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# A General Evaluation of the Reasons for Medication Wastage: A University Hospital Example

# İlaç İsraf Nedenlerine Yönelik Genel Bir Değerlendirme: Bir Üniversite Hastanesi Örneği

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## Abstract

**Aim:** In this study, it was aimed to evaluate the medication wastage and associated factors in a university hospital and to reveal the economic dimension of medication wastage.

**Method:** The population of this descriptive study consisted of 834 medications that were wasted in a university hospital in Istanbul. Sample selection was not made in the study and the entire population was taken into consideration. The data were collected using Medication Wastage Forms and Medication Wastage Reports recorded by the Pharmacy Department. Descriptive statistics (frequency, percentage) were used in the analysis of the data. The World Health Organization Anatomical Therapeutic Chemical (ATC) Classification System was used to classify wasted medications.

**Results:** The study results showed that medication wastage has been mostly caused by preparation-related reasons, treatment changes, and adverse drug reactions. It was determined that the wastage rate was higher in pediatric hematology, chemotherapy, and adult hematology units. It was determined that the total cost of medication wastage was 98,950.12 ₺ and 66.98% of this cost was preventable. According to the Anatomical, Therapeutic and Chemical (ATC) Classification System, 33.81% of the wasted medication was classified as antineoplastic and immunomodulating agents.

**Conclusion:** In this study, it was determined that the amount and cost of medication wastage in the hospital were at a serious level. It was determined that wastage predominantly occurred in units with high-risk patient groups and that a large part of it was preventable. Hospital management needs to focus on preventable causes of waste in terms of the effective use of resources.

**Keywords:** Medication wastage, preventable medication wastage, university hospital, medication wastage cost.

## Öz

**Amaç:** Bu çalışmada, bir üniversite hastanesinde ilaç israfını ve ilişkili etmenleri değerlendirmek ve israfın ekonomik boyutunu ortaya koymak amaçlanmıştır.

**Yöntem:** Tanımlayıcı nitelikte tasarlanan bu araştırmanın evrenini, İstanbul ilinde faaliyet gösteren bir üniversite hastanesinde israf olan 834 adet ilaç oluşturmuştur. Araştırmada örneklem seçimine gidilmemiş ve evrenin tamamı değerlendirmeye alınmıştır. Veriler, hastanenin Eczane Müdürlüğü tarafından kayıt altına alınan "İlaç İsraf Formları ve İlaç Zayi Tutanakları" değerlendirilerek elde edilmiştir. Verilerin analizinde tanımlayıcı istatistiklerden (frekans, yüzde) yararlanılmıştır. İsraf olan ilaçların sınıflandırılmasında Dünya Sağlık Örgütünün Anatomical Therapeutic Chemical (ATC) Sınıflandırma Sistemi kullanılmıştır.

**Bulgular:** Çalışma sonucunda ilaç israfının en fazla hazırlama kaynaklı nedenler, tedavi değişikliği ve istenmeyen (advers) ilaç etkisi nedeniyle gerçekleştiği belirlenmiştir. Çocuk hematoloji, kemoterapi ve erişkin hematoloji ünitelerinde israf oranının daha yüksek olduğu belirlenmiştir. İsraf edilen ilaçların toplam maliyetinin 98.950,12 ₺ olduğu ve bu maliyetin %66,98'inin önlenebilir özellik taşıdığı saptanmıştır. Çalışmada, Anatomik, Terapötik ve Kimyasal (ATC-Anatomical Therapeutic Chemical) Sınıflandırma Sistemi'ne göre israf olan ilaçların %33,81'inin antineoplastik ve immunomodülatör ajanlar olduğu görülmüştür.

**Sonuç:** Bu çalışmada, hastanede ilaç israf miktarının ve maliyetinin ciddi bir boyutta olduğu saptanmıştır. İsrafın ağırlıklı olarak yüksek riskli hasta gruplarının bulunduğu ünitelerde yaşandığı ve büyük bir kısmının önlenebilir olduğu belirlenmiştir. Hastane yönetiminin kaynakların etkin kullanımı açısından, önlenebilir israf nedenlerine odaklanması gerekmektedir.

**Anahtar Sözcükler:** İlaç israfı, önlenebilir ilaç israfı, üniversite hastanesi, ilaç israf maliyeti.

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## Introduction

Pharmaceutical expenditures, which account for approximately one-sixth of the total health expenditures in developed countries (Organization for Economic Co-operation and Development [OECD], 2021), are one of the most important expense items of the Social Security Institution in Turkey (Çalışma ve Sosyal Güvenlik Bakanlığı [ÇSGB], 2021). It has been reported that pharmaceutical expenditures have increased significantly over the last decade, mainly due to expenditures on prescription drugs, increased use, and the introduction of new and costly drugs (Conti et al., 2021; DeMartino et al., 2021). For this reason, countries should control pharmaceutical expenditures and take the necessary precautions. One way to control pharmaceutical expenditures and ease the financial burden on healthcare systems is to reduce medication wastage (Bach et al., 2016; Braund et al., 2008; Braund et al., 2009a; Braund et al., 2009b; Trueman et al., 2010). The World Health Organization (WHO) has defined medication wastage as medicines, vaccines, and serums including expired, unused, spilled, and contaminated pharmaceutical products that are no longer needed and must be disposed of properly (WHO, 1999). It has been stated that wastage occurs at all stages in the supply chain, from the production of the drug to its delivery to the patient, and it is usually the result of management-related errors (Peltoniemi & Suomi, 2019; Saedi et al., 2016). Hospitals are one of the areas with the highest amount of wastage (Graban, 2011). It has been determined that various causative factors are associated with wastage including physician's order, distribution of drugs from pharmacies to units, failure to respond to treatment, treatment changes, allergies, expiration of the drug, and adverse drug reactions (Braund et al., 2009a; Braund et al., 2009b; Dobson & Tilson, 2016). It has been stated that medication wastage occurs in various units of hospitals, especially in emergency services, operating rooms, intensive care, oncology and hematology units, and intensive and specialized units where pediatric patients are admitted (Ang et al., 2020; Bach et al., 2016; Bucak et al., 2020; Fasola et al., 2014; Peker, 2020; Şerefoglu, 2021).

Although some of the medication wastage in hospitals is associated with unavoidable causes such as patient death, change in clinical status, adverse drug reactions, and refusal of treatment, research shows that most of the wastage is preventable (Ang et al., 2020; Kagashe et al., 2014; Karamikhah et al., 2018; Trueman et al., 2010). Reducing medication wastage is one of the most important goals in promoting the appropriate use of limited resources (Braund et al., 2008).

Studies show that the level of knowledge about the extent of medication wastage and associated factors is generally low in developing countries (Kagashe et al., 2014). Although there are studies conducted on this subject at the departmental level in Turkey, there is no study covering the hospital in general. For this reason, it is important to determine the amount of medication wastage in university hospitals, to analyze the preventable causes of medication wastage, and to have information about the economic dimension of wastage. The results of the study have a unique value in terms of raising the awareness of managers and health professionals about medication wastage and opportunities for future improvement.

## Method

**Aim and Design of Research:** This study was carried out in a university hospital to reveal the amount of medication wastage, the causes of wastage, and wasted medication groups and to have information about the preventable economic dimension of medication waste. The study was designed as a descriptive and cross-sectional study.

**Research Questions:** The research sought answers to the following questions:

- What are the causes of medication wastage in university hospitals?
- Which departments are responsible for most of the wastage?
- Which groups of medication are the most wasted?
- What is the cost of preventable medication wastage?

**Location of the Research:** The research was conducted in a university hospital located on the Anatolian side of Istanbul, with the permission of the management.

**Population and Sample of the Research:** The population of the study consisted of all medications that were wasted and recorded in the Medication Wastage Forms and Medication Wastage Reports in the logs between January 1, 2018, and December 31, 2021, in the university hospital (N:834). A sample selection was not selected in the study and the entire population was taken into consideration.

**Data Collection Tools:** The data were collected using the Medication Wastage Forms and Medication Wastage Reports which are recorded by the Pharmacy Department. The Medication Wastage Form includes the date, inpatient floor, name of the wasted medication, quantity, reason for wastage, expiration date, and information of the person who filled out and approved the form. Medication Wastage Reports contain medication name, code, lot number, quantity, unit, expiration date, reason for wastage, unit price, total amount, pharmacy responsible manager, and management approval information.

**Data Collection:** The data were collected using the Medication Wastage Forms and Medication Wastage Reports which are recorded by the Pharmacy Department.

**Data Analysis:** PivotTable reports were used to analyze the data recorded in the Microsoft Excel 2016 database. Descriptive statistics (frequency, percentage) were used in the evaluation of the data. Literature information, pharmacy reports, and expert opinions were used to classify the causes of medication wastage and to categorize medication wastage as preventable or non-preventable. There is a limited number of studies on this subject. Therefore, in this study, the preventable reasons for medication wastage were classified into seven types: preparation error (wrong preparation, breakage, or contamination due to dropping), physician order error, storage error, patient dropping the drug on the floor, device/equipment related wastage, incorrect application of the medication. The non-preventable reasons for medication wastage were classified into three types: treatment change (deterioration of patient's clinical condition, change or discontinuation of medication after preparation due to patient's clinical condition), adverse drug reaction, and patient refusing treatment. The World Health Organization Anatomical Therapeutic Chemical (ATC) Classification System was used to classify wasted medications. The ATC Classification System is developed and supported by the WHO. In this system, drugs are grouped according to the systems or organs in which they are effective and their pharmacological, chemical, and therapeutic properties (WHO, 2021).

**Ethical Aspect of the Research:** Approval for the research was obtained from the Social and Human Sciences Research Ethics Committee of a foundation university (Date: 21.10.2021, No: 2021/16 and Decision No: 01). In addition, permission was obtained from the institution where the research was conducted.

**Limitations of the Research:** This study had some limitations. First, the research is limited to the secondary data of a university hospital in Istanbul, covering the years between 2018 and 2021. Therefore, the results cannot be generalized to all hospitals. Second, literature information, pharmacy reports, and expert opinions were used to classify the causes of medication wastage and to categorize medication wastage as preventable or non-preventable.

## Findings

In line with the analyzes carried out, the causes of medication wastage, the cost, and the preventability of medication wastage are given in Table 1.

**Table 1. Causes and cost of medication wastage (N:834)**

| The cause of medication wastage | Preventable/Non-preventable | n | % | Cost (₺) |
|---|---|---|---|---|
| Preparation | Preventable | 474 | 56.83 | 44,955.54 |
| Treatment change | Not preventable | 155 | 18.59 | 27,546.09 |
| Adverse drug reaction | Not preventable | 109 | 13.07 | 4,235.81 |
| Physician order error | Preventable | 41 | 4.92 | 17,514.16 |
| Storage error | Preventable | 16 | 1.92 | 2,388.54 |
| Patient dropping the medication on the floor | Preventable | 16 | 1.92 | 663.23 |
| Device/equipment | Preventable | 13 | 1.56 | 658.90 |
| Patient refusing treatment | Not preventable | 8 | 0.96 | 895.74 |
| Incorrect application of the medication | Preventable | 2 | 0.24 | 92.12 |
| **Total** | | **834** | **100.00** | **98,950.12** |

As seen in Table 1, the causes of medication wastage were due to preparation for 56.83% of the wasted medication, treatment changes for 18.59%, and adverse drug reactions for 13.07%. It was determined that the total cost of medication wastage was 98,950.12₺, and the cost of preventable medication wastage was 66,272.48₺.

Table 2 presents the findings regarding the distribution and cost of medication wastage rates by hospital departments.

**Table 2. Medication wastage causes and cost by department (N:834)**

| Department-related medication wastage cause | n | % | Cost (₺) |
|---|---|---|---|
| **Pediatric hematology** | **236** | **28.30** | **15,914.36** |
| Preparation | 154 | | 6,613.74 |
| Adverse drug reaction | 43 | | 1,887.39 |
| Treatment change | 21 | | 3,600.34 |
| Patient dropping the medication on the floor | 7 | | 390.46 |
| Storage error | 4 | | 114.08 |
| Physician order error | 4 | | 2910.78 |
| Patient refusing treatment | 3 | | 397.58 |
| **Chemotherapy unit** | **177** | **21.22** | **42,536.45** |
| Treatment change | 88 | | 20,297.04 |
| Preparation | 33 | | 8,292.62 |
| Physician order error | 29 | | 12,947.87 |
| Adverse drug reaction | 17 | | 634.18 |
| Device/equipment | 9 | | 358.45 |
| Storage error | 1 | | 6.29 |
| **Adult hematology** | **126** | **15.11** | **10,918.97** |
| Preparation | 63 | | 6,211.55 |
| Treatment change | 30 | | 2,486.01 |
| Adverse drug reaction | 21 | | 1,302.07 |
| Patient refusing treatment | 4 | | 280.49 |
| Physician order error | 4 | | 623.56 |
| Storage error | 2 | | 6.91 |
| Patient dropping the medication on the floor | 2 | | 8.38 |
| **Pediatric bone marrow transplantation** | **88** | **10.55** | **4,662.84** |
| Preparation | 53 | | 3,146.98 |
| Adverse drug reaction | 20 | | 251.19 |
| Treatment change | 8 | | 923.29 |
| Storage error | 3 | | 46.50 |
| Patient dropping the medication on the floor | 3 | | 42.82 |
| Physician order error | 1 | | 252.07 |
| **Other** | **207** | **24.82** | **24,917.50** |
| Preparation | 171 | | 20,690.66 |
| Treatment change | 8 | | 239.41 |
| Adverse drug reaction | 8 | | 160.98 |
| Storage error | 6 | | 2214.76 |
| Patient dropping the medication on the floor | 4 | | 221.57 |
| Device/equipment | 4 | | 300.45 |
| Physician order error | 3 | | 779.88 |
| Incorrect application of the medication | 2 | | 92.12 |
| Patient refusing treatment | 1 | | 217.67 |
| **Total** | **834** | **100.00** | **98,950.12** |

In Table 2, it was determined that 28.30% of the wastage occurred in the pediatric hematology unit, 21.22% in the chemotherapy unit, 15.11% in the adult hematology unit, and 10.55% in the pediatric bone marrow transplantation unit. It was determined that the departments with the highest cost of medication wastage were chemotherapy (42,536.45₺), pediatric hematology (15,914.36₺), and adult hematology (10,918.97₺) inpatient floors.

The amount and cost of medication wastage according to the Anatomical, Therapeutic and Chemical (ATC) Classification System are given in Table 3.

**Table 3. Amount and cost of medication wastage according to Anatomical, Therapeutic and Chemical Classification System (ATC) (N:834)**

| Anatomical, Therapeutic, and Chemical Classification System* (ATC) | n | % | Cost (₺) |
|---|---|---|---|
| Antineoplastic and immunomodulating agents | 282 | 33.81 | 54,169.95 |
| Nervous system | 148 | 17.75 | 846.71 |
| Anti-infectives for systemic use | 147 | 17.63 | 27,544.90 |
| Blood and blood-forming organs | 90 | 10.79 | 7,527.66 |
| Alimentary tract and metabolism | 53 | 6.35 | 3,183.25 |
| Cardiovascular system | 50 | 6.00 | 348.28 |
| Genitourinary system and sex hormones | 39 | 4.68 | 256.84 |
| Other | 25 | 3.00 | 5,072.53 |
| **Total** | **834** | **100.00** | **98,950.12** |

* WHO, 2021

As seen in Table 3, 33.81% of the wasted medication was classified as antineoplastic and immunomodulating agents, 17.75% were classified in the nervous system group, and 17.63% were classified as anti-infectives for systemic use. Within the scope of the ATC Classification System, it was determined that the wasted medication groups with the highest cost were antineoplastic and immunomodulating agents (54,169.95₺), anti-infectives for systemic use (27,544.90₺), blood and blood-forming organs (7,527.66₺).

## Discussion

It has been stated that controlling healthcare costs is a political and economic priority on a national scale, and a cost advantage can be achieved by reducing waste (Atcheson et al., 2016). In this study, the most preventable medication waste was found to be due to preparation (56.83%) and order-related reasons (4.92%) (Table 1). The medication wastage rate due to preparation-related reasons was found to be 19.20% by AlSamanhodi et al. (2017), 17% by Ueki et al. (2022), and 2% by Ang et al. (2020). In the studies that evaluated medication error reports, Cousins et al. (2012) found the preparation-related error rate to be 16.54%, and Saravi et al. (2015) 15.9%, Ernawati et al., (2014) 14%. Studies show that the rate of medication error due to physician order errors ranges from 13.2% to 42.4% (Cousins et al., 2012; Silva et al., 2011; Ghaleb et al., 2011; Ernawati et al., 2014). The high wastage due to preparation suggests that despite the patient density and workload intensity in university hospitals, manpower capacity, and technology use are not at the desired point. In order to reduce the amount of preventable medication wastage and costs, it may be useful to train employees, conduct labor analysis, use technology-supported medication and preparation systems, use standard protocols for special medications, and improve communication among health professionals.

In this study, it was found that 18.59% of the medications were wasted due to treatment changes. Studies show that the rate of medication wastage due to treatment change ranges from 6% to 60% (Al-Dhawailie, 2011; AlSamanhodi et al., 2017; Kagashe et al., 2014). In a study conducted in Japan, it was determined that the most common cause of medication waste was medication change or medication discontinuation after preparation (35%). Treatment change is a condition that usually occurs as a result of changes in the clinical status of patients. The treatment protocols of the patients can be changed according to the clinical status of patients in high-risk departments such as oncology, hematology, and bone marrow transplantation in university hospitals. This situation is often accepted as a cause of waste that cannot be prevented (Ang et al., 2020; Kagashe et al., 2014).

In this study, it was found that 13.07% of the medications were wasted due to adverse drug reactions. Ang et al. (2020) found the wastage rate due to adverse drug reactions to be 24.53%, while Ueki et al. (2022) found it to be 1.3%. In a study evaluating the wastage experienced in inpatient processes in Turkey, it was determined that the rate of wastage due to adverse drug reactions was 2.62% (Şimşir et al., 2013). It has been stated that drugs were mostly discontinued in patients who had adverse drug reactions (Aykan et al., 2019). It has also been stated that the burden of adverse drug reactions on hospitals is high and there are effective intervention strategies are needed to reduce this burden (Davies et al., 2009).

In this study, the total cost of medication wastage was found to be 98,950.12₺ and 66.98% (66,272.48₺) of this cost was preventable (Table 1). It was determined that the departments with the highest wastage cost were chemotherapy (42,536.44₺), pediatric hematology (15,914.37₺), and adult hematology (10,918.97₺) (Table 2). Oncology is one of the treatment areas with the highest drug expenditures globally. In the USA, where the drug expenditures in cancer treatment are increased by 12% to 15% annually (EvaluatePharma, 2020; The IQVIA Institute, 2018), hospital drug expenditures have increased significantly over the past decade, especially due to the emergence of new high-cost treatments in oncology and immunology clinics (OECD, 2021). Ang et al. (2020) found that the annual cost of medication wastage in a chemotherapy unit was €3,632, while Dobson & Tilson (2016) found that the cost of medication wastage in a university hospital was more than half a million USD annually. In a study conducted at a hospital providing tertiary health care in Saudi Arabia, it was reported that the medication wastage cost per month was $13,877.80 (AlSamanhodi et al., 2017). In a study conducted at a university hospital in Japan, it was determined that the cost of medication waste for two years was 227,820.27 Japanese Yen (Ueki et al., 2022). Ang et al. (2020) stated that 20.8% (€756) of the medication wastage cost (€3,632) was preventable, while Kagashe et al. (2014) stated that at least two-thirds of medication wastage in hospitals was preventable.

The findings obtained from the study showed that 28.30% of the medications were wasted in pediatric hematology and 10.55% in the pediatric bone marrow transplantation unit, and the cost of wastage for these two departments was 20,577.19 ₺ (Table 2). It was seen that medication wastage was higher in pediatric departments than in adult departments. In a study conducted in Iran, it was determined that the medication wastage rate in the pediatric service was 18%, and the monthly cost of wastage was between $368 and $568 (Karamikhah et al., 2018). In a study conducted in the pharmacy of a tertiary care pediatric hospital, the annual cost of medication wastage was found to be $686,752 (Toerper et al., 2014). Ueki et al. (2022) found that the departments with the highest amount of medication waste were inpatient service (65.9%), intensive care unit (12.1%), and hospital pharmacy (8.1%). In the same study, it was seen that the departments with the highest medication waste cost were pharmacy and inpatient services. In a study conducted over four months in the pediatric emergency department of a university hospital in Turkey, the cost of medication wastage was $288.09 (Bucak et al., 2020). In order to reduce the amount and the cost of medication wastage and use resources effectively and efficiently, it is important to study preventable causes of medication wastage in the departments where the most wastage occurs.

When the distribution of medication wastage was examined according to the ATC Classification System, it was found that 33.81% were antineoplastic and immunomodulating agents, 17.75% were nervous system medications and 17.63% were anti-infectives for systemic use. It was determined that the ATC group with the highest cost was antineoplastic and immunomodulating agents (54,169.95₺) and anti-infectives for systemic use (27,544.90₺) (Table 3). Wasted medication groups show significant differences between developed and developing countries. Studies conducted in North America, Italy, and Japan indicate that the cost of wasting oncology drugs is high (Fasola et al., 2014; Leung et al., 2017; Usami et al., 2016). In a study conducted in a tertiary health care hospital in Tanzania, the anti-infective medication wastage rate was found to be 18.9% (Kagashe et al., 2014), similar to this study.

It is possible to reduce the financial burden of medication wastage, primarily by raising awareness of this issue and developing preventive strategies, without compromising the quality of patient care (Peker, 2020). As a result of the efforts to reduce medication wastage, it was determined that significant savings were achieved in the amount and cost of medication wastage (Fasola et al., 2014; Karamikhah et al., 2018; Tilson et al., 2014; Toerper et al., 2014). In a study conducted by L'Hommedieu & Kappeler (2010) to reduce medication wastage due to preparation and distribution processes in a children's hospital, it was stated that the wastage rate decreased from 16.6% to 8.6% and a weekly savings of $8197 was achieved. In a study by Şerefoglu (2021), in which the pharmacoeconomic results of the preparation of drugs under the management of a pharmacist in pediatrics in Turkey were evaluated, an average of 21,535.31₺ savings were achieved per month, while Kanmaz (2019) found it to be 255,979.20₺ in a study conducted in chemotherapy units for 18 months. The limited number of studies on preventable medication waste indicates that more studies are needed. Based on the findings of this study and the results of previous research, it is possible to reduce the amount and cost of wastage through improvement studies on the causes and cost of medication wastage in university hospitals.

## Conclusion and Recommendations

As a result of the research, it was determined that the amount and cost of medication wastage in the university hospital were at a serious level. It was determined that the waste occurred mainly in units with high-risk patient groups such as pediatric hematology, chemotherapy, adult hematology, and pediatric bone marrow transplantation and it was mostly due to preparation-related reasons. It was determined that most of the waste is preventable. It is important for hospital management to focus on preventable causes of waste. The results of this study are important for hospital administrators and healthcare professionals involved in the medication management process to better understand the causes of medication waste and associated factors.

In line with the findings of the study, it is important to make efforts to design efficient and cost-effective workflows that reduce preventable medication wastage for administrative reasons in hospitals. In particular, it is recommended to provide continuous education to healthcare professionals, strengthen interdisciplinary communication and teamwork, educate patients and their relatives, establish standard medication preparation and administration protocols, establish central medication preparation units, benefit from innovation-supported information system technologies, and implement waste-reducing lean management methods. Due to the limited number of studies on this subject in Turkey, it may be beneficial to conduct research in different institutions and on a larger sample and compare the results.

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