Caspian Journal of Internal Medicine 2025 (Spring); 16(2): 314-319
DOI: 10.22088/cjim.16.2.314

Original Article

A real-word survey of anticancer drug wastage in a public chemotherapy center in the west of Iran

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Received: 16 Aug 2023
Revised: 28 Nov 2023
Accepted: 9 Jan 2024
Published: 21 March 2025

Abstract

Background: The cost of anticancer drugs and their wastage has become a major concern for patients and health policy makers in developing countries. To date, no figures have been reported on the rate of loss of anticancer drugs in Iran. Therefore, we aimed to conduct a real-world analysis on the anticancer drug wastage in a public hospital.

Methods: During a 3-month time span, we observationally collected drug information of all patients admitted for receiving anticancer drugs in the inpatient or outpatient unit of chemotherapy center by two oncology nurses. The amount of drug wastage and its financial cost were calculated based on the price approved by the Food and Drug Administration (FDA) of Islamic Republic of Iran (IRI) during the survey period.

Results: A total of 626 patients were admitted for receiving twenty-four injectable anticancer drugs in 2023 infusions. The percentage of total drug wastage was 9.31% (95% CI, 5.90 –12.71%). Overall, these results indicated that the cost of drug wastage in this 3-month period was roughly 31,473 US dollars (USD) and estimated annual cost of wastage was nearly 125,894 USD (5,287,553,080 Iranian Rial).

Conclusion: This is the first report of investigating anticancer drug wastage in Iran. According to this real-world survey, it was shown that the amount of drug wastage in this center is substantial and imposes a heavy financial burden on patients and the health system that need to be taken into account by policy makers.

Keywords: Cancer, Leftover drug, Economic health, Medical economic burden.

Citation:
Baharvand Iran Nia Y, Nourolahi Z, Goudarzi F, et al. A real-word survey of anticancer drug wastage in a public chemotherapy center in the west of Iran. Caspian J Intern Med 2025; 16(2): 314-319.

The cost of cancer care is growing, and has become a major social concern around the world, especially in developing countries such as Iran. Pharmacy expediters represent a substantial part of costs in cancer continuum (1, 2). The increasing cost of anticancer drugs leads to variable access and outcomes worldwide, particularly for countries with low- or medium-incomes which are the most heavily affected (3). Spending on cancer drugs used during the treatment may not be clear as a result of drug wastage (4). It is suggested that drug wastage add costs to patients and health care systems without additional value. The financial impact of drug wastage is substantial, previous studies have reported that estimated annual cost of cancer drug wastage for only one hospital in Canada was up to $22 million (2, 5). One real-world study, conducted in the cancer center of a large tertiary care hospital, has found that oversized vials led to $141,196 in drug wastage in a one-month period (6). In Iran, as a developing country, no attention is paid to the wastage of anti-cancer drugs, which has caused it to impose considerable costs on the health system. Most health policy makers and caregivers in Iran are not aware of the quantity of anticancer drug wastage and its economic burden on patients and health services system. The clinical evidence shows that the amount of anticancer drug wastage in our chemotherapy centers is high, but the amount and its economic burden have remained obscure in Iran.

 Publisher: Babol University of Medical Sciences

Our chemotherapy center is an academic unit admitting more than 600 new patients annually. In terms of number of patients admitted, it is considered as a medium level chemotherapy center in Iran, where drug compounding is conducted in the same place as in most parts of our country. Internationally, a number of studies have been performed to determine and estimate the amount of drug wastage (6-9). However, as far as we know, no previous research has investigated the quantity of anticancer drug wastage in Iran. Therefore, the aim of our investigation was to conduct a real-world survey of drug wastage to assess the extent of drug wastage (in mg of wastage) and the economic burden of anticancer drug wastage in this public hospital. The results of this study will provide policy makers with accurate statistics on drug wastage in this center to significantly reduce pharmacy expenditures of cancer care.

Methods

We conducted a cross-sectional study on roughly all injectable anticancer drugs used during a period of 3 months (March 21–June 21, 2021) in the chemotherapy center of Shahid Rahimi Hospital, a tertiary hospital in the west of Iran. The study was approved by the regional research ethics committee (Approval ID: IR.LUMS.REC.1400.133). During this 3-month period we included all the patients admitted to inpatient or outpatient unit of chemotherapy center to receive anticancer drugs. Oral drugs and anticancer drugs that did not have units of milligram (mg) were excluded from the study. Two trained oncology nurses filled in a daily checklist using direct observational method and the amounts (mg) of drugs that were consumed (i.e., total drugs that patients or hospital prepared) for cancer patients and the prescribed dose (mg) based on the physician's order for each drug were registered. To calculate anticancer drug wastage cost, we first determined drug's price per one mg (Iranian Rial (IRR)/mg) of each drug according to Iran's Food and Drug Organization, then we calculated drug wastage (mg) by subtraction of consumed drug (mg) from prescribed drug (mg). Finally, we achieved drug wastage cost by multiplying drug wastage (mg) by drugs' price per one mg (IRR/mg) for each anticancer drug. Furthermore, estimated annual drug wastage and their cost are estimated through multiplying our results by four, because the average number of admitted patients was similar over the four seasons of the year. To convert prices from IRR to US dollars (USD) we used the exchange rate applied by the IRI Central Bank at the time of the study (May 2021, 1 USD=42,000 IRR). The proportion of drug wastage was determined at 95% confidence interval (CI). Variables such as type of cancer, patient age, sex, total dose prescribed and consumed, and the number of patients for each cancer type were assessed using the Microsoft Excel 2010 spreadsheet.

Results

The purpose of this survey was to assess anticancer drug wastage cost at one of the public chemotherapy centers in Iran. Therefore, during a 3-month prospective phase of the study, we evaluated 626 patients admitted to our cancer center for receiving 2023 drug prescriptions, of these patients, 58% were females and the rest were males, the average age of patients was 56.8 years (±14.52). Looking at table 1, it is apparent that, the five main types of cancer (based on admission frequency) treated with injectable therapy in both (outpatient and inpatient) units of the chemotherapy center were: Breast (17.3%), colorectal (16.8%), esophageal and gastric (12.8%), multiple myeloma (9.65%), and lymphoma (5.7%). Table 2 provides an overview of total anticancer drug wastage and cost of individual drugs in a period of 3 months. Twenty-four injectable anticancer drugs were administered during the survey. The total drug amount prescribed for patients was 2,267,961.6 mg, the quantity consumed (provided by patient or hospital) was 2,450,188.5 mg, and the total amount of drug wastage (unused) was 182,226.9 mg.

Table 1. Proportion of cancer type in patients admitted in a 3-month period

Type of cancer	No. of patients admitted	Percentage (%)
Breast Cancer	350	17.3 %
Colorectal Cancer	340	16.8 %
Esophageal & Gastric	260	12.8 %
Multiple Myeloma	195	9.6 %
Lymphoma	115	5.7 %
Lung Cancer	112	5.5 %
Leukemia	90	4.5 %

Type of cancer	No. of patients admitted	Percentage (%)
Endometrial & Ovarian	85	4.2 %
Prostate Cancer	50	2.5 %
Cystic Cancer	30	1.5 %
Other Types of Cancers	396	19.5 %
Total	2023	100 %

Of course, due to the very different volume of drugs in terms of weight and relative value, the report of this total number does not accurately express the value of drug wastage. Therefore, we have reported the drug wastage separately for each drug in table 2. Overall, these results indicated that total cost of drug wastage in this period was roughly 31,473 USD.

The percentage of total drug wastage was 9.31% (95% CI, 5.90 –12.71%) and two out of 24 drugs (Bendamustine and Bevacizumab) did not have any wastage in the study period. What is striking about the figures in this table is the Bortezomib, which has the highest proportion of drug wastage (30.17%) and, with the highest price per mg (102.04 USD) among anticancer drugs in this center, it was only accounted nearly 18,000 USD for 3 months. After Bortezomib, four drugs with the highest cost wastage during the 3-month period were Paclitaxel (2,780.48 USD), Docetaxel (2,668.46 USD), Oxaliplatin (2,137.02 USD) and 5-fluorouracil (1,067.24 USD). The greatest quantity of prescriptions was with 5-fluorouracil (1,112,480 mg), followed by Gemcitabine (267,920 mg), Cyclophosphamide (232,730 mg), and Ifosphamide (16, 4500 mg) (table 2). Table 3 presents the estimated annual drug loss cost. As can be seen from the table 3, the total expenditure on anticancer drugs in one year was about 125,894 USD (5,287,553,080 Iranian rial).

Table 2. Summary of total anticancer drugs and wastage costs during a 3-month period

Drug Name	Total Drug Prescription (mg)	Total Drug Consuming (mg)	Drug Wastage (mg)	Wastage Proportion (%)	Drug Unit Pricing (IRR/mg)	Drug Wastage Cost (IRR)	Drug Unit Pricing (USD/mg)	Drug Wastage Cost (USD)
Bortezomib	408.1	584.5	176.4	30.17%	4285714	755999949	102.0408095	17999.99879
Paclitaxel	21450	26000	4550	17.50%	25666	116780300	0.611095238	2780.483333
Docetaxel	32440	33630	1190	3.53%	94181	112075390	2.242404762	2668.461667
Oxaliplatin	35425	38520	3095	8.03%	29000	89755000	0.69047619	2137.02381
5-fluorouracil	1112480	1230750	118270	9.60%	379	44824330	0.00902381	1067.245952
Irinotecan	21280	23450	2170	9.25%	16000	34720000	0.380952381	826.6666667
Doxorubicin	6305	7070	765	10.82	35800	27387000	0.852380952	652.0714286
Carboplatin	69700	72150	2450	3.39%	10340	25333000	0.246190476	603.1666667
Leucovorin	108400	120900	12500	10.33%	1959	24487500	0.046642857	583.0357143
Rituximab	36800	37300	500	1.34%	44830	22415000	1.067380952	533.6904762
Cyclophosphamide	232730	257300	24570	9.54%	600	14742000	0.014285714	351
Cisplatin	9115	10450	1335	12.77%	9500	12682500	0.226190476	301.9642857
Methotrexate	5640	6950	1310	18.84%	8160	10689600	0.194285714	254.5142857
Etoposide	10550	13550	3000	22.14%	2820	8460000	0.067142857	201.4285714
Epirubicin	2380	2620	240	9.16%	23600	5664000	0.561904762	134.8571429
Dacarbazine	10780	12600	1820	14.44%	2480	4513600	0.059047619	107.4666667
Gemcitabine	267920	269520	1600	0.59%	2000	3200000	0.047619048	76.19047619

Drug Name	Total Drug Prescription (mg)	Total Drug Consuming (mg)	Drug Wastage (mg)	Wastage Proportion (%)	Drug Unit Pricing (IRR/mg)	Drug Wastage Cost (IRR)	Drug Unit Pricing (USD/mg)	Drug Wastage Cost (USD)
Trastusomab	58920	58940	20	0.03%	128520	2570400	3.06	61.2
Fludarabine	240	300	60	20%	41600	2496000	0.99047619	59.42857143
Vincristine	73.5	79	5.5	7.48%	276000	1518000	6.571428571	36.14285714
Cytarabine	48300	50400	2100	4.16%	572	1201200	0.013619048	28.6
Ifosphamide	164500	165000	500	0.30%	747	373500	0.017785714	8.892857143
Bendamustine	1925	1925	0	0%	96500	0	2.297619048	0
Bevacizumab	10200	10200	0	0%	100000	0	2.380952381	0
Total	**2267961.6**	**2450188.5**	**182226.9**	**9.31%**	**4285714**	**1321888270**	**-**	**31473.53024**

Table 3. Estimated annual cost of the drug wastage

Drug Name	Estimated Yearly Drug Wastage (mg)	Estimated Yearly Drug Wastage Cost (IRR)	Estimated Yearly Drug Wastage Cost (USD)
Bortezomib	705.6	3023999796	71999.99516
Paclitaxel	18200	467121200	11121.93333
Docetaxel	4760	448301560	10673.84667
Oxaliplatin	12380	359020000	8548.09524
5-fluorouracil	473080	179297320	4268.983808
Irinotecan	8680	138880000	3306.666667
Doxorubicin	3060	109548000	2608.285714
Carboplatin	9800	101332000	2412.666667
Leucovorin	50000	97950000	2332.142857
Rituximab	2000	89660000	2134.761905
Cyclophosphamide	98280	58968000	1404
Cisplatin	5340	50730000	1207.857143
Methotrexate	5240	42758400	1018.057143
Etoposide	12000	33840000	805.7142856
Epirubicin	960	22656000	539.4285716
Dacarbazine	7280	18054400	429.8666668
Gemcitabine	6400	12800000	304.7619048
Trastusomab	80	10281600	244.8
Fludarabine	240	9984000	237.7142857
Vincristine	22	6072000	144.5714286
Cytarabine	8400	4804800	114.4
Ifosphamide	2000	1494000	35.57142857
Bendamustine	0	0	0
Bevacizumab	0	0	0
Total	728907.6	5287553080	125894.121

Discussion

Our three-month analysis of anticancer drug wastage in a medium level public chemotherapy center in Lorestan province demonstrated that the amount of wastage in this center is very high and this data contribute a clear understanding of the precise amount of financial burden of this wastage (1,321,888,270 IRR in a 3-month period). Considering the role of the government and insurance organizations in covering the relatively high price of drugs (providing subsidies and insurance coverage), the major part of our research power in this study has been focused on the issue of drug wastage. What is more, we have been aware of the fact that there are other diverse and effective criteria for calculating the cost of drug wastage (10). However, according to the mentioned reasons, in this study our focus particularly was on the cost of the drug itself, and in fact, our research facilities did not allow us to include other costs (such as the drug preparation process, production process costs, etc.). Extrapolating these figures of first 3-month to the whole year, we find that the financial cost of leftover drug in this center is quite noticeable. Drug prices are too high around the world, even in the US with the largest drug market (46% of global pharmaceutical sales) and where pharmaceutical companies typically earn enough to support all global research and development costs associated with a new molecule (2).

Therefore, this wastage is a further burden to patients and health system in middle- and low-income countries where the anticancer drug expenditures are generally unaffordable and also cause more problem for them (3). Previous investigation concerning drug wastage has reported anticancer drug wastage levels of between 1% and 33% (11). In accordance with the present results, previous studies have demonstrated that the real-world anticancer drug leftovers in a large tertiary care cancer center (Davidoff Cancer Center) were 5.11% of the total cost, and it costs them roughly $2,208,876 annually. In this cancer center nearly 150 patients are admitted for receiving infusion cancer treatment daily. Thanks to suitable condition, they kept rest of the dispensed vials and discarded the leftovers based on the stability data sheet. Vial sharing and internal protocols for wastage minimization in this center led to no wastage for 24 out of 74 drugs (32.4% of the drugs being consumed) (6). Another similar research was done by Gopisankar et al. they have reported that 19.72% of dispensed anticancer drugs were wasted (i.e., discarded unused), solely owing to inappropriate size of vial. It differs for individual drugs from 3.15 to 29.07% and the projected total drug wastage cost was £19,046 annually (8). There have been several mitigating and intensifying factors that have placed our center in this rang of wastage (nearly 10%), rounding of drug dosage (even more than 10%) by physicians and lack of most new biologic anticancer drugs are the main reasons for low drug wastage (in total) despite the lack of vial sharing and other mitigating strategy in our cancer center. Perhaps the most striking finding to emerge from our analysis is that Bortezomib solely accounted for more than half of total financial losses and one-third of entire drug wastage. Bortezomib is a proteasome inhibitor considered as the part of standard induction regimen for multiple myeloma patients (12).

One of the chief reasons for this huge wastage is that Bortezomib is available only as a 3.5 mg vial in Iran and other countries as well, but the common dose for our patients had been 2 mg during the study period. In addition, when it comes to the stability, it must be used within 8 hours straight after dispensing due to lack of preserve condition. This enormous waste of Bortezomib can be prevented by revising size of the vial and/or sharing the vial between patients receiving this kind of drug (7). Another key finding in our survey was that only two out of 24 anticancer drugs were without wasting. Among all of the anticancer drugs, we just assessed 24 of them because the rest of them were far less commonly administered in our chemotherapy center. On top of that, due to the high cost and inaccessibility, most of biologic anticancer drug, which have a very high price compare with other type of drugs, were not prescribed by our physicians in this center. This finding is contrary to previous studies which suggested that there was no anticancer drug wastage in 24 out of 74 drugs (6). They have claimed that this high rate of non-wastage may partly be the result of implantation of internal mitigation strategies for minimizing drug wastage.

So far, several mitigation strategies have been implemented by various institutes for reducing drug wastage which can be implanted to the centers like our chemotherapy unit, namely the rounding of drug dosages within 5% to 10% of the calculated dose, centralization of drug preparation, vial sharing, selection of the most convenient vial size among different available options, grouping patients receiving a particular drug in one day, continuous monitoring between drug prescription and consumption, unification of prescribed doses between physicians and active information and feedback between members of the medical staff (5-7, 13-16). This investigation has several limitations. This survey was performed prospectively for only a 3-month period. Because the availability of most anticancer drugs may vary throughout the year in our province and even in the country, it is not easy to generalize the results of this study to a whole

year. It seems further data collection with longer time span or in more separated time of year is required to determine a more exact cost of anticancer drug wastage in Iran. In addition, owing to high cost and inaccessibility, some new biologic anticancer drugs approved by the FDA are not prescribed (or are rarely prescribed) by physicians in our province. So, we could not evaluate their wastage in this center. Further research should be undertaken in other cancer centers (public and private) to provide us with a more accurate view of economic impact caused by anticancer drug wastage in Iran. To our knowledge, this is the first report of analyzing anticancer drug wastage in Iran. Based on this real-world survey, we showed that amount of drug wastage in this center is quite considerable and essential measures should be taken, more specifically for drugs with high usage rate and cost, to diminish the financial impact of anticancer drug wastage.

Acknowledgments

We are grateful to acknowledge the deputy of Shahid Rahimi Hospital for their support.

Funding: This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics approval: This study was approved by the regional research of ethics committee of Lorestan University of Medical Sciences, Khorramabad, Iran.

Conflict of Interests: There are no conflicts of interest.

Authors' contribution: Concept and design: Dr. Baharvand and Shahram Ahmadi. Acquisition of data: Roya Fooladi and Fatemeh Goudarzi. Drafting of the manuscript: Shahram Ahmadi and Zahra Nourolahi. Intellectual content: Lam, Olivier, Haslam, Prasad. Statistical analysis: Dr. Rasool Mohammadi. Administrative, technical, or material support: Zahra Nourolahi. Supervision: Dr. Baharvand.

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