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ASSESSING THE FORECASTING BY MSMS FOR MEDICAL STORES MANAGEMENT OF A TERTIARY CARE TEACHING HOSPITAL

Healthcare

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ABSTRACT

Medical Stores management is an important aspect in healthcare delivery to patients. Inventory in a medical store is one of the vital components of the current assets. Excess holdings of inventory may not only increase the cost but may also lead to wastage. Effective and efficient management of inventory is an integral part of supply chain. Improper use of pharmaceutical products or shortage of medicine not only cause financial loss but may also affect the patients adversely. Contrary to the traditional techniques of managing inventory, Artificial Intelligence (AI) is gaining credibility in making the process more effective and efficient. AI is the application of computer program that demonstrates action like a human being, learns from experience, gets new input and processes big data by reasoning. It can acquire large amount of data and create rules for turning the data into actionable information. This study aims to assess the effective implementation of the medical stores management system (MSMS) by correlating the forecasted Monthly Maintenance Figure (MMF) and the actual consumption pattern of the consumables used in the hospital in the 3 consecutive years using Root mean Square error (RMSE). RMSE was used as a measures for evaluating the quality of predictions. As RMSE is used to measure the deviation from the expected and actual values, the values closer to 0 are considered better. The RMSE was found to be 3.8 in 2020, 3.33 in 2021 and reduced to 1.33 in 2022 forecast with a correlation coefficient of 0.75(p-value= 0.001 x 10-20).

KEYWORDS

Medical Stores, Inventory Management, Forecasting, Drug Store Management, AI in Healthcare, AI in Decision making

INTRODUCTION

The provision of affordable, high quality and appropriate essential medicines is a vital component of a well-functioning health system. Nearly 10 million lives could be saved by improved access to essential medicines, of which 4 million are in Africa and South-East Asia alone (1). However, providing universal access to essential medicines is a major challenge in low and middle income countries (LMICs)(2). The growing urge of hospitals to adopt technologically automated systems to meet the demands for efficiently managing the large volumes of data generated and its availability to the medical practitioners, when required, are the driving forces behind the adoption of Artificial Intelligence in Hospital Information System (HIS). Informatics involves information acquisition, organization, validation, storage, retrieval, integration, analysis, communication and presentation, using Information Technology as a key resource (Lifshitz et al., 2007; Sinard, 2006). HIS is defined as the "computer system designed to ease the management of all the hospital's medical and administrative information and to improve the quality of healthcare" (Degoulet and Fieschi, 1997). The global healthcare information system market size was valued at USD 406.4 billion in 2022 and is expected to expand at a compound annual growth rate (CAGR) of 13.3% from 2023 to 2030 (3). A comprehensive AI-powered HIS collects, stores, and communicates patients and medical data within the hospital network by integrating the system with the data collected from mobile apps, IoT sensors, EHRs, etc. With AI technology, the HIS automates the clinical, administrative, Electronic Health Record, inventory and treatment processes.

Hospitals equipped with HIS and integrated with other departments generate vast amounts of patient and medical data from all the integrated departments. This data must be harnessed to get deep data intelligence on patient inflow and outflow, data access, data security, inventory and equipment, strategies to overcome the inefficiencies in the manual procedures, etc. Integrating a HIS to various departments (like finance, inventory, operations, administration, etc) and imbibing the AI technologies will enable the healthcare providers to deliver the true patient care and enable the entire network to manage efficiently in a cost-effective way. It can be beneficial for Healthcare Organisations (HCOs) to track their forecast accuracy over time to measure their average forecast error. Knowing the forecast error can help HCOs understand how to use a forecast effectively to predict future trends. It's important to track forecast accuracy because it can help to:

1. Improve the forecasting process: Tracking forecast accuracy can improve the overall forecasting process by helping businesses learn when they can make adjustments to a forecast to increase its accuracy. For example, hospital may learn that a forecast typically underestimates the demand for products during COVID-19 Pandemic, and forecasting teams can make adjustments to the forecast to ensure the hospital can meet the demand.

2. Benchmark forecasts: Consistently tracking accuracy can provide HCOs with benchmarks to measure their forecast accuracy with others in their industry. Benchmarking forecasts against similar organizations can help HCOs identify areas where they can improve their forecasts to remain competitive.

3. Identify changes early: Managing forecast accuracy can help HCO identify changes in trends early, which can help them manage their operations. For example, if a new/ alternate drug is being added in Standard Treatment Guidelines (STGs), HCOs can see how that change affects their demand and quickly adjust their production processes as needed. For eg demand of Remdesivir and medical oxygen increased drastically during second wave of COVID-19 for the treatment of moderate and critical patients.
To measure forecast accuracy following steps can be taken:

a. Gather forecasts: Begin by gathering the forecasts to measure over a set time period. For example, if you want to measure the accuracy of a HCO's medical store's demand forecasts over a six-month period, you can obtain the forecasts for each of those months. Some HCOs have a forecasting team that produces this data, while others rely on inventory managers to compile these statistics.

b. Measure actual trends, so that the forecasts (of a defined time period) is compared with the actual trends (of the respective time period). This can be achieved by looking into the past consumption patterns of the consumables in ledgers as well as in the medical stores management system (MSMS). Having both the actual and forecasted numbers is important to evaluate the accuracy and consistency of the Hospital's medical store's forecasts.

c. Choose a metric: While there are many methods to measure forecast accuracy, some of them that can provide valuable insight based on the HCO's data are eg. Mean absolute percentage error (MAPE), Mean absolute deviation (MAD), Root mean square error (RMSE), etc.(4)

d. Make calculations: Once the method to assess the error in forecast determined, the calculations are done using the forecast and actual values.

e. **Identify accuracy trends:** Tracking accuracy trends consistently

helps in monitoring forecasting progress and make improvements to achieve continued accuracy.

METHODS

Forecast accuracy metrics are measurements that show the reliability of a forecast, which is a prediction of future trends based on historical data. These types of metrics measure the forecast error, which is the difference between an actual value and its expected forecast. Many HCOs use forecast accuracy as a key performance indicator (KPI) and measure their average forecast accuracy to help make organizational decisions. For example, businesses can use forecast accuracy metrics to predict the demand for a new product or service, which can help them manage inventory levels and ensure customer satisfaction.(5)

In machine learning, it is extremely helpful to have a single number to judge a model's performance, whether it be during training, cross-validation, or monitoring after deployment. Root mean square error is one of the most widely used measures for this. It is a proper scoring rule that is intuitive to understand and compatible with some of the most common statistical assumptions.(6)

This study aims to assess the accuracy of the MMF forecasting (using MSMS) by medical store to procure the hospital consumables every year for a 1082 bedded tertiary care teaching hospital. The accuracy is assessed using RMSE as an indicator. A total of 2759 consumables were listed in the inventory module of the MSMS software and the MMF was forecasted every year. The forecasting of these 2759 consumables was assessed across the 3 consecutive years i.e. Forecast of 2020 was compared with actual consumption pattern of 2020, and the forecast for 2021 was compared with actual consumption in 2021, similarly for 2022.

RESULTS

The MSMS was implemented in the medical stores of the hospital under study, in Dec 2019 as part of HIS. The data of consumption pattern of consumables used by the hospital in 2019 was feed into to the software and the software forecasted the next year's (2020) MMF. This Forecasted MMF had a RMSE of 3.8 and a spearman correlation coefficient of 0.50 indicating mild correlation with a p-value of 0.008×10^{-5} which is highly significant. The RMSE was 3.33 in the forecast of FY 2021 with correlation coefficient of 0.72 indicating moderate to strong correlation (p-value= 0.001×10^{-18}). The RMSE was further reduced in the FY 2022 forecast to 1.33 with a correlation coefficient of 0.75(p-value= 0.001×10^{-20}).

The forecast of 2020 was 57.75% accurate with 10% margin of error. But 39.73% items were consumed more than the forecasted MMF (i.e. stock over-utilized), as shown in Table-1.

TABLE – 1
Year-wise details of no. of consumables as per forecast by MSMS

No. of Consumables (With 10% error)	Count of items in MMF 2020	%	Count of items in MMF 2021	%	Count of items in MMF 2022	%
Correct Prediction	1593	57.75	1342	48.65	1391	50.43
Predicted less than required (defi)	1096	39.73	1399	50.72	1334	48.36
Predicted in excess (Surplus)	69	2.5	17	0.61	33	1.19
Grand Total of Items	2758		2758		2758	

Whereas for the year 2021 the accuracy reduced to 48.65% (with 10% margin of error) and the quantity of 50.72% items was forecasted less leading to deficiency of those items. The accuracy then improved a little to 50.43% in the year 2022 as shown in Table 1.

The availability of drugs in medical stores is being reflected at various sites in the hospital where the similar system is being installed (eg. wards HIS, etc), it has improved the staff and patient satisfaction, as now they don't have to travel all the way to medical stores to know about the availability of the drugs. Inventory management also improved drastically due to automation, with disposal orders being initiated four months prior to the expiry of drugs (near expiry alerts by MSMS) and correct demands being generated two months prior to depletion of stocks. The monthly expense summary of drugs was now being done within ten days of the closing month.

DISCUSSION

Recent studies report that in LMICs the average availability of medicines in the public sector is only 35 % (7). According to a World Health Organization (WHO) report, almost 68 % of the people in India have limited or no access to essential medicines (2). Poor availability of medicines in the public sector has pushed up household out-of-pocket (OOP) expenditure, making them the largest household expenditure item after food (8).

The ever increasing inventory of medical stores due to introduction of newer medicines and their variants/combinations and acute shortage of pharmacists in our hospitals, have resulted in a situation where it is extremely difficult to maintain medical stores manually. This leads to a large number of medicines remain unused and they eventually expire. In addition, due to communication gaps between the pharmacy and clinicians, a large variety of medicines, both generic and branded, were prescribed with wide variations in consumption. This frequently leads to some essential medicines being unavailable for patients (stock-out) while some other medicines becoming slow moving and eventually expiring. This causes HCOs to face financial losses and also decreases patient satisfaction as well as clinician satisfaction. Automating the inventory management system (MSMS) effectively by training the HCWs (clinicians and ward attendants, etc) involved in indent preparation as well as medical stores personals involved in procurement and issue etc, improved the communication gaps within organization (HCWs and medical store) as well as outside the organization (Medical store personals and the vendor management). This was further aided by forecast by MSMS about the MMF, that was evaluated by RMSE.

Because RMSE and MAPE are used to measure the deviation from the expected and actual values, the values closer to 0 are considered better (9). Contrary to the study by Bon et al (2017) (10) with RMSE of 1501 and the study by Burhan at al (2018) (11) with RMSE of 8767 , the software in this study forecasted with an RMSE of 3.38.

Rather than improving (decreasing), the RMSE was 3.33 in the forecast for the year 2021, as can be due to the fluctuations in the demand and utilization of the consumables owing to the COVID-19 Pandemic as was shown in study by Padhan et al (2021) (12).A before and after cross-sectional study conducted by Abelenda-Alonso et al showed similar results (13).Another study by Gonzalez- Zorn showed that antibiotic consumption increased significantly by 115% when the consumption pattern peaks were compared (2019 and 2020 years) (14).The RMSE improved in 2021 forecast as the STGs were more streamlined. Although due to increased demand for consumables globally, the shortage of drugs and drug stock-out increased to 50.72% in 2021, while it reduced to 48.36 in 2022 forecast.

CONCLUSION

Improving communication systems within the hospital with vendor database management and reaching out to clinicians is important. Automation of inventory management requires to be simple and user-friendly, by utilizing existing hardware. Physical stores monitoring is indispensable, especially due to the scattered nature of stores. Staff training and standardized documentation protocols are the other keystones for optimal medical store management.

REFERENCES:

1. Zarocostas J. Better access to drugs could save 10 million lives a year, says UN expert. BMJ [Internet]. 2007 [cited 2023 Apr 2];335(7621):635. Available from: https://pubmed.ncbi.nlm.nih.gov/17901494/
2. Prinja S, Bahuguna P, Tripathy JP, Kumar R. Availability of medicines in public sector health facilities of two North Indian States. BMC Pharmacol Toxicol [Internet]. 2015 Dec 23 [cited 2023 Apr 2];16(1):1–11. Available from: https://bmcpharmacoltoxicol.biomedcentral.com/articles/10.1186/s40360-015-0043-8
3. Healthcare Information System Market Size Report, 2030 [Internet]. [cited 2023 Apr 1]. Available from: https://www.grandviewresearch.com/industry-analysis/healthcare-information-system-market
4. Chen ZA, Yang YP. Assessing forecast accuracy measures. TY - JOUR AU [Internet]. 2004 [cited 2023 Apr 2]; Available from: https://www.researchgate.net/publication/228774888_Assessing_forecast_accuracy_measures
5. Hyndman RJ. Measuring forecast accuracy. Environ Sci Econ. 2014;
6. Root-Mean-Squared Error - an overview | ScienceDirect Topics [Internet]. [cited 2023 Apr 1]. Available from: https://www.sciencedirect.com/topics/engineering/root-mean-squared-error
7. Cameron A, Ewen M, Ross-Degnan D, Ball D, Laing R. Medicine prices, availability,

and affordability in 36 developing and middle-income countries: a secondary analysis. Lancet. 2009 Jan 17;373(9659):240–9.
8. Oberoi S, pharmaceutical AO-I journal of, 2014 undefined. Pharmacoeconomics guidelines: The need of hour for India. ncbi.nlm.nih.gov [Internet]. [cited 2023 Apr 2]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4131381/
9. Wang J, Wang J, Fang W, Niu H. Financial Time Series Prediction Using Elman Recurrent Random Neural Networks. Comput Intell Neurosci [Internet]. 2016 [cited 2023 Apr 2];2016. Available from: https://pubmed.ncbi.nlm.nih.gov/27293423/
10. Bon AT, Ng TK. An Optimization of Inventory Demand Forecasting in University Healthcare Centre. IOP Conf Ser Mater Sci Eng [Internet]. 2017 Jan 1 [cited 2023 Apr 2];166(1):012035. Available from: https://iopscience.iop.or g/article/10.1088/1757-899X/166/1/012035
11. Hussein BP. INVENTORY FORECASTING AT BRUNEI STATE MEDICAL STORE USING DATA MINING [Internet]. TY - BOOK AU. 2018 [cited 2023 Apr 2]. Available from: https://www.researchgate.net/publication/326632772_INVENTORY_FORECASTING_AT_BRUNEI_STATE_MEDICAL_STORE_USING_DATA_MINING
12. Padhan S, T P, Chandrakar R, Galhotra A, Borkar NB. Assessment of the Impact of COVID-19 on Drug Store Management in a Tertiary Care Teaching Hospital of Central India. Cureus [Internet]. 2021 Nov 19 [cited 2023 Apr 2];13(11). Available from: /pmc/articles/PMC8684361/
13. Abelenda-Alonso G, Padullés A, Rombauts A, Gudiol C, Pujol M, Alvarez-Pouso C, et al. Antibiotic prescription during the COVID-19 pandemic: A biphasic pattern. Infect Control Hosp Epidemiol [Internet]. 2020 Nov 1 [cited 2023 Apr 2];41(11):1371–2. Available from: https://pubmed.ncbi.nlm.nih.gov/32729437/
14. Gonzalez-Zorn B. Antibiotic use in the COVID-19 crisis in Spain. Clin Microbiol Infect [Internet]. 2021 Apr 1 [cited 2023 May 5];27(4):646. Available from: /pmc/articles/PMC7688281/