening per surgery	Total cost saving per annum
0.05	0.54	0.026	100	2.57	54	2.57	5.14

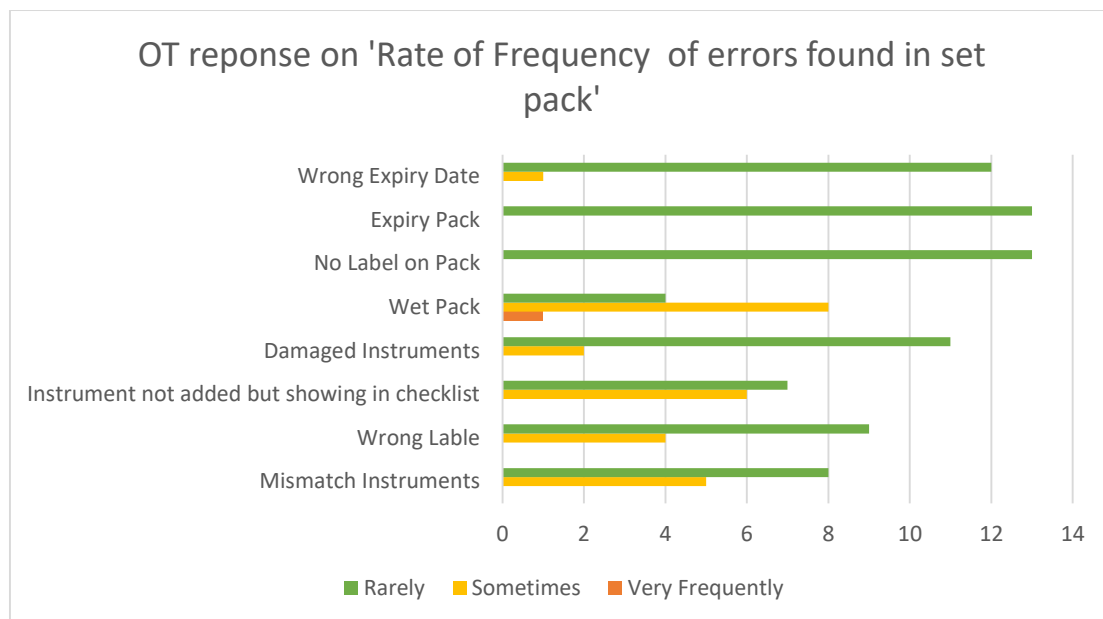


Table No 9 shows Physical Inventory Verification

Physical inventory done twice per year, so out of 10 CSSD staff and 5 attendant, 9 CSSD staff and 2 attendants works on physical inventory for OT inventory and 1 Technician and 1 attendant do the regular work. Staff starts to do inventory at morning on Off day, Morning staff continued for Evening shift and the staff comes for evening do continue for night shift to complete inventory process.

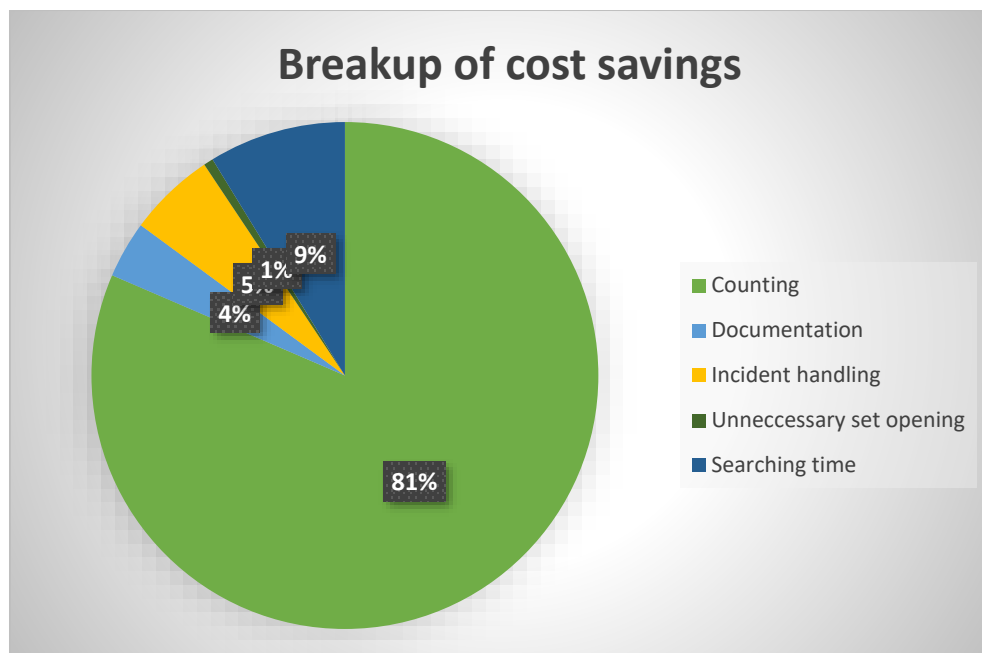
Manhour required: CSSD technician 8 hours plus do double shift for 6 hours.

Department	Physical verification done by double shift of each technician on week off day	No of people involved	Total man hours	Cost saving	No. of verifications cost per	Cost of reprocessing 170 sets X Rs.55 (reprocessing cost) 4	No .of Verifications per year	Total cost savings per annum
CSSD Technicians	2	9	252	100	25200		2	50400
CSSD Attendants	2	4	112	40	4480		2	8960
Total					29680	9350	2	78060

4. Reprocessing cost includes all indicators (Type 4, Type5, 3 line and PCD) Electricity cost, R.O. water consumption and sterilization wrapping material.

Table No. 10 shows Breakup of Saving on Incidence handling and Inventory management

Breakup of savings:	Per surgery (With RFID)	Per Surgery (Without RFID)	Total savings per annum (RFID)
Incident handling	46.46	46.46	139,365
Unnecessary set opening	5.14	5.14	15,415
Searching time	73.33	73.33	220,000
Inventory verification costs	-	-	78060
Total savings	124.93		452840



Discussion:

Sharing few incidents during study:

1. One grabber forceps 8” was not found during receiving by CSSD technician. She searched it again in all received sets which came in the same Ortho case. Then it was informed to OT. The 3 OT staff who involved in surgery started searching in OT and all other places including garbage and linen liner. It was ultimately found in dump area (in soiled linen garbage)
2. Once a suction tip pooli which got used in Liver transplant got mixed with Laparotomy set. Surgeon got angry with this incident because he deals with very delicate part like liver, at such point this minor mistake is not at all acceptable. The design of suction tip of both in Laparotomy set and in Liver set has minute difference at end point of cannula tip which again get cover with outer cannula.
3. Got complaint from OT that 1 Atragrip mixture clamp from Thoracotomy set got mixed. So opened all 3 Laparotomy set and checked, finally it found one of them.

We all people working in CSSD knows such type of incidents happens very frequently.

Conclusion:

CSSD and OT deals with thousands of instruments every day. So there are possibility of happening such incidents due to Job complexity, Complex Regulation, Environment, Human factor, staff shortage whether these can be mitigated through use of Technology can make the process simple, smother and can save the cost on such incidents handling.

Results:

Table No. 11 shows total Saving cost with RFID

TOTAL SAVINGS (Per annum):		With RFID	Without RFID
Total surgeries	3000	25,92,963	525,391

Recommendation:

We should try for small quantity on surgical instruments for small period of RFID as experiment and should see the difference how RFID will help us to save Manpower, bring efficiency and accuracy to the process, remove the human fatigue, fill staff knowledge gaps and make process easier, bring cost down and make process safer for patients.

ACKNOWLEDGEMENTS

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