Effect of closed-loop medication administration on medication billing leakage: A case study

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Abstract

Sustainability is one of the critical issues in all healthcare systems. Correct invoicing of the service provided to the payment institution is fundamental for sustainability. Medications dispensed in inpatient facilities make up a considerable share of the total cost, but leaks persist for different reasons. Closed-loop medication administration (CLMA) has been found to provide beneficial consequences for healthcare quality. In this study, we analyzed invoicing leakage of medications dispensed in the inpatient facilities of a public hospital in Turkey. Then we compared the invoicing leakage before and after CLMA implementation. We found that invoicing leakage of medications decreased from 4.4% in 2015 to 0.5% in 2018 when CLMA was implemented entirely. Moreover, despite an increase in the number of drugs ordered in 2018, the loss of revenue due to billing leakage decreased by 83.8%. The results show that CLMA is not only beneficial for healthcare quality but also sustainability.

Introduction

Increased costs and patient expectations are making it more challenging to maintain the sustainability of healthcare systems in all countries. Whether the healthcare system is digitally transformed or not, there are still many gaps to narrow. The sustainability of healthcare systems is dependent on many factors, such as infrastructure, investment requirements, human resources, payment models, service quality, efficiency, patient expectations, patient perception, etc. The hospital costs always have a considerable share in overall healthcare costs in all countries. As such, the sustainability of hospitals is essential for the sustainability of the overall healthcare system. There are many aspects to consider when looking at the efficiency and sustainability of hospitals. While some studies present the benefits of hospital business process management to decrease costs and increase revenue (1), other studies focus on predictive analyses to prevent revenue leakage (2).

Medication management is an essential issue for hospitals that must supply a sufficient volume of pharmaceuticals for diagnosis and treatment protocols (3). Significant economic losses can occur when the medication management processes, including ordering, delivering, and administering the medication, are not correctly planned, implemented, and monitored. Errors such as non-evidence-based prescribing and incorrect or incomplete orders can also increase pharmaceutical costs unnecessarily. Studies have shown that millions of dollars can be saved by improving the quality of orders (4). In addition, nurses can make mistakes in terms of administering the right medication at the right dose to the right patient at the right time using the right route, especially when medication orders are verbal. These errors pose severe risks in terms of patient safety (5–8). Studies have shown that electronic order applications used in conjunction with decision support systems reduce over-use, under-use, and misuse of medications, which are also critical problems for hospitals (9–11).

Medication ordering, administration, and invoicing involves many people and can be difficult to achieve successfully and monitor. Many studies show the benefits of using electronic medication management systems to handle this process. In particular, they provide a significant reduction in the number of incorrect prescriptions (8)(12)(13). The administration of medications through electronic systems also helps to achieve treatment in a shorter time (14). The impact of all these benefits on patient health is becoming more important for hospitals where medications are consumed extensively (15)(16).

Closed-loop medication administration (CLMA) describes a three step process beginning with the physician's medication orders supported by decision support systems (DSS), continuing with a second verification of the medications by the pharmacist, and ending with a checkpoint during bedside medication administration by the nurse regarding the five-right rules (right patient, right medication, right dose, right time, right route) (17). The positive effects of CLMA on health service quality, patient, and medication safety have been presented in many studies (18–

21). Although the duration of medication administration at the bedside lengthens slightly (21), it is rapidly becoming widespread due to other gains. To date, no study has been found in the literature discussing the direct effect of CLMA on billing leakage. In this study, the effect of the implementation of CLMA on medication billing leakage was investigated in a Turkish public hospital (İzmir Tire State Hospital) using a fee-for-service payment model.

Methods

All data was collected from the database of the hospital information system (HIS). Data was extracted from 2015 (pre-CLMA implementation) and 2018 (post-CLMA) for medication utilization throughout the hospital, including the emergency service, intensive care unit, and operating theaters. To understand the significance of pharmaceutical revenue, we calculated the share of pharmaceutical revenue in overall revenue of the hospital for both 2015 and 2018. Then, the billing leakage for *n* different medications per day was calculated using the following equation:

$$Drug\ billing\ leakage = \sum_{i=1}^{n} (orderd\ drug_i - returned\ drug_i - invoiced\ drug_i)$$

These calculations were based on the unique identifier (barcode number) of each medication and the unique protocol number given to each admitted patient. In this way, medications that were not reflected in the bill for each day were identified with their trade name and quantity. Medication forms that could be measured in unit doses were calculated, but those in cream or syrup forms that are difficult to calculate in unit doses were excluded from the calculations. The hospital has a total of 232 beds, 32 of which are in the intensive care unit.

Next, the quality management unit of the hospital investigated the medication management process, which begins with pharmacy logistics (receiving and stock) and ends with bedside medication administration. This analysis determined potential risks for medication billing leakage due to human error. Some of these indicators are as follows:

1. The list of medications that are not recorded in the bill even though administered by the nurse
2. The list of medications administered, returned, or not recorded in the bill (by the operating rooms)
3. The list of medications administered, returned, or not recorded in the bill (by the emergency rooms)
4. The list of medications administered, returned, or not recorded in the bill (by the active substance)
5. The list of medications administered, returned, or not recorded in the bill (by physicians)
6. The stock status of medication dispensing machines in inpatient wards

These indicators were monitored and discussed monthly at quality management meetings in 2018. Corresponding corrective-preventive actions were taken where appropriate. For example, it was found that inventory management of the automatic dispensing machines in inpatient wards was insufficient in that sometimes the medications ordered were not available in the machines. Besides, a verbal medication order ban was implemented throughout the hospital, and the necessary training was given to physicians and nurses. Then new features in the HIS were developed that reminds nurses when it is time to administer patient medications. This DSS ensured that medications were either administered to the patient at the right time or returned to the pharmacy on the same day if not administered.

Finally, we analyzed main indicators, such as patient volume, occupancy rate, and length of stay in the inpatient wards, to understand any changes in the service between 2015 and 2018 to identify any other factors that may affect the billing leakage ratio.

Results

We found that were 960,237 unit-doses (including returned medications) ordered in 2015, but only 917,901 unit-doses recorded in the billing. Thus, the billing leakage ratio for 2015 was 4.4%, with 42,336 unit-doses. In 2018, when CLMA as implemented throughout the hospital, 1.056.998 unit-doses were ordered, and 1,051,521 unit-doses were recorded in in the billing. Thus, the billing leakage ratio decreased to 0.5% in 2018 as indicated in Table 1. Despite the increase in the total number of unit-dose medication orders, the decrease in billing leakage was attributed to the CLMA supported by electronic ordering and the nursing decision support system (DSS). A significant portion of the small amount of billing leakage that persisted occurred in the emergency service where conditions may make timely

and complete records entry more difficult. Some of the billing leakages may also be related to medications that have been damaged or lost in some way that could not be recorded in the HIS.

Table 1. Comparison of billing leakage (by unit-dose)

	Unit Dose	
	2015	2018
Number of medication orders	960,237	1,056,998
Number of medications billed	917,901	1,051,521
Billing leakage (%)	42,336 (4.4%)	5,477 (0.5%)

The loss of revenue due to billing leakage for the same years is shown in Table 2. As can be seen here, despite the increase in both the number of drugs ordered and the cost in 2018, the loss of revenue due to billing leakage decreased by 83.8% (even though the costs are not normalized with inflation).

Table 2. Comparison of billing leakage (by cost)

	Cost	
	2015	2018
Price of mediation orders	2,305,589 TL	3,287,067 TL
Billed medication orders	2,204,143 TL	3,270,632 TL
Billing leakage (TL)	101,446 TL	16,435 TL

Indicators about inpatient wards are shown in Table 3. No significant change was identified when comparing 2015 and 2018. Moreover, the patient volume and the bed occupancy rate decreased slightly in 2018, but the average length of stay remained the same. When considering the results of Table 3 and Table 1 together, the number of unit-doses increased while the number of patients decreased, so the unit dose per patient increased. Since we have no further information about the case-mix of the hospital, we cannot suggest the exact reason causing an increase in unit-dose per patient. One possible explanation may be that the verbal orders, which were permitted in 2015 but not registered on the HIS, may make 2015 unit-dose numbers appear artificially low.

Table 3. Inpatient indicators of 2015 and 2018

	2015	2018
Patient volume (# of admissions)	11,362	10,130
The bed occupancy rate	88.8%	84.8%
Average length of stay (day)	5.1	5.1

Finally, the share of the pharmaceutical revenue to overall revenue and inpatient services revenue is given in Figure 1.

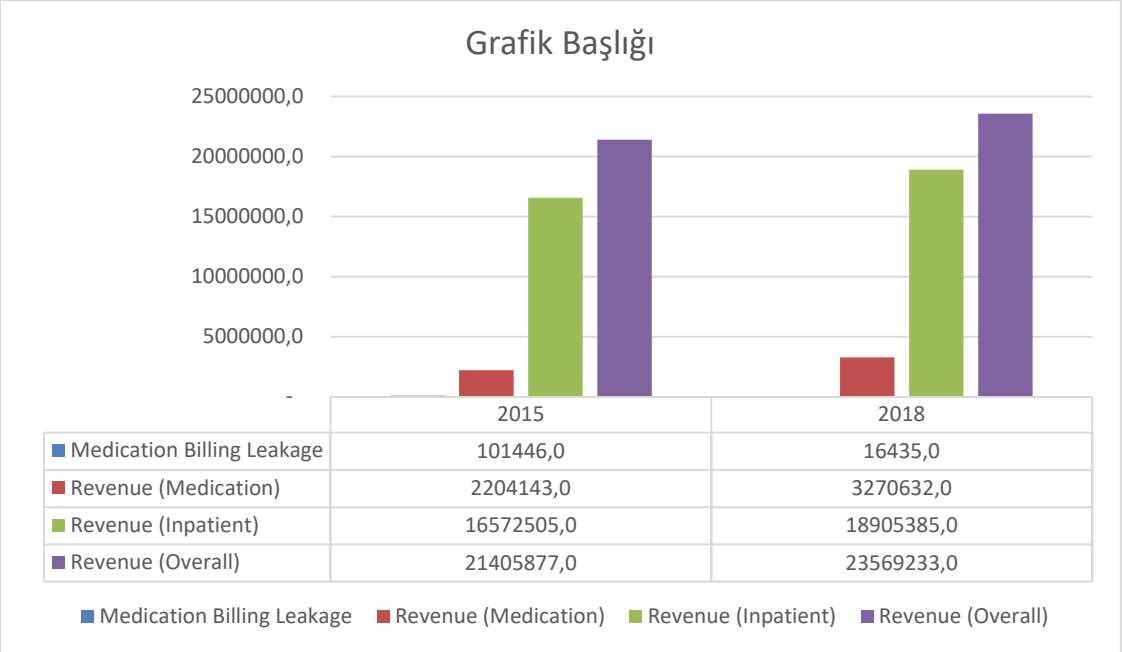

Figure 1. Comparison of the revenue share of medications

As seen in Figure 1, the share of pharmaceutical revenue in 2015 was 13.3% of the revenue of inpatient services, and 10.3% of overall revenue. In 2018, it was 17.3% and 13.9% correspondingly. That means that the share of pharmaceutical revenue increased significantly in both inpatient and overall revenues in 2018. Thus, when we consider the results in Figure 1 with the medication billing leakage given in Table 2, the share of medication billing leakage in the revenue of inpatient services is 0.61%, and represents 0.47% of overall revenue. Similarly, after adopting CLMA throughout hospital, the share of medication billing leakage became 0.09% of inpatient services revenue and 0.07% of overall revenue.

Conclusion

Preventing revenue leakage is an essential step for hospitals to achieve sustainable management. Medication billing leakage is widespread in hospitals due to the difficulties of management, monitoring, and controlling the medication management process. When there is a billing leakage of 4.4% of all drug revenue, it has a considerable share in overall revenue, in our case 0.47%. Such a loss is a considerable amount for sustainability. There are many studies in the literature showing the benefits of CLMA associated with health care quality, patient and drug safety. However, no study has been found identifying the direct effect of CLMA on reducing billing leakage of the drugs. According to the results of this study, CLMA decreased medication billing leakage by 83.8%. It has the indirect potential to overcome verbal order problems in hospitals, which is a crucial risk for patient safety and cost management. In conclusion, it can be suggested that CLMA, when strengthened by electronic order and nursing DSS, reduces medication billing leakage. The successful results here are promising and imply that medication billing leakage can be eliminated if precautions are taken.

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