Original Research

Impact of pharmacy-led medication reconciliation on medication errors during transition in the hospital setting

Lillian SMITH, Juan MOSLEY, Sonia LOTT, Ernie CYR Jr, Raid AMIN, Emily EVERTON, Abdullah ISLAMI, Linh PHAN, Opeyemi KOMOLAFE.

ABSTRACT[*]

Objective: To assess if the pharmacy department should be more involved in the medication reconciliation process to assist in the reduction of medication errors that occur during transition of care points in the hospital setting.
Methods: This was an observational prospective cohort study at a 531-bed hospital in Pensacola, FL from June 1, 2014 to August 31, 2014. Patients were included in the study if they had health insurance and were taking five or more medications. Patients with congestive heart failure were excluded from the study. Student pharmacists collected and evaluated medication histories obtained from patients' community pharmacies, and directed patient interviews. Primary care providers were only contacted on an as needed basis. The information collected was presented to the clinical pharmacist, where interventions were made utilizing clinical judgment.
Results: During the three month study, 1045 home medications were reviewed by student pharmacist. Of these, 290 discrepancies were discovered (27.8%; p=0.02). The most common medication discrepancy found was dose optimization (45.5%). The remaining discrepancies included: added therapy (27.6%), other (15.2%), and discontinued therapy (11.7%). Pharmacists made 143 interventions based on clinical judgment (49.3%; p=0.04).
Conclusion: Involvement of pharmacy personnel during the medication reconciliation process can be an essential component in reducing medical errors. With the addition of the pharmacy department during the admission process, accuracy, cost savings, and patient safety across all phases and transition points of care were achieved.

Keywords: Medication Reconciliation; Patient Admission; Pharmacy Service, Hospital; Medication Errors; Pharmacists; Students, Pharmacy; United States

[*] **Lillian SMITH**. Pharm. D., MBA, CPh. Assistant Professor of Pharmacy Practice. Florida Agricultural & Mechanical University. Tallahassee, FL (United States). Lillian.smith@famu.edu
Juan MOSLEY. Pharm. D., CPh, AAHIVP. Assistant Professor of Pharmacy Practice. Florida Agricultural & Mechanical University. Tallahassee, FL (United States). juan.mosley@famu.edu
Sonia LOTT. RPh, MPH, PhD. Director of Pharmacy and Co-Ethics & Compliance Officer. West Florida Hospital Pharmacy. Pensacola, FL (United States). sonia.lott@hcahealthcare.com
Ernie CYR Jr. PharmD. Clinical Coordinator and Residency Program Director. West Florida Hospital. Pensacola, FL (United States). ernie.cyr@hcahealthcare.com
Raid AMIN. PhD, MS, BS. Department of Mathematics and Statistics Professor. University of West Florida. Pensacola, FL (United States). ramin@uwf.edu
Emily EVERTON. PharmD. Florida Agricultural & Mechanical University. Tallahassee, FL (United States). emily1.everton@famu.edu
Abdullah ISLAMI. PharmD. Florida Agricultural & Mechanical University. Tallahassee, FL (United States). abdullah1.islami@famu.edu
Linh PHAN. PharmD. Florida Agricultural & Mechanical University. Tallahassee, FL (United States). linh1.phan@famu.edu
Opeyemi KOMOLAFE. PharmD. Florida Agricultural & Mechanical University. Tallahassee, FL (United States). opeyemi1.komolafe@famu.edu

INTRODUCTION

The Joint Commission defines medication reconciliation as the process of comparing a patient's medication orders to all of the medications that the patient has been taking. This reconciliation is done to avoid medication errors such as omissions, duplications, dosing errors, and drug interactions. It should be performed at every transition of care in which new medications are ordered or existing orders are rewritten.[1] In July 2011, the Joint Commission incorporated medication reconciliation into their third National Patient Safety Goal. Most medication errors (66%) occur at transition of care points such as admission, transfer, discharge, and outpatient.[2]

According to the following reports, adverse drug events (ADEs) can greatly affect the quantity, quality and financial stability of an individual's life. Over 770,000 people are injured or die each year in hospitals due to ADEs.[3] According to the Agency for Healthcare Research and Quality (AHRQ), ADEs at a community hospital were associated with an increased adjusted cost of USD 3,420 and an adjusted increase in the length of stay by 3 days.[4] In 2006, the average cost added to a hospital stay for each preventable adverse drug event was USD 8,750, as reported by the Institute of Medicine. The estimated annual cost of preventable adverse drug events for Medicare patients in 2006 was USD 887 million.[5]

Previous literature has shown that inpatient medication histories are often incomplete with as much as 25% of home medications being omitted.[6] A study team consisting of a pharmacist, student pharmacist and medical student found that 53.6% of patients had at least one unintended medication discrepancy upon admission. Although most discrepancies were identified as having little to no potential of causing harm (61%), 33% were ranked as having the potential to cause moderate clinical deterioration, and 6% were ranked as having the potential to cause severe clinical deterioration.[7] In a study conducted by Pippins, pharmacists found a

high prevalence of unintentional medication discrepancies (an average of 1.4 per patient) with potential for patient harm.[8]

Studies have shown that pharmacist and student pharmacist involvement during the medication reconciliation process can prevent medication errors. Hayes observed that medication histories completed by pharmacists in the emergency department resulted in significantly fewer errors in documentation and increased documentation of allergies.[9] A study conducted by Lu Y showed that inpatient and discharge medication reconciliations conducted by the pharmacy department reduced the risk of 30-day related readmissions by 43.2% (p=0.1180).[10] In an additional study, pharmacists reviewed 5,006 medications and resolved 467 admission medication errors. Of these medication errors 46% were considered significant or serious.[11]

In the past, physicians and nurses have shared the responsibility of conducting medication reconciliations.[12] Many studies have established that pharmacy-led medication reconciliations provide more accurate medication lists, and identify more discrepancies compared to physician-led or nurse-led medication reconciliation programs. Nester found that pharmacists implemented more interventions (34% vs 15%), confirmed the use of herbal or non-prescription products (98% vs 70%), and verified more medications with outpatient pharmacies (24% vs 4%) when compared to nurses.[13] Lancaster observed that student pharmacists discovered significantly more medication discrepancies per patient (10.2) compared to physicians (7.1) and nurses (6.8). Of the medications identified by student pharmacists that were not identified by physicians and nurses, 68% were nonprescription medications.[14] Mergenhagen found that during the medication reconciliation process, pharmacists documented statistically more changes than physicians (3.6 vs 0.8).[15]

A study conducted by Murphy describes the benefits of a newly implemented pharmacy-driven medication reconciliation program. The current process for obtaining medication histories was assessed prior to the implementation of the new reconciliation process. Every patient admitted to the hospital received a complete and comprehensive home medication interview conducted by pharmacists or student pharmacists within 24 hours of admittance. At discharge, patients also received medication reconciliation, and were provided with a medication report for their personal record. At the conclusion of the study, medication errors were reduced from 90% to 47% on the surgical unit and from 57% to 33% in the medicine unit.[16]

Past studies show that pharmacists are better equipped to decrease medication reconciliation discrepancies, this research assessed if the pharmacy department should be more involved in the medication reconciliation process in order to assist in the reduction of medication errors that occur during transition of care points. The secondary endpoint evaluated the potential cost-savings due to prevention of adverse effects.

Therefore, the involvement of the pharmacy department promoted quality assurance by preventing medication errors through accurate medication reconciliations. The study also justified the need for pharmacy department-led medication reconciliation through the pharmacoeconomic model of cost saving as its secondary endpoint. This makes a strong economic justification for the role of pharmacists in reducing medication errors by decreasing costs in addition to ensuring patient's safety. In line with ensuring quality assurance across healthcare systems, the Joint Commission recognizes medication reconciliation as one of the objectives in the National Patient Safety Goals.[1]

METHODS

The study was conducted from June 2014 to August 2014, and received prior approval from the Clinical Studies Coordinator at the hospital institution and the Institutional Review Board at Florida A&M University. This hospital institution is a 531-bed, for-profit, community hospital and is a part of the Hospital Corporation of America (HCA) healthcare system. The pharmacy department is open 24 hours, with pharmacists providing services from patient care units occurring for 10 hours. Pharmacists play a vital role in the hospital and function in team rounding as well as medication monitoring. Patient's home medication histories are obtained by the nursing staff upon patient admission, which are utilized by physicians to decide which medications to resume, modify, discontinue, or start while the patient is hospitalized.

A total of six student pharmacists completing their Advanced Pharmacy Practice Experience (APPE) were assigned to five decentralized stations throughout the hospital, excluding labor and delivery, physical therapy, and hospice and palliative care, from 7 a.m. to 5 p.m. five days a week. They collected and evaluated medication histories, under the supervision of a pharmacist, obtained from hospitalized patients' outpatient-community pharmacies via phone or fax, and by conducting direct patient interviews. Patients' primary care providers were also contacted on an as-needed basis to offer further clarification on medication histories. Upon retrieval of data, student pharmacists then identified discrepancies by comparing their medication histories to the list collected by nurses upon initial admission. Potential discrepancies were then presented to the clinical pharmacist, who reviewed the discrepancies identified by student pharmacist. A discrepancy is defined as any difference between the nurse's medication list received at the time of admission compared to the information gathered by the student pharmacist from outpatient pharmacies and patient interviews. Discrepancies were organized into four categories: dose optimization, added therapy, discontinued therapy, and other. Once discrepancies were validated and verified by the clinical pharmacist, interventions were implemented based on clinical judgement. The percentage of discrepancies identified was 27.8%, which indicates

that approximately one-third of all patients' home medications contained some form of a discrepancy.

Patients were included in the study if they were admitted within 24 hours, insured, and on a medical regimen consisting of five or more medications. Patients with congestive heart failure were excluded from the study as patients with this disease state are generally readmitted more often and could skew the data.

Consistent data collection was achieved through the implementation of a centralized computer program, protocols, and a hospital developed checklist. All student pharmacists were trained by the same specific tutorial system developed by the hospital for this study. All data was collected in the same order in accordance with the hospital developed checklist. The data was collected using a centralized Excel spreadsheet with the following categories: drug name, dose, frequency, time last taken, and community pharmacy name. Additional data collected was the total amount of time needed for a student pharmacist to obtain a medication history and for a pharmacist to make interventions. Chi-square tests were used to evaluate the statistical data for discovered discrepancies, interventions, and overall outcome. Results of these analyses were considered significant when the p value was less than 0.05. All statistical analyses were performed using the Statistical Analysis Software (SAS) system. The potential financial impact was calculated based on a report of the estimated additional cost of hospitalization due to a preventable adverse drug event from the Institute of Medicine. In order to limit bias, data analysis and statistics were completed by a distinguished professor from a local university.

RESULTS

During the three-month research period, 1045 home medications, in 90 patients, were reviewed by student pharmacist and validated by clinical pharmacists. Upon comparison to the nursing

Table 1. Pharmacy interventions by clinical pharmacists, by type. Among the total of 143 medication discrepancies	
Optimized patients' medication strength or frequency	75 (52.4%)
Added additional medication to home medication list	49 (34.3%)
Discontinued medication	15 (10.5%)
Other	4 (2.8%)

composed home medication list, 290 (27.8%) medication discrepancies were discovered, showing statistical significance with a confidence interval of 95% (p=0.02).The most common medication discrepancies were dose optimization (45.5%), added therapy (27.6%), discontinued therapy (11.7%), and other (15.2%). Summary of discrepancies is shown in Figure 1.

Of the 290 medication discrepancies validated by clinical pharmacists, 143 (49.3%) required interventions based on their clinical judgement, which were accepted by providers. The data showed statistical significance with a confidence interval of 95% (p=0.04). The remaining 147 (50.7%) of discrepancies were not intervened upon, but were correctly updated in the patient's electronic home medication record. A majority of non-intervened discrepancies were oral diabetic medications due to hospital protocol of switching all patients with diabetes to insulin therapy for glycemic control while admitted. The most common intervention noted was dose optimization (52%), followed by added therapy (34%), discontinued therapy (11%), and other (3%). As shown in Table 1.

The potential effect of implementing a pharmacy-led medication reconciliation program over a twelve-month period was extrapolated based on the facilities 2013 total admissions of 14, 701 patients and 1.6 interventions per patient found in the study, which could result in 23,521 possible medication interventions. According to the Institute of Medicine, each preventable ADE could potentially contribute an estimated additional USD 8,750 towards hospital stay cost.[5] The annual estimated total gross cost
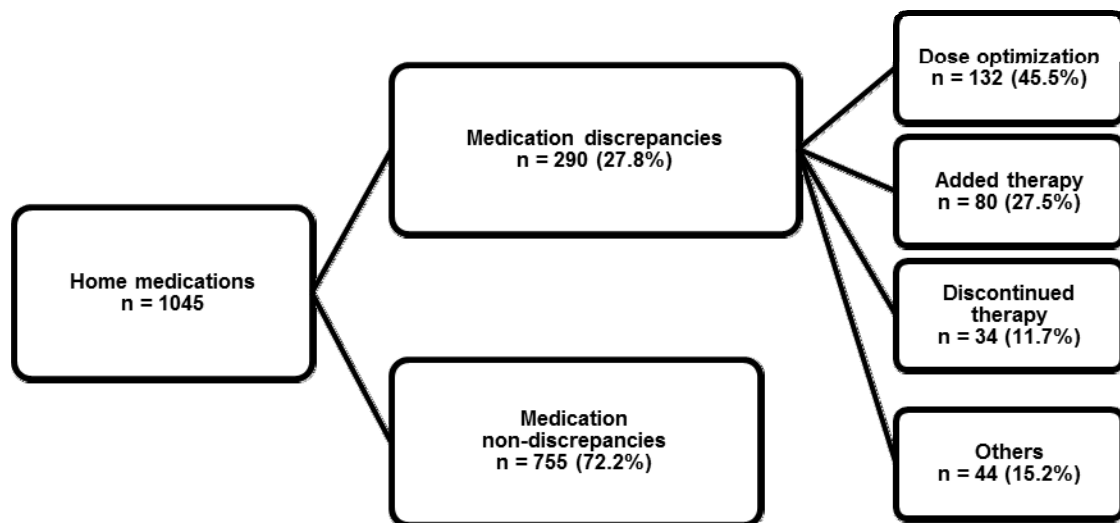

Figure 1: Pharmacy Medication Discrepancies, by type. Student pharmacists reviewed total of 1045 patients' home medications, in 90 patients, and 290 medication discrepancies were found.

Table 2. Projected annual cost impact of medication discrepancies to hospital institution, based on the current standard of care

Projected cost impact	Value
Average intervention per patient	1.6
Number of patients admitted (2013*)	14,701
Estimated total yearly interventions‡	23,521
Average cost per preventable ade	USD 8,750*
Estimated total annual gross costs	USD 205,814,000

*The total number of patients admitted at West Florida Hospital in 2013
‡ Calculated by multiplying the average interventions per patient in the study with the number of patients admitted at the facility in 2013.

Table 3. Extrapolated annual cost impact of medication reconciliation process.

Actual Cost Impact of Project	Value
Number of Interventions	143
Estimated Cost per Preventable ADE	USD 8,750*
Gross Costs	USD 1,251,250
Average Student Pharmacist Time per Medication Reconciliation	47 minutes

would be in the region of USD 2 million, based on the current standard of care. The findings are summarized in Table 2.

The medication reconciliation process conducted by student pharmacist took approximately 47 minutes per patient. Unfortunately, the amount of time it took the clinical pharmacists to validate the discrepancies found by the student and to place the interventions was not documented. More details can be seen in Table 3.

The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores for medication communications was 60% in May, the month prior to the study starting. The medication communication score increased to a peak of 64% in the month of July, and the average score over the three month course of the study was 63%. Although the impact on HCAHPS was not significant, the month following the study the score fell to 63% in September, which may convey a positive impact of student pharmacists during the study. Details are provided in Figure 2.

DISCUSSION

The number of discrepancies discovered was statistically significant, indicated by a p-value of 0.02. The high percentage of discrepancies

discovered reinforced the premise of the study at which student pharmacists are the vanguard for detecting medication discrepancies.

Discrepancies were organized into four categories: dose optimization, added therapy, discontinued therapy, and other. Discrepancies were categorized as dose optimization if changes had to be made regarding the medication strength or frequency. Discrepancies were categorized as added therapy if a medication that the patient takes at home does not appear on their medication list. Discrepancies were categorized as discontinued therapy if a medication that the patient was no longer taking appeared on their medication list. Discrepancies were categorized as other if they did not fit into the other three categories. Examples of the other category include differences in salt forms or formulations and medication samples utilized by patients. The most prominent discrepancy identified was dose optimization at 45.5% (n=132).

All medication discrepancies were corrected in the patient's home medication record, but only clinically significant discrepancies resulted in an intervention. Of the total 290 discrepancies identified, approximately half, 49.3% (n=143), were significant enough for the pharmacist to proceed with an intervention. An intervention is defined as a change made to the patient's current inpatient hospital medications. Student pharmacists would identify discrepancies and present them verbally and in written format to the pharmacist. If a discrepancy was clinically significant, the pharmacist would then call the physician to authorize changes to the
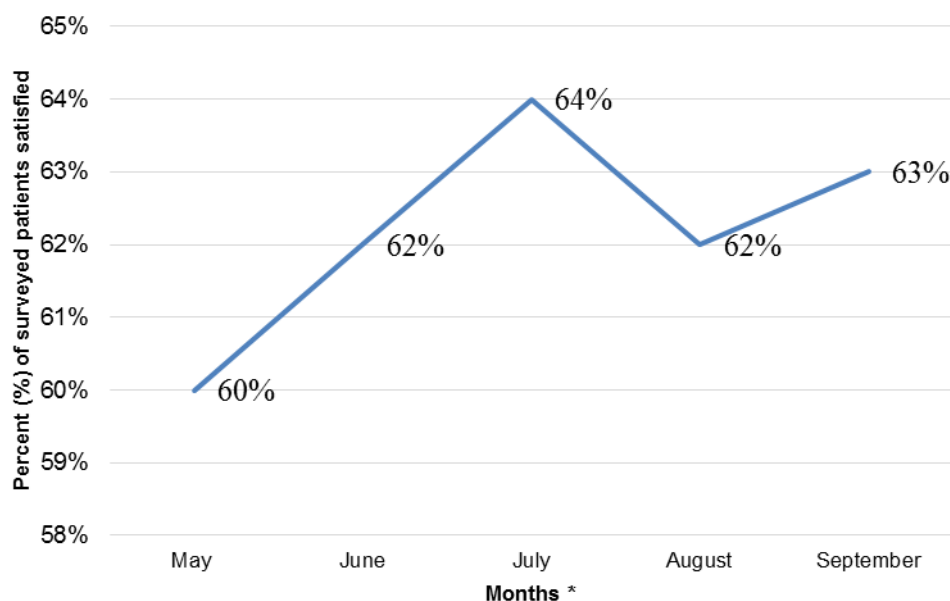

Figure 2. HCAHPS Communication about Mediations Scores.
*Study months include June, July, and August.

inpatient medication regimen. If the physician accepted the proposed changes, the pharmacist would then modify the electronic medication administration record (eMAR). The number of interventions made was statistically significant, which was indicated by a p-value of 0.04. The most common intervention was dose optimization at 52% (n=75).

HCAHPS is a national, standardized survey with the goal of providing a data collection tool to measure hospital care from a patient's perspective. The survey is distributed to a random sample of patients 48 hours to 6 weeks after discharge. The results of the survey are publicly reported on the Hospital Compare web site, www.medicare.gov/hospitalcompare. The survey consists of 32 questions and addresses 21 areas of care in the hospital, such as communication about medications. The factors involved in the communication about medications include discussing the patient's current medications, new medications, and any potential adverse event or side effects.[17] In Figure 2, an increase in medication communication from 62% the month prior to starting the study to 64% at the end of the study is shown, although not significant. Multiple factors influenced why only a slight impact was seen from the medication reconciliation process on this score including conducting the project from 7am-5pm only and relying on student pharmacists with inconsistent scheduling. Since the survey is distributed only to a sample of patients, it does not reflect the entire patient population. The decreased score seen in August may be due to a lower number of student pharmacist completing medication reconciliations, and the hospital implementation of a new intervention documentation software program.

Although steps were taken to minimize the potential for human error causing limitations within the study, these factors were present as interventions were made based off the clinical judgment of the pharmacist. Also, the potential for patients to have inconsistent recall and reporting of home medications occurred, this was an immeasurable limitation. This was mitigated through the implementation of a three-step verification process (i.e. physicians' office, community pharmacies, insurance companies).

Another limitation of the study was the reliance on student pharmacists that were completing rotations. Student pharmacists had multiple obligations, such as rounding with multidisciplinary teams, which competed for the time that was available to complete medication reconciliations. The number of student pharmacists available to complete medication reconciliations was not always consistent. The majority of students completed their clinical experience during 7 a.m. to 5 p.m., but occasionally student pharmacists would be assigned to the evening, overnight, or weekend shift. Also every 4 to 5 weeks, a group of student pharmacists would complete their rotation and would be replaced by a new group of students. This was a contributing factor to the small sample collection over the three-month period. Another

limitation was the change in software used to record interventions for the pharmacy department in late June. Since pharmacists had to complete software training over a two-week period, less data was collected during this time.

One of the challenges encountered during the study was streamlining the medication reconciliation process. At the beginning of the study it was uncertain if student pharmacists needed to verify medication information in two steps (i.e. patient and pharmacy/medication bottles/insurance company) or three steps (i.e. patient, pharmacy/medication bottles/insurance company, and physician) for every medication list. After trying out both methods for a period of time, we concluded that verification with two steps was more time appropriate, and that physician offices would be contacted on an as needed basis for further verification.

An additional challenge was to obtain consistent useful data. In order to create uniformity, student pharmacists developed a tutorial for their peers that consisted of step-by-step instructions with screen shots for the entire medication reconciliation process. New student pharmacists were required to complete the tutorial prior to reconciling medications. Another challenge that was observed in the study was the process of the hospital staff becoming accustomed to student pharmacists entering patients' rooms. In the past, student pharmacists either worked alongside clinical pharmacists in decentralized work stations or worked in the pharmacy. In order to ease the transition of student pharmacists being involved in the medication reconciliation process, nurses were educated on the upcoming process and fliers were posted at nursing stations. Student pharmacists were also encouraged to call the nursing station before visiting a patient as a courtesy.

There are several differences in this study compared to past literature. Patients were included in the study if they were taking 5 or more medications. In the study conducted by Lubowski, the number of medications a patient was taking was not considered an inclusion criteria.[18] Lancaster compared the number of discrepancies identified by student pharmacists with the number of discrepancies identified by physicians and nurses. In contrast, our study did not make comparisons between discrepancies found by student pharmacists and other health care providers.[14] During this study student pharmacists focused on admission medication reconciliation, whereas Murphy focused on both admission and discharge medication reconciliations.[16]

At the conclusion of this study the estimated annual gross savings of preventable ADEs was USD 205,814,000, which justified the opening of two full-time pharmacy technician positions dedicated solely to medication reconciliation. AHRQ estimated that a proper medication reconciliation should take 15-30 minutes, but our study took an average of 47 minutes per medication reconciliation which included interventions made. Time is an important factor, as other studies show a range from 33 minutes to 44.4 minutes + 21.8 minutes.[11,19] In

order to dedicate sufficient time to complete thorough medication reconciliations in the future, the pharmacy department requires sufficient full-time staffing in addition to the aid of student pharmacists. One study showed a 44.3% to 95% improvement in accuracy in medication histories which were completed by technicians who were in a 2:1 ratio with the pharmacist and who were only assigned to complete medication histories.[19]

The preventable ADEs and cost savings achieved by this institution due to pharmacy involvement can also be achieved at other institutions. If an institution does not have student pharmacists, pharmacists and/or pharmacy technicians can be responsible for obtaining accurate medication histories, identifying discrepancies, and preventing adverse drug events.[19] A thorough assessment of the current medication obtaining processes may be beneficial in order to find out the specific needs of an institution.[16] During a particular instance when pharmacists conducted medication histories, a healthcare organization benefited through a 50% decrease in adverse drug, a 16% decrease in hospital readmission rates, an increase in efficiency, and an increase in employee and physician satisfaction.[20]

CONCLUSIONS

The process of medication reconciliation while complex is very important in today's healthcare marketplace and continues to evolve. Having the pharmacy department perform or aid in this process greatly enhances accuracy, promotes cost savings, and ensures patient safety across all phases and transition of care points. As healthcare becomes more complex, with more patients entering the system, additional providers integrated on care teams, greater use of technology, and increasingly greater oversight, new strategies for medication reconciliation will continue to be needed. Though some studies found medication omission to be the most common error, dose optimization still remained among the most common found discrepancy. Other studies with similar findings, adds validity to this study's findings. Similar findings in discrepancies help to reveal common areas of weakness in the medication reconciliation process. This allows supervising entities to be able to focus new procedures and employee education on these particular areas. This will also allow accreditation entities such as the Joint Commission to be able to design and implement advance patient safety goals that will cater to future challenges.

CONFLICT OF INTEREST

The authors of this manuscript report no conflicts of interest including, but not limited to, consulting fees, paid expert testimony, employment, grants, honoraria, patents, royalties, stocks, or other financial or material gain that may involve the subject matter of the manuscript.

IMPACTO DE LA RECONCILIACIÓN DE MEDICACIÓN POR EL SERVICIO DE FARMACIA EN LOS ERRORES DE MEDICACIÓN DURANTE LA TRANSICIÓN EN EL HOSPITAL

RESUMEN
Objetivo: Evaluar si un servicio de farmacia debería estar más involucrado en el proceso de reconciliación de la medicación para ayudar a reducir los errores de medicación que ocurren durante la transición de servicio en un hospital.
Métodos: Este fue un estudio de cohorte prospectiva observacional en un hospital de 531 camas en Pensacola, FL desde 1 de junio a 31 de agosto de 2014. Se incluyó a los pacientes si tenían seguro de salud y estaban tomando 5 o más medicamentos. Los pacientes con fallo cardiaco congestivo fueron excluidos del estudio. Los estudiantes de farmacia recogieron y evaluaron las historais de medicación obtenidas de las farmacias comunitarias de los pacientes y realizaron entrevistas a los pacientes. Solo se contactaba a los médicos de atención primaria si era necesario. La información recogida era presentada al farmacéutico clínico, que hacía intervenciones si lo consideraba adecuado.
Resultados: Durante los 3 meses de estudio, se revisaron 1045 medicaciones ambulatorias. De ellas, se descubrieron 290 discrepancias (27,8%; p=0,02). La discrepancia más común fue la optimización de dosis (45,5%). Las restantes discrepancias incluían: tratamiento añadido (27.6%), otras (15.2%), y tratamiento discontinuado (11.7%). Los farmacéuticos realizaron 143 intervenciones basadas en su juicio clínico (49.3%; p=0.04).
Conclusión: La participación de l personal de farmacia durante el proceso de reconciliación de la medicación puede ser un componente esencial para reducir errores de medicación. Con la inclusión del servicio de farmacia durante el proceso de ingreso, se consiguió precisión, ahorro de costes y aumento de seguridad del paciente en todas las fases de la transición de servicio.

Palabras clave: Conciliación de Medicamentos; Admisión del Paciente; Pharmacy Service, Hospital; Errores de Medicación; Farmacéuticos; Estudiantes de Farmacia; Estados Unidos

References

1. The Joint Commission. Using medication reconciliation to prevent errors. Sentinel Event Alert. 2006;(35):1-2.

2. USP Patient Safety CAPSLink. US Pharmacopeia. Available at: http://www.usp.org/patientSafety/newsletters/capsLink (accessed on November 4, 2015).

3. Budnitz DS, Pollock DA, Weidenbach KN, Mendelsohn AB, Schroeder TJ, Annest JL. National surveillance of emergency department visits for outpatient adverse drug events. JAMA. 2006;296(15):1858-1866.

4. Hug BL, Keohane C, Seger DL, Yoon C, Bates DW. The costs of adverse drug events in community hospitals. Jt Comm J Qual Patient Saf. 2012;38(3):120-126.

5. Bootman L, Cronenwett LR. Preventing Medication Errors. Institute of Medicine Report Brief. Jan. 2006. Web. 12 Sept. 2014.

6. Lau HS, Florax C, Porsius AJ, de Boer A. The completeness of medication histories in hospital medical records of patients admitted to general internal medicine wards. Br J Clin Pharmacol. 2000;49(6):597-603.

7. Cornish PL, Knowles SR, Marchesano R, Tam V, Shadowitz S, Juurlink DN, Etchells EE. Unintended medication discrepancies at the time of hospital admission. Arch Intern Med. 2005;165(4):424-429.

8. Pippins JR, Gandhi TK, Hamann C, Ndumele C, Labonville SA, Diedrichsen EK, Carty MG, Andrew S. Karson, Bhan I, Coley CM, Liang CL, Turchin A, McCarthy PC, Schnipper JL. Classifying and predicting errors of inpatient medication reconciliation. J Gen Intern Med. 2008;23(9):1414-1422. doi: 10.1007/s11606-008-0687-9

9. Hayes BD, Donovan JL, Smith BS, Hartman CA. Pharmacist-conducted medication reconciliation in an emergency department. Am J Health Syst Pharm. 2007;64(16):1720-1723.

10. Lu Y, Clifford P, Bjorneby A, Thompson B, VanNorman S, Won K, Larsen K. Quality improvement through implementation of discharge order reconciliation. Am J Health Syst Pharm. 2013;70(9):815-820. doi: 10.2146/ajhp120050

11. Buckley MS, Harinstein LM, Clark KB, Smithburger PL, Eckhardt DJ, Alexander E, Devabhakthuni S, Westley CA, David B, Kane-Gill SL. Impact of clinical pharmacy admission medication reconciliation program on medication errors in "high-risk" patients. Ann Pharmacother. 2013;47(12):1599-1610. doi: 10.1177/1060028013507428

12. Lee KP, Hartridge C, Corbett K, Vittinghoff E, Auerbach AD. "Whose job is it, really?" physicians', nurses', and pharmacist' perspectives on completing inpatient medication reconciliation. J Hosp Med. 2015;10(3):184-186. doi: 10.1002/jhm.2289

13. Nester TM, Hale LS. Effectiveness of a pharmacist-acquired medication history in promoting patient safety. Am J Health Syst Pharm. 2002;59(22):2221-2225.

14. Lancaster JW, Grgurich PE. Impact of student pharmacist on the medication reconciliation process in high –risk hospitalized general medicine patients. Am J Pharm Educ. 2014;78(2):34. doi: 10.5688/ajpe78234

15. Mergenhagen KA, Blum SS, Kugler A, Livote EE, Nebeker JR, Ott MC, Signor D, Sung S, Yeh J, Boockvar KS. Pharmacist- versus physician-initiated admission medication reconciliation: impact on adverse drug events. Am J Geriatr Pharmacother. 2012;10(4):242-250. doi: 10.1016/j.amjopharm.2012.06.001

16. Murphy EM, Oxencis CJ, Klauck JA, Meyer DA, Zimmerman JM. Medication reconciliation at an academic medical center: Implementation of a comprehensive program from admission to discharge. Am J Health Syst Pharm. 2009;66(23):2126-2131. doi: 10.2146/ajhp080552

17. CAHPS Hospital Survey. Background and About Survey. http://www.hcahpsonline.org/home.aspx (accessed 2015 Jan 27).

18. Lubowski TJ, Cronin LM, Pavelka RW, Briscoe-Dwyer LA, Briceland LL, Hamilton RA. Effectiveness of a medication reconciliation project conducted by PharmD students. Am J Pharm Educ. 2007;71(5):94.

19. Smith SB, Mango MD. Pharmacy-based medication reconciliation program utilizing pharmacists and technicians: a process improvement initiative. Hosp Pharm. 2013;48(2):112-9. doi: 10.1310/hpj4802-112.test

20. George LJW, Senturk-Raif R, Hodgkinson MR, Emmerton M, Larmour I. Impact of a surgical preadmission clinic pharmacist on the quality of medication management from preadmission to discharge: a randomized controlled study. J Pharm Pract Res. 2011;41(3): 212-216.