ABSTRACT
To generate a statistically significant difference in terms of ITR after ABC & SFN analysis in the General Store section of GNRC Hospitals Pvt. Ltd. The core experiment under the study had a sample size of 660 types of consumable items. The study was done by observing the difference in Inventory Turnover Rate (ITR) of the existing system of Inventory control and then carrying out ABC & SFN analysis by classifying the inventory of last 4 months. It was found that the implementation of ABC & SFN analysis was successful in the study setting in terms of increased turnover of items. The average ITR of the sample was 1.34. Then the ABC & SFN (FSN classification was already existing in some extent) classification of the working sample was carried out and for 20 days, the standard control guidelines for A, B and C categories were followed. Thereafter the same sample measurements were retaken i.e. the ITR s were calculated after implementation and this time average was seen to be 1.71. There was an increase in ITR s before and after implementation of ABC & SFN analysis. The increment percentage was tested for its statistical significance through paired t-test and SPSS software package was used to generate the results along with the sought significance. An induced survey was carried out among the employees in the hospital which was aimed at increasing the acceptance level of the management change after adoption of the new analysis techniques of inventory control.

KEY WORDS
Material/inventory Management Technique, Efficiency, Effectiveness, Health Service, Inventory Turnover Rate.

1. Introduction
Aim of the material management in the hospital is to ensure adequate stock required for continuous supply and at the same time not to have too much also to ensure that resources available are most effectively and efficiently used.Material management [1] as a function is responsible for coordinating, Planning, sourcing, purchasing and controlling in such way as to achieve efficiency and to provide services to the consumers at minimum price. Inventory is the most important function of the material management. It is practically impossible for maintaining zero time lags. Theoretically it may seem to meet the day to day requirements of demand then inventory can be avoided, but which is not the case. Inventory acts as a cushion in case supply fails to meet day to day demand. The study is aimed at optimizing the uses of modern material management techniques and tools and thereby reducing materials cost per patient day incurred in a hospital.

The study is important to minimize idle time by avoiding stock out & storage of essential items and to optimize financial investments. It avoids obsolescence and thereby improves the quality of patient care operations in hospital.[10]

2. Materials and Methods
2.1 Experimental Study
A hospital-based Experimental study was carried out in general store section of GNRC Hospitals Pvt Ltd, Dispur, Guwahati. It is a 314 bedded multi-speciality hospital. It is an ISO 9001 certified organization. Institute of Neurological Science & GNRC Heart Institute are accredited from the following organization State governments of Arunchal Pradesh, Assam, Sikkim, Meghalaya, Manipur and Tripur.

The study was aimed at generating a difference in terms of increased ITR[4] in the sample after ABC & FSN methods implementation. The yield difference was tested for significance to conclude that the intervention of implemented methods were useful.

3. Sampling and Sample Sizing
Sampling method was Stratified Random Sampling (SRS). The stratification was based on Average Consumption Rate [4] of the items as per the previous 4 months’ record. Number of stratum was 3. Formula used for Sample Size Calculation:
\[ n = \frac{2(Z_\alpha + Z_\beta)^2 \times \sigma^2}{d^2} \]
Where, \( n \) = sample size, \( Z_\alpha = \) value at specified CI, \( Z_\beta = \) value at specified power, \( \sigma = \) pooled SD of the observations, \( d = \) degrees of certainty. Here, At 95% CI,
Zα= 1.96, At 80% Power, Zβ= 0.84, σ= 0.32 (calculated based on the Pilot Study) and d= 5 (preset)
Note: The value of ‘n’ was rounded for stratification ease and taken as 660.

3.1 Inclusion Criteria
- Based on random pick from each Stratum i.e. from S1, S2, S3 (for Implementation Phase)[9]
- Based on willingness & consent (for User driven need survey phase)

3.2 Collection of Data
A Study of the current procedures was carried out in General Stores section under the headings of Acquiring, Ordering, Inventorying, Stock taking, Distribution & Issue process. Then measurement of the current departmental procedures by calculation of ITR and EOQ[4][7] as comparable parameters. ABC analysis was carried out on the study sample and the standard control guidelines were followed for 20 days. The sample was kept under the observation and during the time the hospital’s normal operations were been allowed on the experimented sample. Recalculation of ITR was done after the implementation. The mean was observed to be increased to some units. The percent of increment was then tested for significance according to Paired t test for difference of means.

3.3 Statistical Analysis
Data were entered in the Excel sheet and various calculations were done using excel application formulae. Data collected were analyzed in the following way:
Excel application package were used for calculation of the ITRs, average ITRs, ∑D, SD, SE and t.
Excel Data Analysis package were used for generating Statistical Summary of paired t-test for difference of means.[8][9]
SPSS package were used for verification of D(ITR) by conducting a paired t-test.

4. Results and Discussion
Results were analyzed according to three interlinked objectives. The first 10 days were spent on studying and collecting data of the day to day departmental working rules, protocols and policies. The current usages of modern inventory control and management techniques were studied. Based on the study results, the proposed implementation of ABC & FSN analysis was confirmed. The hospital’s inventory management policy was consisting of FIFO, LIFO, out/in reorder level method, alphabetical storage and VED analysis[1][2]. Hence the investigator was convinced to use ABC & FSN analysis techniques as the central theme of this proposed experimental study.
Pilot study was carried over a period of six working days on 20 items of the main inventory of General store. This was carried out with the objective of calculating the value of σ (pooled SD of the observations), the value of which was to be used to calculate the Sample Size (n) for the projected experimental study.

Calculation of pooled SD (σ):  
\[ SD_1 = \sqrt{\frac{\sum (x-x_\mu)^2}{n-1}} = \sqrt{28.7227/20-1} = \sqrt{1.51172} = 1.23 \]
\[ SD_2 = \sqrt{\frac{\sum (x-x_\mu)^2}{n-1}} = \sqrt{32.0025/20-1} = \sqrt{1.68434} = 1.29 \]
Therefore, Pooled SD (σ) = \( \frac{SD_1 + SD_2}{2} \) = 1.23 + 1.29 / 2 = 2.52 /2 = 1.26
So, for the four (4) month Pooled SD (σ) is 1.26,
Therefore, for each month, the value of σ is (1.26/4) = 0.32
This value is used and sample size is calculated thereafter, as-
Formula used for Sample Size Calculation:  
\[ n = \frac{2[(Z_\alpha + Z_\beta)^2 \times \sigma^2]}{d^2} \]
The value was found and was rounded to 660 for stratification ease.

It was evident that there was an increase in the ITR (Inventory Turnover Rate) after implementation of ABC analysis and control tools. The ITR average value before the Implementation was 1.34 and it was increased to 1.71 in the same study sample of 660 items after implementation of ABC analysis. So, there was an increase of 0.37 in the average value of ITRs. As there was a change found in re-measurement after the implemental intervention of the study parameter, it can be concluded that the implementation was successful in the study setting. So, hence, it will be proved that in the study setting ABC analysis tools and techniques were found successful to increase the turnover of the items in the stores. The increase in Turnover rates of inventoried items will definitely result in increase in subsequent increase in optimal usage of materials which in turn will result in reduction in expenses in terms of inventory build-up, redundancy, excess holding cost etc. and hence may be useful in reduction of MCPPD i.e. Material Cost Per Patient Day. Thus the Hospital will be able to offer cost effective service to the patients which is an important factor in increasing the business of the hospital and similarly useful in increasing hospital service revenues which is the ultimate goal of hospital management.

Comparative analysis of the experimental project work entails manual analysis of the collected data and performing statistical test (Paired t-test) using Excel application tool or SPSS (Statistical Package for Social Science) software package.
H0 = µ1 = µ2 or D = 0, i.e. there is no change in the ITR after ABC Implementation.
H$_1 = \mu_1 \neq \mu_2$ or $D \neq 0$, i.e. there is a change in the ITR after ABC Implementation.

For example, the following ITR data format (not complete) is considered (MAIN STUDY SHEET.xls):

The SPSS outputs: Compare Means -> Paired sample T test

Paired Samples Correlation

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
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<tr>
<td>0.545</td>
<td>0.511</td>
<td>0.02147</td>
<td>0.3253</td>
<td>0.001</td>
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<td>----</td>
<td>----------------</td>
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</tbody>
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Pair 1

Paired samples Statistics

<table>
<thead>
<tr>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
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</thead>
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<tr>
<td>1.3411</td>
<td>0.2125</td>
<td>0.00827</td>
</tr>
<tr>
<td>1.7086</td>
<td>0.5649</td>
<td>0.02201</td>
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</table>

The Interview phase was aimed at finding out any setbacks or obstacles that can be foreseen while adopting the new techniques in the existing setting. The main Phases of the Interview will be designed to access the opinions on the following issues [9]:

- Major Changes foreseen in terms of setbacks
- Training Needs
- Risk of change management process

The survey was carried out and the response rates were analyzed to identify the considerable forces towards the successful adaptation of the tested materials management tools & techniques.

Force-Field Scores

<table>
<thead>
<tr>
<th>Responds</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
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</thead>
<tbody>
<tr>
<td>YES</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NOT SURE</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Survey Results

<table>
<thead>
<tr>
<th>Employee no.s</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>YES</td>
<td>YES</td>
<td>NOT SURE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>E2</td>
<td>YES</td>
<td>YES</td>
<td>NOT SURE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>E3</td>
<td>YES</td>
<td>NOT SURE</td>
<td>YES</td>
<td>NOT SURE</td>
<td>YES</td>
</tr>
<tr>
<td>E4</td>
<td>NOT SURE</td>
<td>NOT SURE</td>
<td>YES</td>
<td>YES</td>
<td>NOT SURE</td>
</tr>
<tr>
<td>E5</td>
<td>YES</td>
<td>NOT SURE</td>
<td>YES</td>
<td>NOT SURE</td>
<td>YES</td>
</tr>
</tbody>
</table>

The found percentage were assembled and put forward to use for the interpretation of the forces in the field. The percentage scores are given in the following table:
4. Conclusion

The study was started with observational learnings of the departmental procedure and policies, the methods & protocols followed etc. The study was carried out to get the information about the acquiring process, ordering process, inventorying process, stock taking process, distribution & Issue process[3]. Thereafter the measurement of the ITR for the working sample was calculated. The average ITR of the sample was 1.34. Then the ABC & FSN (FSN classification was already existing in some extent) classification of the working sample was carried out and for 20 days, the standard control guidelines for A, B and C categories were followed. Thereafter the same sample measurements were retaken i.e. the ITRs were calculated after implementation and this time average was seen to be 1.71. There was an increase in ITRs before and after implementation of ABC & FSN analysis. The increment percentage was tested for its statistical significance through paired t-test and SPSS software package was used to generate the results. A survey was carried out in the department among the concerned employees and the report was put forwarded as a Force-Field Analysis[3][6] which identified a good percentage of positive forces towards the future implementation of new inventory management tools & techniques in this particular hospital.

References

<table>
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<tr>
<th>Question No.s</th>
<th>Interpretation</th>
<th>Percentage Scores</th>
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</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Successful Implementation</td>
<td>90</td>
</tr>
<tr>
<td>Q2</td>
<td>Readiness for Change</td>
<td>70</td>
</tr>
<tr>
<td>Q3</td>
<td>Training Needs</td>
<td>80</td>
</tr>
<tr>
<td>Q4</td>
<td>Confidence to adopt Changes</td>
<td>90</td>
</tr>
<tr>
<td>Q5</td>
<td>Concern for Performance Improvement</td>
<td>90</td>
</tr>
</tbody>
</table>


