

Cost analysis of returned medicines at the outpatient pharmacy of a Malaysian state hospital

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ABSTRACT

Introduction: Returning unused medications to pharmacies is encouraged to reduce environmental pollution and safety hazards. However, this practice can impose financial losses on public health providers due to wasted drug supplies. This study aimed to quantify the costs of returned medicines at a Malaysian state hospital outpatient pharmacy and to characterise the returned items by therapeutic class and procurement category.

Materials and Methods: This was a prevalence-based, bottom-up cost-analysis study of all solid medicines at the outpatient pharmacy of Hospital Tuanku Fauziah from May to October 2023. Returned items (tablets/capsules) were collected, identified by WHO Anatomical Therapeutic Chemical (ATC) class and hospital's Always Better Control (ABC) inventory group, and recorded. Acquisition costs were obtained from hospital procurement records, and retail values were estimated using the Malaysian Consumer Price Guide. Disposal cost was calculated based on the contracted waste service. Descriptive statistics were used to summarise quantities and costs.

Results: The total government acquisition cost for returned medicines was RM18,487, with a retail replacement value of RM101,300. The top five returned medicines by quantity were metformin (14.3%), atorvastatin (6.9%), calcium carbonate (5.3%), ferrous fumarate (3.8%) and trimetazidine MR (3.8%). The top three pharmacological groups returned were cardiovascular system (39.6%), alimentary/endocrine (31.7%), and blood and blood-forming organs (10.9%). Group A medicines, according to ABC analysis, constituted the highest return in both acquisition cost (66.8%) and quantity (34.1%). The median (IQR) acquisition and retail values of medicines returned per month were RM5,429 (8,010) and RM19,609 (12,027), respectively. The monthly disposal cost ranged RM22.32-55.80 (excluding transportation fees).

Conclusion: Returned medicines lead to significant financial losses from both medication wastage and disposal for public providers. Shorter refill durations, medication adherence support, deprescribing and controls on high-value ABC group A items could reduce wastage.

KEYWORDS:

Returned medicines, cost analysis, outpatients, pharmaceuticals

INTRODUCTION

Medicines return programmes aim to prevent environmental contamination and improper disposal of unused medicines, aligning with national sustainability strategies. In Malaysia, the Ministry of Health Malaysia launched the "Return Your Medicines" (RYM) programme in 2010, subsequently improvised to relaunch as MyMediSAFE in 2024, to route unused medicines back to health facilities for safe disposal; returned items are not reused to safeguard quality and safety.¹⁻² Previous studies have attributed returns to factors such as non-adherence, therapy changes, oversupply, adverse effects and expiry.³⁻⁵

Given Malaysia's highly subsidised public healthcare, wastage can accumulate materially.⁶ Co-payment models have been proposed as one lever to reduce unwarranted demand.⁷ Hospital Tuanku Fauziah (HTF), a state hospital in Perlis, Malaysia, was granted RM22 million in 2023 to procure medicines, as reported by the logistic pharmacy. In a logistic pharmacy unit of a public hospital, "Always Better Control" (ABC) analysis is normally used to monitor inventory and categorise the medicines based on their cost allocation. Group A medicines have the highest annual usage, accounting for 10–20% of medicines ordered and allocated 70% of the total budget. Group B medicines represent moderate annual usage, accounting for 10–20% of medicines ordered and allocating 20% of the total budget. Meanwhile, group C medicines account for the lowest annual usage, comprising 60–80% of medicines ordered and allocating 10% of the total budget. Within hospital inventory control, ABC analysis prioritises high-value drugs; if many returns are group A, monetary losses are amplified.

Despite environmental benefits, returns entail economic loss from acquisition spending on unused stock and incremental disposal costs borne by public providers. Prior Malaysian reports^{2,5} described wastage primarily using acquisition prices, with limited triangulation against retail pricing or inventory priority frameworks such as ABC analysis, and with variation across settings regarding drug groups most often returned. The present study addresses these gaps by providing, for the first time in the Malaysian setting, a simultaneous quantification of acquisition and retail costs of returned medicines, coupled with World Health Organisation (WHO) Anatomical Therapeutic Chemical (ATC) and ABC inventory stratification to identify high-value waste items.

This article was accepted: 10 July 2026

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This dual-perspective analysis allows direct comparison of the financial impact on the public provider and the broader societal replacement cost.

MATERIALS AND METHODS

A prevalence-based, bottom-up cost analysis was performed at the outpatient pharmacy of HTF. The bottom-up costing approach was employed as the individual returned items were counted and valued using unit acquisition cost (AC) and estimated retail price (RP). The analysis covered medicines returned by patients/caregivers at the pharmacy counter from May to October 2023. Returned solid oral dosage forms (tablets/capsules) dispensed by the outpatient pharmacy were included, while items without labels or originating from other facilities; non-tablet/capsule dosage forms were excluded. Non-solid dosage forms and unlabelled items were excluded because only tablets/capsules could be reliably identified and quantified against procurement records, and items without labels could not be verified for origin or safety, in line with standard return programme protocols.

Returned medicines were collected in a designated bin, identified and recorded. Items were classified by WHO ATC pharmacological grouping and by the ABC inventory group according to local procurement categorisation. AC was obtained as unit prices from hospital pharmacy procurement records, reflecting the direct public provider loss. RP was as mapped from the Malaysian Consumer Price Guide⁷, reflecting private sector replacement value to communicate the broader market-equivalent value of wasted medicines. A simple sensitivity analysis was also applied to the RP estimate by varying unit prices by $\pm 10\%$ to gauge the robustness of the total RP. AC was not subjected to sensitivity analysis because it was obtained from hospital procurement records. Disposal cost was the per-kilogram rate quoted by the hospital support services contractor; recorded monthly ranges were calculated from observed weights of returns.

Descriptive statistics summarised volumes, AC and RP totals and medians, distributions by ATC classification and ABC grouping, and top medicines by quantity and value. No imputation or inferential tests were conducted. The study was purely descriptive because the objective was to quantify and characterise the return load without hypothesis testing. Ethical approval was obtained from the Medical Research & Ethics Committee, MOHM (NMRR ID-22-01404-D4Q) before the study was conducted.

RESULTS

A total of 124,435 tablets/capsules were returned to the outpatient pharmacy. The calculated AC was about RM 18,486.61, which translated into a RP of RM 101,300.00. Sensitivity analysis varying the RP guide values by $\pm 10\%$ produced a total RP of RM91,170-111,430. The median (IQR) AC and RP of medicines returned per month of RM5,428.85 (8,010.35) and RM19,607.71 (12,026.78), respectively.

The top five medicines returned by quantity were metformin (14.3%), atorvastatin (6.9%), calcium carbonate (5.3%), ferrous fumarate (3.8%) and trimetazidine MR (modified release) (3.8%). However, trimetazidine MR was the most returned in terms of the AC, which is around RM1,351.00, followed by metformin (RM1,344.53) and atorvastatin (RM1,070.12). By pharmacological patterns (ATC), cardiovascular medicines constituted the largest share of returned items by quantity ($\approx 40\%$), followed by alimentary tract and metabolism/endocrine ($\approx 32\%$), then blood and blood-forming organs ($\approx 11\%$). Other groups (nervous system, musculoskeletal, respiratory, others) contributed smaller proportions (Figure 1).

According to ABC analysis, RM2,275,083.96 was spent in 2023 for medicines expenditure. The AC of medicines returned from May to October 2023 were 0.8% of the total expenditure in 2023.

The top ten medicines accounted for RM7,951.94, approximately 43.0% of total AC (Table I). The highest cost based on AC was trimetazidine 35mg MR. Pantoprazole 40mg was the most expensive in terms of RP. However, neither medicines were not the most returned in terms of quantity, but was metformin 500mg. While metformin accounted for the largest share of returned units, trimetazidine MR, as a higher-cost cardiac drug, generated the greatest acquisition cost, highlighting the importance of examining both volume and value.

The majority of medicines returned by quantity (Figure 1) and five out of the top ten (Table I) by AC were cardiovascular agents. Pantoprazole was found to be the highest RP replacement among medicines returned.

ABC analysis revealed that group A medicines constituted the in the highest total returned AC (66.8%) and a proportionally high item-return (34.1%) (Table II). Group A comprised

Table I: Top ten medicines returned by acquisition cost

Tablet	Quantity (Tab/Cap)	AC (RM)/Tab	Total AC (RM)	RP (RM)/Tab	Total RP (RM)
Trimetazidine 35mg MR (I)	4,475	0.30	1,351.00	1.62	7,249.50
Metformin 500mg (G)	17,041	0.08	1,344.53	0.16	2,726.56
Atorvastatin 20mg (G)	8,238	0.13	1,070.12	0.93	7,661.34
Ferrous Fumarate 200mg (G)	4,493	0.21	943.53	0.56	2,516.08
Clozapine 100mg (I)	754	0.91	687.20	3.75	2,827.50
Metoprolol Tartrate 100mg (G)	3,294	0.18	582.05	0.39	1,284.66
Pantoprazole 40mg (G)	3,003	0.19	557.66	3.4	10,210.20
Fenofibrate 145mg (I)	839	0.58	485.86	4.41	3,699.99
Calcitriol 0.25mcg (G)	1,837	0.26	477.44	1.58	2,902.46
Prazosin 2mg (G)	2,564	0.18	452.55	0.54	1,384.56
AC: Acquisition cost, RP: Retail price					

Table II: ABC grouping based on total medicines returned

Group	Number of item	Percentage of item returned (%)	Total AC (RM)	Percentage of AC (%)
A	43	34.1	12,349.06	66.8
B	34	26.6	4,418.30	23.9
C	49	38.3	1,719.25	9.3
Total	126	100	18,486.61	100

AC: Acquisition cost

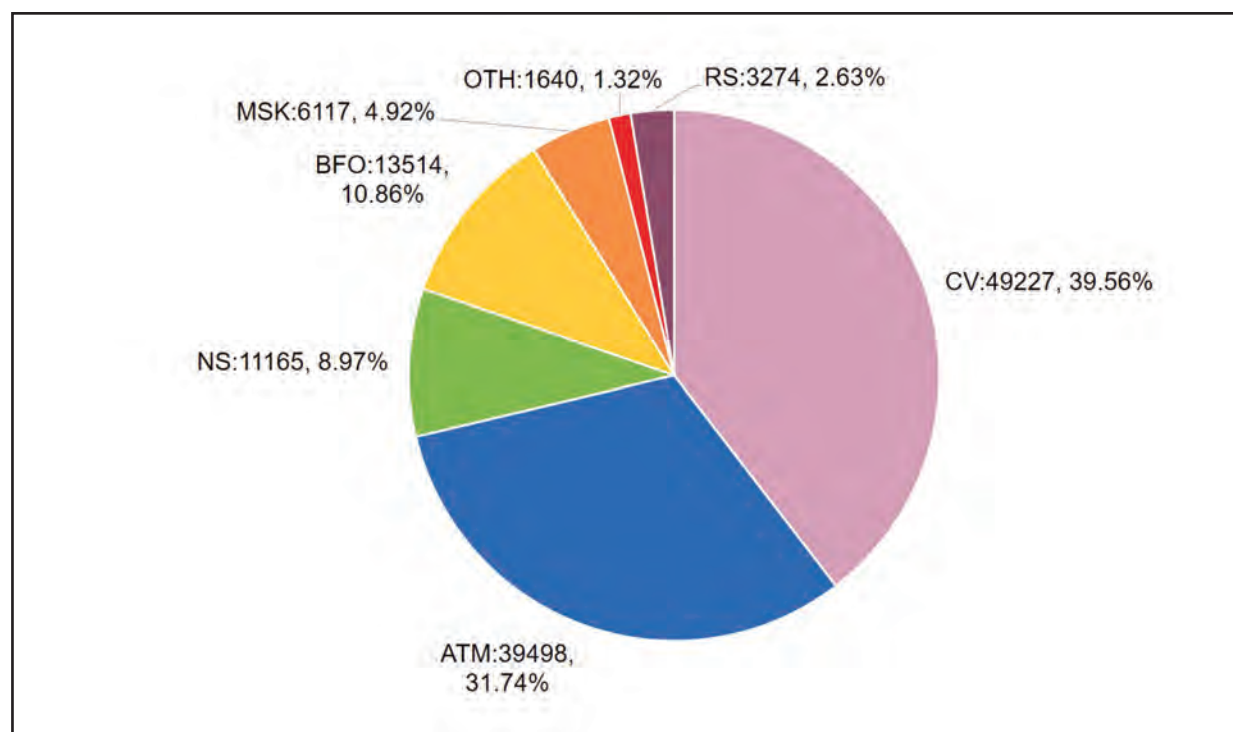


Fig. 1: Distribution of medicines returned by WHO ATC classification, expressed as percentage of total quantity (tablets/capsules)
Abbreviations: CV, cardiovascular system; ATM, alimentary tract and metabolism; BFO, blood and blood-forming organs; NS, nervous system; MSK, musculoskeletal system; RS, respiratory system; OTH, others.

expensive medicines that were highly prescribed by physicians. However, the types of medicine returned from group A were significantly higher and resembled group C. To illustrate the potential savings from targeted interventions, a 50% reduction in the wastage of group A items over the same six-month period would yield an estimated acquisition-cost saving of approximately RM6,175, or RM12,350 annualised. Even modest prevention among high-cost, high-volume group A drugs could therefore materially reduce financial losses.

At RM2.79/kg and ~2–5kg/week, the estimated disposal cost was RM22–56/month (excluding transport and packaging fees).

DISCUSSION

This study quantified the financial burden of outpatient medication returns in a Malaysian state hospital and profiled the returned items by therapeutic class and ABC inventory category. Three empirical patterns emerged: (1) cardiovascular and endocrine agents dominated returns by

quantity (~72% combined), reflecting the high prevalence of chronic diseases in our catchment population; (2) high-value (ABC group A) items, though representing only 34.1% of returned quantity, accounted for two-thirds (66.8%) of acquisition cost, indicating concentrated monetary loss among high-value inventory; and (3) the median RP (RM19,609/month) exceeded AC (RM5,429/month) by nearly four-fold, highlighting the broader societal opportunity cost beyond immediate budget impact. These patterns align with international reports wherein chronic-disease medicines comprise the largest share of unused or returned drugs, including studies from Oman and Italy.^{8,9} Local experience at a Malaysian teaching hospital similarly documented substantial return volumes and costs.⁵

Expressing wastage in both AC and the estimated RP served different stakeholders. AC reflects the immediate budgetary loss to the public provider. RP, while not paid by our patients, approximates a market replacement value that is more intuitive to the public and can therefore help communicate the opportunity cost of returns. In Malaysia's highly subsidised context, even small percentages of wastage can

translate into meaningful absolute losses at system scale, reinforcing the need for stewardship.⁶ Proposals such as minimal co-payments have been discussed nationally as one lever to reduce unwarranted demand; any exploration of such measures would require careful equity safeguards.⁷

The concentration of wastage among group A inventory items is operationally important. ABC analysis is designed to focus managerial control on the few, high-value items that consume most of the budget; finding that these same items constitute two-thirds of returned costs suggests an efficiency gap that targeted interventions could close. Practical levers supported by evidence on medication waste include shorter initial refill intervals (e.g., 2-4 weeks) for high-cost chronic therapies to test tolerance and adherence before issuing longer supplies; pharmacist-led medication reviews at refills; and structured deprescribing when risk-benefit turns unfavourable.¹²⁻¹³ Education to avoid stockpiling and to improve disposal behaviours complements these changes.¹⁻²

Specific therapeutic patterns in our data merit attention. Pantoprazole 40 mg generated the highest aggregate RP despite modest quantities returned, reflecting its high unit price and frequent gastroprotective prescribing in multimorbid patients. In our setting, proton-pump inhibitors (PPIs) were among the most commonly prescribed potentially inappropriate medications in older outpatients, indicating a priority area for medication review and deprescribing to reduce both clinical risk and waste.¹¹ Conversely, metformin 500 mg was the single most returned item by count, consistent with the large prevalent population with type 2 diabetes and the chronic, long-term nature of therapy. While our design did not capture patient-level reasons, previously described drivers: confusion, adverse effects, and regimen changes, likely apply.³⁻⁵ Addressing these requires clearer counselling, regimen simplification where appropriate, and early follow-up after initiation to adjust therapy before large supplies accrue.¹²⁻¹³

Disposal costs in our study were modest relative to the value of the medicines themselves, yet they represent a recurring operational outlay and an environmental responsibility. Safe return and disposal programmes remain essential to protect public and environmental health, and continued public education on correct return practices is warranted.¹⁻² Ultimately, preventing avoidable returns upstream will deliver the greatest gains by reducing both wastage and disposal costs.¹²⁻¹³

For the most-returned group A cardiovascular and endocrine drugs, short initial supplies and pharmacist-led adherence checks could directly reduce the oversupply. At the facility level, a pragmatic bundle could include: (i) default shorter initial supplies for ABC group A drugs and for patients newly started on long-term therapy; (ii) pharmacist-delivered adherence checks and medication reviews at each repeat; (iii) targeted deprescribing audits for medicines frequently returned (e.g. PPIs in older adults); and (iv) dashboards that track returns and costs by ABC group and ATC class to guide feedback to prescribers.¹²⁻¹³

Recent international evidence further supports interpreting medicine returns as a health-system stewardship issue rather than only a disposal activity. The Organisation for Economic Co-operation and Development (OECD) has highlighted unused or expired medicines as a source of environmental risk, public health risk and wasted healthcare resources and recommends combined strategies involving waste prevention, separate collection or take-back systems, public awareness and clear financing or governance arrangements.¹⁴ Similarly, a 2024 systematic review of unused medicine take-back programmes across 15 countries found that better-performing programmes were characterised by accessible collection points, regular collection schedules, clear programme ownership and legislation defining financial responsibilities.¹⁵ The same review reported that returned medicines commonly involved the nervous system, cardiovascular system, alimentary tract and metabolism groups,¹⁵ which is broadly consistent with the therapeutic pattern observed in the present study. At the system level, sustained public messaging on the MyMediSAFE programme and patient engagement around not stockpiling medicines may curb returns, particularly for high-cost ABC group A chronic-disease medicines. Any consideration of cost-sharing as a demand-management tool should be evaluated prospectively for impact on access and equity.⁷

The study's strengths include bottom-up costing of all returned solid oral medications over six months, linkage to ABC groups, and expression of waste in both AC and RP to address different audiences. This study is not without its limitations. The single-centre design limits generalisability, although HTF is a typical state hospital serving a predominantly rural population, suggesting relevance to similar settings. The six-month period precludes assessment of seasonal variation in return patterns. Exclusion of non-tablet/capsule dosage forms and unlabelled items almost certainly leads to an underestimation of total medication wastage; future studies should capture all dosage forms.

We also did not apply VEN categorisation alongside ABC, which could further inform prioritisation. These constraints likely bias our estimates towards under-counting total wastage and limit causal inference. We were unable to relate returned quantities to per-product dispensing volumes because full utilisation data were unavailable at the drug-specific level; consequently, return rates could not be expressed as a proportion of dispensed medicines, limiting the assessment of relative wastage for individual agents.

While our design did not capture patient-level reasons, the same factors commonly reported in the literature,³⁻⁵ including confusion, adverse effects and regimen changes, are likely contributors to the high volumes of metformin and cardiovascular returns observed. Additionally, only medicines returned through formal pharmacy channels were captured, so informal disposal or stockpiling at home was missed, potentially biasing the cost estimates downward.

Multi-centre, year-round surveillance capturing patient-reported reasons for returns would better characterise drivers and seasonal effects. Embedding and evaluating targeted

interventions (shorter initial refills, pharmacist review, deprescribing prompts) using quality-improvement or stepped-wedge designs could quantify reductions in returns, particularly among ABC group A items. Adding ABC-VEN mapping could help align stewardship with clinical criticality.

CONCLUSION

Medication returns in this public hospital setting represent a substantial and quantifiable financial loss, driven primarily by the wastage of high-value, high-priority medicines prescribed for chronic diseases. The significant margin between the government's acquisition cost and the societal retail value highlights the full economic impact of this preventable loss. Developing patient education tools, particularly for high-return therapeutic classes (cardiovascular, endocrine) and ABC group A items, could communicate the societal value of medications, foster patient stewardship and support the sustainability of healthcare resources.

ACKNOWLEDGEMENTS

The authors would like to thank the Director-General of Health, Malaysia for his permission to publish this research. We also appreciate Dr. Haji Amin Sah Haji Ahmad (Hospital Director), Dr Suhaila Ab Wahab (Infectious Disease specialist), her team in the HIV clinic and all respondents who participated in this study.

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