RESEARCH ARTICLE

ADDRESS THE FACTORS RELATED TO INCREASES THE LEVEL OF EXPIRY IN PHARMACEUTICAL STOCK AT KING ABDULLAH MEDICAL CITY

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ABSTRACT

The pharmaceutical stock has been identified as second largest annual expenses in the budget of healthcare institutions. Pharmacy overstock is high expenses and it's very important to estimate annual level of inventories to overcome waste in resources. Current study aims to identify pharmaceutical items with high growth rate during the 8 years and percentage of wrong estimation. Cohort Retrospective study design uses medical inventories data from the ERP system "Enterprise resource planning Software". Total number of medical items are about 2077 some of them unplanned requested and other have substitutes so the total number addressed where 974 pharmaceutical products in the study were analyzed to generate the percentage of estimation. Result shows that Radiology and Gastroenterology departments have highest percentage of wrong estimating in their annual demand. It also shows that most of the department underestimated their annual quantity utilization. Many reasons increase the quantity of lending some medication such as transferring patients to another institution this will force KAMC to provide medication for transferred patient. Additionally, unstable utilization urges KAMC to redistribute the nearly expired Medication by lending them to other healthcare organization and get new quantity upon the request in different time. The drugs products with high percentage of borrowing are refer to bad quality of services due to discontinuity of healthcare services and even borrowing process not immediately cover the need it takes time, and this will affected the business continuity. The study found high discrepancy between proposed maximum values and actual maximum values during eight years. Research team decides to be generated new amount from the average values of previous years recorded and add to them the amount of growth value to decreases the variances in the future quantity.

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INTRODUCTION

The health care sector is considered one of the largest industries that consumes about ten percent of the national income, and because the services provided are related to quality of patients life this percentage is increased (Akbar *et al.*, 2022). The pharmaceutical stock has been identified as second largest annual expenses in the budget of healthcare institutions after healthcare workers' salaries (Sari, 2017). Pharmacy overstock is high expenses and it's very important to estimate annual level of inventories to avoid waste and use the resources efficiently. With regards to mutual warehouse "multi hospital network" activated in Saudi Arabia between the healthcare organizations in different cities, it purposes to cover patients' needs through mobilize the medical items upon the need of patients and reduce level of expired items, but the problem of expiration is still running. Pharmaceutical wastage refers to medical items with a specific timeline or date for use, after this period the product will be labeled waste if proper atmosphere exist(Lyon *et al.*, 2006), (Tull, 2018), (Sarla, 2020).

Regardless that the date of expiry is approximately the issue of medical inventory management has become a global issues (Mohammed, Kahissay and Hailu, 2021)and the common proposed solution is to rationally estimate the amount of money consumed due to expiration to cope with financial resources expenses. This attractive method is used to increase the importance of the cost of pharmaceutical products issues that raise-up, as well as encourage healthcare organizations to meet their future demand with minimum waste, avoid the shortage in pharmaceutical items, and maintain the financial stability. Since the periodic review of supply stocks is important that's due to changes in the pattern of pharmaceutical stock utilization, the supply chain team must assess the pattern of use to save money on expired items. The study aims to address the level of expired items and analysis the reason related to them to reduce and manage the number of expiries over time.

Objectives

Primary Objective: Current study aims to identify the issues related to pharmaceutical overstock and recommend new methods to estimate

quantity overtime. Rare studies concentrate on the estimating the level of inventories after addressing the huge records of previous utilization.

Secondary Objectives: List the items with high growth ratefor8 years and percentage of wrong estimation. Propose new techniques to enhance the ability of supply chain staff estimating their stock over time.

LITERATURE REVIEW

Literature state that there is tremendous increase in unused pharmaceutical products all over the world. Tablet set as most common type in pharmaceutical wastage versus the other type such as vial, bottle and so on, (Mohammed, Kahissay and Hailu, 2021)and in current study it was highlighted to investigate the rate of wrong estimation on the inventories. Moreover, multi reasons contributes to poor inventories management process as unsuitable storage standard, ineffective monitoring system, and unreasonable utilization. The medical supplies issue is result of shortage of important medical services and exposed of financial resources as well as increase the expenses level. Furthermore, previous Study document that there is no guidelines for overstock medical inventories, also the donation was not recommended especially between individual to avoid the risk of poor storage or bad quality of medical product that's led to poor health status(Tull, 2018) additionally, organization could lend medical items nearly expired or gives few quantity to maintain the healthcare services stability in their institutions. From the other hand, Staff accountability will play an important role in evaluation the accurate level of inventories and they might wrongly estimate the utilization quantity based on their limited experience and skills to forecast the level of medical stock, also changes in the pattern of utilization negatively affect the annual quantity estimation. Open new services or close it has also positive and negative effect, thus led healthcare organization to predict inaccurate level of inventories due to changes in the demand. There is also indication that the update in evidence based practice has change the pattern of utilization annually plus the environmental events like COVID-19 pandemic or natural disaster.

METHODOLOGY

Study design: Cohort Retrospective study uses data of medical inventories on the ERP system "Enterprise resource planning Software", for 8 years and excel sheet uses to retrieve data from data based.

Study Sample

All pharmaceutical items will be included: All items whether in OPD, Inpatients and Oncology Pharmacy at KAMC

Inclusion /Exclusion Criteria: Study will address the pharmaceutical items during last 8 years. Study variables will be (item Code, item Descriptions, Borrowing Quantities, lending Quantities, Minimum Quantities, Maximum Quantities, Quantity Out or dispensing). Inclusion criteria:

- Pharmaceutical items, between 2014 and July 2021.
- Item type (Ampoule, Tablet, Vial,and other)
- Lending & Borrowing items during study period

Exclusion criteria

- Pharmaceutical items used with no Min-Max Quantity assumption, that's mean not routine required or unplanned because it's not in the scope of services for KAMC.
- Non-pharmaceutical items.
- Some of the items with wrong estimation percentages that exceeded 100 were caused by a policy applied among healthcare facilities, refer to the availability of some pharmaceutical materials in facilities versus others, so they are lent or borrow the whole number of medical items and high

rates appears because the facilities rely on each other to provide sufficient stocks for their patients through other organizations without purchasing items.

Study procedures

- Item codes will use to summaries the group of items in one row because sometimes items have been requested from many Cost Centers \ (Departments).
- Include Maximum Quantity and compare them with Quantity dispensing.

Retrospective chart review collects the data based on the following variables:

- Items code.
- Items descriptions.
- Date of Dispensing.
- Type of items (pharmaceutical, non-pharmaceutical) \ (Ampoule, Tablet, Vial and so on..).
- Consumption/Quantity Out.
- Lending, Borrowing Quantity.
- Min/Max Quantity.

Minimum a Month Maximum 3 Month for data collection
Decode items based on generic name.

Study Duration/ Study Timeline: The Study will start collecting data after getting IRB approval, approximately one to six months to clean and analyze the data then interpreted the result.

Outcome Assessment: Study outcome must clarify the reasons behind high level of consumption and expire during study period and give a clear instruction to avoid them in the future.

List the top twenty items with high lending& borrowing percentage for last8 years. And display the percentage of wrong estimation among the different departments using the pharmaceutical products.

Data collection and management: Data collection sheet will be created to service the study purpose, the source of data is ERP system data owner is medical inventories department. Data collection forms not showing any nominative information Datasheet will be kept in a safe locked place two to three member will extract and clean the data then one of them will transfer data to SPSS data based to analyze them.

Sample size determination: Eight years data will retrieve from system. Multi department will be include, as they have pharmaceutical items stock during study period. Total number of medical items are about 2077 some of them unplanned requested and other have substitutes. 974 pharmaceutical items in the study were analyzed to generate the percentage of estimation for each one.

Statistical Analysis Plan: Current study will use SPSS version 21 to address the study hypothesis by applying different statistical analysis methods. First, the study will evaluate the percentage of error in predicting the inventory level among different departments to increase awareness and decrease expenses based on the department with the highest incorrect estimating value. Odds ratio will be applied to assess the difference in-between the proposed and current maximum quantity to identify the most affected items for 8 years and determine the status of under and overutilization among all medical items in the study. Examine the relation between consumption quantity and lending quantity "to assess the overestimate" and help supply staff to enhance their ability of predicting the annual inventories level of their utilization. Assess the differences between consumption quantity versus borrowing "to evaluate under estimation in utilization" in order to improve level of evaluating the accurate level of annual quantity for future.

Statistical Result: In this section study will display the data in different ways that reveal the research result using odds ratio to assess the wrong determination during eight years records. Current study shows that the Radiology and Gastroenterology departments have highest percentage of error estimating their annual demand this emerge in table number one. Unlike Urology and Pediatrics, the percentage % of wrong demand determination was less versus other departments. Wrong demand determination led to over or under stock, and both will highly affect the quality of services negatively as well as healthcare financial resources.

Table 1. Demonstrate the department order according to the highest wrong estimation rate

Item Group per Cost Center	%Wrong Estimation
Radiology	26.94%
Gastroenterology	26.10%
Narcotics & Controlled Medications	24.70%
Biological product	23.27%
Anesthesia	22.93%
Neurology	19.91%
Oncology	19.81%
Chemicals	19.80%
Vaccines	19.58%
Obstetrics & Gynecology	18.42%
Antimicrobial	17.12%
Emergency medications	17.11%
Other Group	16.99%
Pulmonology	16.94%
Dermatology	15.77%
Endocrinology	15.30%
Antidote	14.59%
Ophthalmology	14.55%
Electrolytes & Fluids	14.39%
Non-Formulary	13.82%
General	13.81%
Cardiology	13.73%
Pediatrics	12.80%
Urology	10.49%

Table-2 display the amount of residual in top twenty items for 8 years with high growth rate and wrong percentage of estimation generated from suggested maximum quantity subtracted from actual maximum quantity among eight years utilized by stakeholders. If the different between them is negative value that's mean the department underestimated their annual utilization. Less amount directed the supply chain staff to borrow items from other health institutions or the healthcare workers will not be able to continue deliver the healthcare services. On the other hand, if result of residual is positive that mean the stakeholders overestimate their stock and organization resources will wasted due to overstock. Even in the case of items borrowing the demand does not cover because some of items have high utilization rate in other organization so, no one will lend these items, or they will send a few amounts or limited quantity such as if organization ask for 100 BEVACIZUMAB VIAL (AVASTIN) they will provide 20 out of 100 in order to avoid refusing the request. In terms of collaboration and multi hospital networks activation other healthcare institutions must accept the request even if they provide less quantity than the required quantity to keep the continue of services in their organization and peer organization. The negative wrong estimation with high growth rate displays the level of severity in medical resource availability and the deficiency due to poor forecasting. Table-3 shows the items with high level of lending quantity during eight years to highlight the stock with overestimation such as surplus in medical items since the lending techniques help the organization to avoid items disposable, but the supply planning team should take this into consideration because this will affect forecasting process in the future. Without lending wrong estimating rate will become worst. In the current situation lending process between the hospitals rely on many reasons, which is a shortage of medication in other healthcare institutions for example when study analyze those items as MESALAZINE 4 G ENEMA found that was highly demand from gastroenterology clinics among the other healthcare organizations in multi hospitals network, medical staff need this medication as its

importance for continuity of services in many hospitals if they provided this type of service under gastroenterology. Although, Study found that the ALTEPLASE, TPA 50 MG TREATMENT SET is very important medication for Acute Ischemic Stroke, Myocardial Infarction, and Pulmonary Embolism (PE), those classify as high-risk cases, so the demand was high and supply shortage will be severe, as governmental cooperation try to avoid service discontinue. In addition, this drug was affecting the patient safety, current result encourages to utilize and lend remaining quantity to other hospital in state of face the risk of shortage. As the KAMC is the main oncology centre at Makkah FLUOROURACIL, 5-FU 1000 MG VIAL: is essential medication for the treat the oncology patient and deficiency not acceptable as it links to high critical services. Antidote medication as ACTIVATED CHARCOAL 100 G POWDER: is a lifesaving pharmaceutical product for many cases of toxicity. Moreover, VERAPAMIL HCL 5 MG (2.5 MG/ML) AMPOULE: shortage of diltiazem and this medication very important in emergency department as calcium channel blocker used for hypertension and angina. Many purposes led to lending this medication in the table three such as transferring patients to other healthcare institution with indication and general specialties not available at KAMC, that force KAMC to provide medication for transferred patient. Additionally, unstable utilization urges KAMC to redistribute the nearly expired Medication by lending them to other healthcare organization to utilize and consumed from other hospitals and get new quantity upon the request in different time. Table-4 show that the drugs products with high percentage of borrowing are refer to bad quality of services due to discontinuity of health services and even borrowing process not immediately it takes time until found institutions accept the request and also the long distance between institutions affect the duration of items availability especially if the organization in another city. An example the five items in the below table for different type of VACCINEs, the utilization of vaccine increases during the seasons period of time especially in (winter & Hajj), furthermore vaccine campaigns lead by the Preventive Medicine Clinic team, all are secured from the Ministry of Health and borrowed as it's the main center for distribution vaccine and provided to polyclinic and main hospitals above 70% of borrowing rate was due to seasonal demand so the planning of this items will be different based on timing and quantity with regards that the patients number is fixed according to previously annual recodes. Another example for DEXAMETHASONE 0.5 MG TABLET the reason behind high borrowing rate is shortage of other concentration such as 2mg &4mg, replaced by 0.5 mg and will dispensed to patient more pills to cover high dosages, this stimulates to increase in consumption and need of borrowing from other hospital to cover the annual consumption. More example as CETIRIZINE HCL 10 MG TABLET shortage was result of other antihistamine for example: Loratadine, and switch the consumption by CETIRIZINE, this directed to duplicate in consumption of CETIRIZINE, the appeal to borrow from other institutions to cover unexpected consumption in annual need. Different reasons call for borrowing and make the process of assumption very complicated and advance.

DISCUSSION

Current study highlighted the pharmaceutical inventories management and issues related to them. Some of issues led to financial resources wastage and other affect the services continuity. With regards to all the proposed implemented solutions the problem still running due to interrelated factors such as the utilization pattern changes and scarcity of substitution as well as mentioned in the result. Also, staff behavior will increase the level of wrong estimation severity and absence standard too. But the accountability with improving the storage process plus good monitoring system will enhance the medical resources management. Additionally, the responsible department awareness level surely will decrease the percentage of error in estimating the future demand. Current study avoided to calculate the medication dedicated for certain patient as (non-formulary) medication, and there is no need to use them for many reasons; as if the patients transfer to other hospitals, or if they left home

Table 2. Demonstrate the pharmaceutical items with high growth rate during eight years

Item Code	Item Description	Total	Growth Rate	Suggested Min value	Suggested Max value	Min Value of 8 Years	Max Value of 8 Years	%Wrong Estimation	Residual QTY
400100	ATORVASTATIN 20 MG TABLET	6503560	93.13%	200000	400000	10200	1974500	-79.74%	-1574500
400973	OMEPRAZOLE 20 MG CAPSULE	3093314	85.91%	100000	200000	10080	1438528	-86.10%	-1238528
400634	HYDRALAZINE 25 MG TABLET	2750980	85.52%	200000	400000	4800	673500	-40.61%	-273500
401030	PERTUZUMAB 420 MG / 14 ML VIAL (PERJETA)	3444	81.74%	360	720	4	1071	-32.77%	-351
400135	BEVACIZUMAB 100 MG/4 ML IN 4ML VIAL (AVASTIN)	3063	81.62%	50	100	8	947	-89.44%	-847
401267	TACROLIMUS 0.5 MG CAPSULE	150400	78.32%	20000	40000	400	40900	-2.20%	-900
401165	ROSUVASTATIN 20 MG TABLET	851408	72.48%	18300	36600	5000	391600	-90.65%	-355000
401164	ROSUVASTATIN 10 MG TABLET	1333309	69.97%	83000	166000	5000	400410	-58.54%	-234410
401219	SODIUM CHLORIDE 9 MG/ML (0.9%) IN 1000 ML BAG	27758	68.57%	1500	3000	80	5338	-43.80%	-2338
400290	CLINDAMYCIN TOPICAL SOLUTION 10 MG/ML SOLUTION	5231	65.28%	300	600	20	1114	-46.14%	-514
400627	HUMAN IMMUNOGLOBULIN (5%) 2.5 G \ 50 ML VIAL	10215	65.03%	1000	2000	50	2751	-27.30%	-751
401401	VORICONAZOLE 200 MG TABLET	50370	63.63%	5000	10000	150	10890	-8.17%	-890
400716	ISOSORBIDE DINITRATE, ISDN 5 MG TABLET Sub Lingual	973760	63.10%	70000	140000	4300	225200	-37.83%	-85200
400764	LEVETIRACETAM 500 MG TABLET	1366640	60.12%	80000	160000	6900	298090	-46.32%	-138090
400746	LAMOTRIGINE 25 MG TABLET	87052	59.82%	5500	11000	300	17884	-38.49%	-6884
400128	BETAHISTINE DIHYDROCHLORIDE 16 MG TABLET	266150	59.33%	15000	30000	1200	59680	-49.73%	-29680
400217	CARVEDILOL 25 MG TABLET	598510	59.26%	40000	80000	2880	119200	-32.89%	-39200
400264	CHOLECALCIFEROL; VITAMIN D{3} 50,000 IU CAPSULES	514276	56.72%	35000	70000	3000	109200	-35.90%	-39200

Table 3. Demonstrate the top 20 lending items for eight years.

Item Code	Item Description	Min Quantity	Max Quantity	Dispensed QTY (2014-2021)	%Lending out of Consumption >> Overestimation
400842	MESALAZINE 4 G ENEMA	500	1000	5509	99.84%
400037	ALTEPLASE, TPA 50 MG TREATMENT SET	40	80	659	95.90%
401428	RADIOLOGY BARIUM SULFATE 100 ML SUSP (ORAL)	20	40	100	95.00%
401050	PHYTOMENADIONE, VITAMIN K{1} 10 MG/ML AMPOULE	200	400	3590	92.06%
400552	FLUOROURACIL, 5-FU 1000 MG VIAL	40	80	8618	89.92%
401099	PROCHLORPERAZINE 5 MG TABLET	700	1400	1700	88.24%
400137	BICALUTAMIDE 50 MG TABLET	1200	2400	11936	87.97%
400712	ISOPRENALINE 0.2 MG / ML AMPOULE	50	100	2390	85.98%
401387	VERAPAMIL HCL 5 MG (2.5 MG/ML) AMPOULE	150	300	3594	83.72%
401111	PROPYLTHIOURACIL 50 MG TABLET	170	340	8290	80.94%
401077	POTASSIUM PHOSPHATE 4.4 MMOL potassium /ML 3 Mmol phosphate	500	1000	5803	80.30%
400007	ACTIVATED CHARCOAL 100 G POWDER	3	7	84	79.76%
401124	VACCINE, RABIES Immune Globulin EQUINE 200 - 400 I.U	9	18	98	78.57%
400178	CALCIPOTRIOL CREAM 0.05 mg/g TUBE 30 G	40	80	130	76.92%
401439	RADIOLOGY, ORAL IONIC IODINE CONTRAST MEDIUM Gastrografin 370 mg iodio/ml VIAL (100 ML)	400	800	1999	75.04%
400721	ITRACONAZOLE 100 MG CAPSULE	800	1600	22460	74.89%
401071	POTASSIUM ACETATE 40 MEQ (2 MEQ / ML) VIAL	500	1000	4070	73.59%
400069	AMOXICILLIN; CLAVULANIC ACID 1.2 G VIAL	300	700	6500	72.46%

Item Code	Item Description	Min Quantity	Max Quantity	Dispensed QTY (2014-2021)	%Borrowing out of Consmption>> Underestimation
401567	PARAFFIN WHITE SOFT emollient 45 G TUBE	4000	8000	35142	95.90%
401482	VACCINE, TETANUS IMMUNE GLOBULIN, HUMAN 250 IU/1M PRE	12	24	112	91.07%
401459	VACCINE, HAEMOPHILUS INFLUENZA CONJUGATE VACCINE	30	60	147	88.44%
400678	VACCINE, INFLUENZA VIRUS VACCINE 0.5ML P.SYRINGE	2500	5000	22631	81.19%
400815	VACCINE, MEASLES VIRUS VACCINE	35	70	915	76.50%
400925	MUPIROCIN 2MG/G (2%) IN 15G OINTMENT	100	200	1450	75.31%
400623	VACCINE, HEPATITIS B VACCINE, RECOMBINANT 20 MCG/ ML (ADULT VACCINE) VIAL	180	360	2541	70.84%
400376	DEXAMETHASONE 0.5 MG TABLET	1400	2800	50990	67.05%
400334	CYCLOSPORINE (ciclosporine) MODIFIED 25 MG CAPSULE	700	1400	28800	65.98%
401922	VACCINE, TETANUS TOXOID-TETAVAX 40 UNIT AMPOULE	14	28	380	65.79%
400584	GENTAMICIN 3 MG/ML (0.3%) EYE/EAR DROPS (8 ML) BOTTLE	30	60	989	64.71%
400317	CROTAMITON 10% CREAM IN 20 G TUBE	50	100	618	64.40%
400972	OMALIZUMAB 150 MG VIAL (XOLAIR)	80	160	760	64.08%
401079	POVIDONE-IODINE 10% SOLUTION	1200	2400	23889	63.80%
401084	PRAZIQUANTEL 600 MG TABLET	50	100	1380	62.32%
400656	HYOSCINE-N-BUTYLBROMIDE 20 MG/ML AMPOULE	1000	2000	14080	61.72%
401106	PROPARACAINE (0.5%) EYE DROPS 15 ML BOTTLE	120	240	1926	61.37%
400242	CETIRIZINE HCL 10 MG TABLET	11700	23400	154912	60.73%
400831	VACCINE, MENINGOCOCCAL POLYSACCHARIDE DIPHTHERIA TOXOID CONJUGATED VACCINE SINGLE DOSE 0.5 ML VIAL	100	200	3858	60.39%
401547	GONADOTROPHINUM CHORIONICUM 1500 international unit AMP	30	60	82	58.54%

and changing their place of residence, moreover in case of death as the patient pass away no one will use the drugs. From the other perspective, substitution scarcity led to high utilization due to global shortage of some medication that' usually increase in consumption of other medication. Updating the formulary list of drugs led to change the status of planned medication and stock items as well to unplanned or non-stock items. Major changes in the annual quantity sometimes affected due to new standard implemented and guidelines applied in treatments plan, for instance, oncology Medication and Antibiotic Medication plan that's called evidence-based practices. One of the reasons that led to wrong medical quantity is the pharmaceutical items that were requested by specific physicians and if they were not around nobody will use them due to certain protocol they followed. Sometimes, wrong medication received especially from multi hospital network at the time of borrowing request raised to get some drugs. Moreover, New service activated or new clinics opening in other hospital defiantly will change the annual utilization level. Other type of medication for instance: vaccines, the utilization level increases based on the seasons demand especially in (winter & Hajj), furthermore if any campaigns activated by the Preventive Medicine department. All mentioned points will cooperate to fluctuate the level of utilization annually and make the inventory management process very difficult so supply chain management team has to take them into consideration to ensure the quality of the annual estimation process.

Recommendation and lesson learned

Research team discuss the result and suggest new method to forecast the demand amount in the future. After reading the result current study found high discrepancy between proposed maximum values and actual values during eight years. Research team decides to be generated new amount from the average values of previous years records and add amount of growth value to it. New methods will help supply chain team to manage the resources and decrease the risk of underestimation for stock. Additionally, team will limit the wastage during the process of supplies forecasting of planning.

Limitation: New methods will work for items with positive growth rate and result might be not accurate for items with negative growth values. Also stock totally granted by King Abdullah Medical City and distributed to other healthcare institutional can't predicted because the pattern of utilization not recorded at KAMC and no control on the changes happen to the stocks.

As well as stock totally granted by other healthcare organizations and KAMC collected from them periodically.

Ethical part& confidentiality: No consent will request because data dose not related to patients. Data collection start after getting the final approval from KAMC IRB committee. The ethical approval granted on 16 of October 2022 and No. (22-1001)

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REFERENCES

Akbar, M. A. *et al.* (2022) 'Towards roadmap to implement blockchain in healthcare systems based on a maturity model', *Journal of Software: Evolution and Process*, (August). doi: 10.1002/smr.2500.

Lyon, R. C. *et al.* (2006) 'Stability profiles of drug products extended beyond labeled expiration dates', *Journal of Pharmaceutical Sciences*, 95(7), pp. 1549–1560. doi: 10.1002/jps.20636.

Mohammed, S. A., Kahissay, M. H. and Hailu, A. D. (2021) 'Pharmaceuticals wastage and pharmaceuticals waste management in public health facilities of Dessie town, North East Ethiopia', *PLoS ONE*, 16(10 October), pp. 1–15. doi: 10.1371/journal.pone.0259160.

Sari, A. N. (2017) 'ANALYSIS OF INVENTORY MANAGEMENT FOR PHARMACEUTICAL PRODUCTS PHARMACEUTICAL PRODUCTS AND CONSUMABLE FINAL PROJECT By Alivia Nurlita Sari Undergraduate Program School of Business and Management Institut Teknologi Bandung', (August). doi: 10.13140/RG.2.2.12089.06244.

Sarla, G. S. (2020) 'Efficacy and disposal of drugs after the expiry date', *The Egyptian Jouranl of Internal Medicine*, 31(4), pp. 431–434. doi: 10.4103/ejim.ejim.

Tull, K. (2018) 'Drug expiry standards in developing countries Question • What is the global evidence/experience on expiry of drugs?' Available at: http://www.accessdata.fda.

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