

Cost estimation related to drug waste in two major pediatric referral centers and one adult hospital in southern Iran: A comparative cross-sectional study

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Abstract

Children are a large group of patients receiving medications. Since pediatric dosage forms are generally not available, adult dosage forms have to be used for children instead, which leads to large amounts of drug wastage, and high costs are imposed on the healthcare system. This study was carried out to evaluate the amount of medication waste and its cost in pediatric wards of two major pediatric referral centers in southern Iran. The results were compared with an adult ward in the same hospital. This comparative cross-sectional study was carried out during a three-month period, from April to June 2014, assigning one month of study to each ward. A trained pharmacist collected the data using direct observational method during morning shifts. All the drug preparation processes were evaluated by direct visual observation. During this supervision, factors involved in medication waste and also the dose of drug prescribed and wasted were evaluated. The percent of medication waste in pediatric wards of Nemazee and “Shiraz Ghadir Mother and Child” hospital was 17.4% and 18.05%. The cost of wastage was estimated to be 568.11 USD and 368.11 USD for each hospital during one-month. According to the results, in pediatric wards of “Nemazee” and “Shiraz Ghadir Mother and Child” hospitals 101 out of 290 and 45 out of 80 prescriptions consisted of at least one antibiotic. In both hospitals the most prescribed antibiotic was vancomycin. The results indicated that medication waste in pediatric ward of Nemazee hospital was not significantly different in comparison with pediatric ward of Shiraz Ghadir Mother and Child hospital, but the waste was calculated to be more in the pediatric ward in comparison with the adult ward of Nemazee hospital. The most wasted group of medication was reported to be antibiotics. Vancomycin was reported to have the highest consumption and gentamicin was the leading wasted medication.

Keywords: Cost, Drug waste, Pediatric wards.

1. Introduction

Health care cost has risen significantly during the past few decades, and has become a major challenge in many countries. Health care cost has risen from 3% of world Gross Domestic products (GDP) in 1948 to over 8% in 2004 (1)

and 10% in 2013. In 2013 the United States’ health care cost consumed 17.4% (2) of their GDP, and in Iran this cost has been reported by World Health Organization (WHO) to be 29.7% in 2008 (3).

For hospitals, pharmaceutical wastage rate was reported to be 16.6-28.7%, depending on the type of pharmaceutical product, hospital, and patient. (4) According to previous studies, important factors that increase health care cost can be

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patient's visit to a doctor, medication prescription and other services provided for the patient (5,6). Increase in cost is a lot more significant in hospital units involved in medication preparation in comparison with other units that are mostly involved in health care. This can be partially related to demographic changes in the normal population, as well as increase in the general population, especially elderly. Different studies have shown the rise in medication cost. For example, annually in Thailand 173 million dollars is being added to the medication costs (7, 8). Having mentioned previously, medications administered for patients in a hospital, play an important role in increasing health care cost, and therefore can be an important focus in the management of cost. Taking into account that medication costs consume a large proportion of health care budget, and its rate of increase is a lot faster than other units of the health care system, the annual budget allocated to this unit, has become somewhat competitive (9).

On the other hand, medication wastage due to inappropriate use in hospitals, as well as the unavailability of different drug dosage forms, has been the major causes of an increase in health care system cost. With regards to this issue, different countries have sought different solutions in order to manage their costs. Also, they have introduced different ways to save their budget related to prescription drugs (10,11). Another important cause in rising healthcare cost is the inefficient use of resources. In fact, drug waste occurs when a part of medication is eliminated from the treatment cycle by either a wrong prescription, incomplete treatment of a disease, or inappropriate preparation (12). Studies have shown that inappropriate use of drugs, and also drug wastage can lead to economical burden, however, such studies are limited and most studies had focused on other aspects of disease treatment (6). Money spent on medication, consists of one fifth of the total health care expenditure. Therefore, programs that can manage these expenses could be beneficial (13, 14).

Considering the above facts, collecting information on how to use medication and prevent wastage can play an important role in the appropriate use of financial resources in health care systems (9). This is the first study on drug wastage

cost in pediatric wards, which aimed to estimate the amount of drug waste, and also extra related costs, in two major pediatric referral centers in comparison with an adult ward.

2. Material and methods

This is a comparative cross-sectional study carried out in two pediatric wards of "Nemazee" hospital, affiliated to Shiraz University of Medical Sciences, and the semiprivate "Shiraz Ghadir Mother and Child" hospital, and patients for the control group were selected from the adult general internal medicine wards of cardiology and gastroenterology of "Nemazee" hospital. Drug wastage was defined as the inappropriate discarding of unused or partially used medication in different dosage forms including prefilled syringes, vials, injectable ampoules or oral forms (15).

This study was carried out during a three-month period, from April to June 2014, assigning one month of study to each ward. All patients admitted in each ward were included in this study. A trained pharmacist filled in a daily log sheet using direct observational method. This information was documented according to the amount of drugs prescribed and wasted by registering the drug name and its dosage form. Considering the periodical reports of the hospital pharmacy on the negotiated price per milligram of each observed drug, the estimated total medication waste and the total related cost was calculated. To convert prices from Rials to US dollars, calculations were done according to exchange rates provided by the central bank of Iran in 2014 and the cost was reported in US dollars. All costs related to medication wastage during the three months, were summed up to give a total cost of waste. Waste costs were also calculated per patient, and data was collected for each ward. To minimize bias, data was transferred and analyzed by 3 individual pharmacists.

Method of drug waste estimation is described separately according to each dosage form.

Oral medication: Suspensions and syrups: the date in which the medication container was first opened and refrigerated was registered. If there was a similar prescription for other patients, the same container was used for all patients until it was finished. The medication waste in this group

Table 1. “Top 10” medication waste and cost in Nemazee vs. Shiraz Ghadir Mother and Child hospital pediatric wards.

Nemazee hospital	Waste, mg (%)	Cost (\$ USD)	Shiraz Ghadir Mother and Child” hospital	Waste, mg (%)	Cost (\$ USD)
Acetaminophen	10350 (45)	28.66	Amikacin	2850 (73.71)	1.37
Ranitidine	895 (44.75)	5.39	Gentamicin	320 (57.14)	2.41
Vitamin K	180 (47.37)	11.61	Vancomycin	4500 (52.94)	1.79
Sildenafil	941 (41.82)	2.77	Ranitidine	310 (47.69)	1.81
Furosemide	694 (38.55)	6.69	Diazepam	71 (44.37)	2.15
Pantoprazole	623 (37.98)	73.38	Ceftazidim	1650 (47.14)	0.66
Dexamethasone	184 (36.94)	7.41	Ondansetron	40 (37.03)	5.4
Phenobarbital	3823 (35.39)	7.30	Acetaminophen	6120 (36)	17.27
Vancomycin	10011.5 (35.12)	12.60	Meropenem	1450 (33.72)	6.65
Diazepam	183 (33.27)	5.08	Dexamethasone	44 (32.35)	1.77
total	27884.5 (42.38)	160.89	total	17355 (46.21)	41.28

was measured with a metered syringe.

Tablets and capsules: after using the specified dose, the rest of the medication was considered as waste.

Parenteral medication: after injection of the required amount, the rest was discarded and considered as waste. Metered syringes were used to estimate the medication waste in this dosage form by calculating the drug amount in milligrams.

Vials: The amount of excess medication

left in the vial after opening and refrigeration for 24 hours was considered as waste and was discarded. The date the vials were first opened was registered.

Statistical analysis: To analyze the data, SPSS 17 software was used. In this study P-value≤0.05 was considered as significant. To compare the waste estimated in the two studied hospitals, Mann-Whitney test was used.

Table 2. “Top 10” medication waste and cost per capita in Nemazee vs. Shiraz Ghadir Mother and Child hospital pediatric wards.

Nemazee hospital	Cost (\$ USD)/ number of patients	Waste (mg) / number of patients	Shiraz Ghadir Mother and Child hospital	Cost (\$ USD)/ number of patients	Waste (mg) / number of patients
Hydrocortisone	3.17	25.37	Imipenem	2.21	77.77
Albumin	3.14	2142.85	Aciclovir	1.68	17.3
Pantoprazole	1.80	15.57	Acetaminophen	1.23	437.7
Acetaminophen	1.14	423.6	Pantoprazole	1.13	9.09
Meropenem	0.59	62.13	Hydrocortisone	0.4	26.25
Aciclovir	0.57	28.94	Ondansetrone	0.20	1.48
Piperaciline/tazobactam	0.37	52	Clindamycin	0.18	66.66
Metronidazole	0.36	112.48	Ceftazidim	0.15	75
Vitamin K	0.28	4.39	Ranitidine	0.13	23.84
Amikacin	0.24	85.51	Diazepam	0.13	4.43

Table 3. The waste and cost of most prescribed medications by drug class in both Nemazee and Shiraz Ghadir Mother and Child hospital pediatric wards.

Drug	Wastage, mg (%)	Cost (USD)
Antibiotics	40,138 (34.5)	310.62
Analgesic	34,350 (28.75)	130.28
Anticonvulsant	14405 (15)	20.6
Digestive	9,326 (9.3)	118.64
Corticosteroid	2850 (13.8)	50.79

3. Results

Data was collected during a three-month period (one month for each ward). The age and weight range of patients is reported as Mean±SD 5.5±2.2 and 18±3.47, respectively. The wastage and the economic cost of the “top 10” most prescribed medications in pediatric wards of both hospitals were calculated and listed in Table 1. The difference between the two hospitals has not been statistically significant ($P>0.05$). Also, the pharmaceutical wastage and the related cost per capita are shown in Table 2. As a whole, the results of our study showed that antibiotics are the leading class of medication being wasted at a high cost (Table 3). Percent of drug waste and total cost for parenteral dosage forms were 80.64% and 458.13 USD for “Nemazee” hospital and 94.12% and 346.46 USD for “Shiraz Ghadir Mother and Child” hospital and for oral medications 19.36% and 109.98 USD for “Nemazee” hospital and 5.88% and 21.64 USD for “Shiraz Ghadir Mother and Child” hospital, respectively (Table 4).

4. Discussion

In the present study carried out in

“Nemazee” and “Shiraz Ghadir Mother and Child” hospitals, in “Nemazee” hospital, from 3,645 times that the medication Kardexes of 290 patients was reviewed the amount and percent of medication wastage was 96,035 grams and 17.4%, and the cost was estimated to be 568.11 USD per month. In “Shiraz Ghadir Mother and Child” hospital this amount was 25,425.6 grams estimated by 802 times of medication Kardex check of 79 patients. Percent of waste was equal to 18.05%, and the cost was calculated to be 368.11 USD per month.

We also evaluated the amount of medication waste in a ward with adult patients and compared it with our previous results. The results indicated that the amount of medication waste and the cost accounted for it was more in the pediatric wards. Worldwide, in the pharmaceutical market almost all dosage forms of medications are formulated in a way that a single dose of a drug is appropriate for its indication in an adult. Therefore, if the formulated dosage form is to be used in children, the amount of medication would be excess. If the dosage form is formulated in a way that can be preserved, it can be used for further usage, but if not, it will be discarded and accounted

Table 4. Highest percent of waste in drug dosage forms and their cost used in pediatric wards of both “Nemazee” and “Shiraz Ghadir Mother and Child” hospitals.

Drug dosage form	Wastage %	Cost (USD)
Ampoule	40.31	240.21
Vial	38.30	346.49
Collapsible pack	8.76	17.53
Capsule and tablet	12.36	131.62
Syrup and suspension	00.00	00.00

as medication waste, and the cost will be imposed on health care system. In our study, the percentage of drug waste in pediatric wards (17.4%) was much more than wards with adult patients (4.4%) and this difference was statistically significant ($P < 0.001$). Statistical analysis showed no significant difference between the two hospitals regarding the amount and cost of medication waste in the pediatric wards.

Previous studies regarding medication waste and its cost in pediatric wards are very limited.

In a study by Weinger on excess parenteral anesthetic drugs that was carried out in a hospital in California, a solution was suggested that could help reducing drug waste cost. The suggestion was to prepare and place emergency medication syringes along with opened vials in a designated location (7). Due to variety of medications used in our study, and differences in the wards studied between our study and Weinger's study, there cannot be an accurate comparison between the two. Hoolihan et al., (10) reported the total cost of all parenteral medications used in a hospital, where medications might have included expensive and non-routinely ordered medications, and therefore there is a difference in terms of cost reported.

In our study, the overall amount of drug waste and its cost in both hospitals was estimated to be 121, 460.6 grams at a cost of 926.23 USD per month. These estimations were only based on the data gathered from 369 patients hospitalized in the pediatric wards of two hospitals. However, if these estimations were generalized to all patients and hospitals in Iran, the results would be much more significant, which places a great burden on the healthcare system. For instance, if these calculations were done for the duration of one year in both "Nemazee" and "Shiraz Ghadir Mother and Child" hospitals, the total cost would turn out to be 11,234.76 USD.

4.1. Waste in Different drug dosage forms

Tablets and capsules: unavailability of drug dosage forms for pediatrics has led to the fact that sometimes dosage forms such as tablets and capsules are used to prepare solutions for usage in pediatric patients. But in such cases more pharma-

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cokinetic studies need to be carried out (8). In this study 19.53% wastage was related to this group of dosage forms.

Powder for injectable solution: must be prepared right before the injection otherwise it will lose its effectiveness.

Ampoules: This dosage form gets contaminated once opened and aerobic contaminations are inevitable. Therefore, its excess must be discarded immediately. The highest percent of medication waste in "Nemazee" hospital belonged to this group of dosage form and was calculated to be 42.93%.

Vials: vials are produced in two forms; single and multiple dose. Multiple dose vials can be used several times with the registration of the exact time and date of opening. This dosage form had the second highest wastage rate of 32.25%.

Cartridges: the waste estimated for this group was 6.45%.

In our study one of the most important factors responsible for medication waste in both hospitals, was the size of drug vials. In "Nemazee" hospital, 39% of the medication waste equal to 37,453 grams of the total waste was due to vial size, and the cost was estimated to be 2,398 USD per month. These estimations were 29.5%, 7500.5 grams and 108.59 USD for "Shiraz Ghadir Mother and Child" hospital. Another important factor affecting medication waste was the number of patients admitted to the pediatric ward. The fewer the patients, the more waste was estimated. The waste was calculated to be 14% equivalent to 13,444.9 grams of medication at a cost of 79.53 USD for "Nemazee" hospital, and 38% equivalent to 9,661.7 grams of medication at a cost of 139.88 USD for "Shiraz Ghadir Mother and Child" hospital. One of the most important factors involved in the medication waste in "Shiraz Ghadir Mother and Child" hospital was discarding of the remaining excess medication. Taking into account that some drugs are stable even at room temperature after opening of the vial or even preparing a solvent from the vial contents, the ingredients of a vial might have the characteristics to be used more than once. However, in "Shiraz Ghadir Mother and Child" hospital, most of the excess medication was thrown away.

Another issue influencing waste in this hospital was the fact that fewer patients were admitted in the pediatric ward, since the hospital is a semiprivate hospital in comparison to “Nemazee”, which is a public hospital.

The results also indicate a higher waste rate in pediatric wards in comparison with the general adult ward. Unavailability of drug dosage forms in different doses can be another important issue affecting waste. Different strengths of medication are available worldwide, but only one or two is available in Iran. Results gathered respecting this issue was almost the same in both hospitals; 25% (8.5847 grams and 84.66 USD) for “Nemazee” and 23% (7.24008 grams and 142.02 USD) for “Shiraz Ghadir Mother and Child hospital”. It should be mentioned that medication dosage form unavailability might have been due to its scarcity. During preparation and use of medications, they should be prepared in a clean room so that less waste would be attributed to multiple dose preparations.

The other factor responsible for drug waste can be poor adherence of the patient to the use of medication. In pediatric patients, this adherence was even lower. Waste due to this factor was 4.5% in “Shiraz Ghadir Mother and Child” hospital.

4.2. Use of Antibiotics

In another study performed in Shiraz University Hospital in 2013 in Iran, it was reported that antibiotic consumption increased from 95.4 defined daily doses (DDD) per patient’s bed days (DBDs) in 2000 to 124 DBDs in 2005 (16).

A study performed in Tehran University of Medical Sciences and Health Services in Iran, showed that the total systemic antibiotic prescription was 101.92 DDD/100 Bed-Day; (17) and in “Nemazee” and “Shiraz Ghadir Mother and Child” hospitals, it was one out of two and one out of 3 patients who received antibiotics, respectively.

Undoubtedly, it is important to rationalize drug consumption and lead pharmaceutical policy makers toward this goal. According to WHO, use of appropriate medicine for the appropriate indication in order to answer the clinical needs of patients in a specific geographical region with the

least expenses can be an important step in reaching this goal (18).

We have to mention that because medication preparation in all pediatric wards took place at the same time, direct control and observation in all wards was not possible. Although with the cooperation of some nursing staff, medication excess was collected in a specific place, there were cases in which excess drug was discarded; therefore, the cost estimated is probably less than the actual cost.

Other shortcomings of this study can be the fact that the results were obtained from only one working shift, and the other can be that this study was carried out only in the pediatric ward of the hospital, and we might not be able to generalize the obtained results to other wards with adult patients and even to other hospitals. Lack of similar studies in pediatric wards is another limitation of this study.

In order to perform a better comparison, the study should be carried out in different months and Seasons, different wards and hospitals, both private and public where all costs are considered.

5. Conclusion

The difference between the two studied hospitals was not significant, but the results were significantly different in pediatric ward in comparison with the general internal medicine ward. The highest rate of medications used was attributed to antibiotics; therefore, this class will require closer supervision in the hospital. Pharmaceutical waste due to lack of access to and availability of appropriate pediatric products, seeks the attention of pharmaceutical industries.

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Conflict of Interest

None declared.

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