

Bachelor-Thesis

Improving electronic medication reconciliation

University of Heidelberg, Heilbronn University and Harvard Medical School
Bachelor thesis in Medical Informatics



Presented by:	Esen Filiz
Born:	21.10.1986
Advisor:	Prof. Dr. Thomas Wetter
Subject:	Medical Informatics (MIB)
Second Advisor:	Shobha Phansalkar, RPh, PhD

To Serkan Filiz, my brother

-

**Ergün and Vildan Filiz, my parents, who supported me in every
condition of life!**

Thank you for everything!

Abstract

Medication reconciliation is defined by the American Society of Health- System Pharmacists (ASHP) and the American Pharmacists Association (AphA) as “the comprehensive evaluation of a patient’s medication regimen any time there is a change in therapy in an effort to avoid medication errors such as omissions, duplications, dosing errors or drug interactions, as well as to observe compliance and adherence patterns”.

Medication reconciliation is very important to avoid medication errors but it is also a complex and time-consuming process. Medication histories, i.e. records of prescription, purchase, and refill sequences are considered to be a resource from which conclusions about medication reconciliation can be drawn. However, medication histories spread across diverse paper and electronic media may lack the required accuracy. By employing multiple electronic sources this thesis will evaluate if more accurate medication histories can be collected.

To find out how the process of obtaining accurate and complete medication histories can be less time consuming, different medication history sources were analyzed.

The aim was to determine discrepancies between these medication history sources, what the reasons are and to find a way to avoid them. Furthermore identifying the unintentional medication discrepancies and prevent potential harm.

Therefore two different scenarios were implemented for four different medication history sources. First, patient-interview data, EMR and discharge records and the Blue Cross Blue Shield insurance claims data were compared and the second scenario compared patient-interview data, EMR and discharge records with the Tufts-Healthplan database.

It turned out that the most discrepancies are system-generated errors and also and the majority of them ensued from discontinued or expired medications that had been pursued on the medication list.

In the first scenario there were in total 1251 records and 570 discrepancies regarding these medication records for 14 individual patients. In the second case there were 660 medication records including 267 discrepancies in total for nine individual patients.

Contents

Abstract	III
Contents	I
Glossary	II
List of Figures	III
List of Tables	IV
1. Introduction	1
2. Methods	3
2.1. Background	4
2.1.1. Partners Medication Reconciliation (PMR) Study	4
2.1.2. Electronic Medication Reconciliation at Partners Healthcare	5
2.1.3. Medication data from insurance claims	6
2.2. Databases	7
2.2.1. Gold Standard Medication History Database	7
2.2.2. Pre- Admission Medication List Database	7
2.2.3. Blue Cross Blue Shield Database	8
2.2.4. Tufts Health Plan Database	8
2.3. Analysis	9
3. Results and Findings	15
3.1. Results regarding BCBS, PAML and GOLD STANDARD	16
Medication History Sources	16
3.1.1. Results regarding BCBS, PAML and GOLD STANDARD Medication History Sources	20
3.2. Results regarding TUFTS, PAML and GOLD STANDARD	21
Medication History Sources	21
3.2.1. Results regarding TUFTS, PAML and GOLD STANDARD Medication History Sources	25
3.3. Reasons for the discrepancies	25
4. Discussion	26
5. Appendix	29
6. References	34

Glossary

ADE Adverse Drug Events

AphA American Pharmacists Association

ASHP American Society of Health- System Pharmacists

BCBS Blue Cross Blue Shield

BWH Brigham and Women's Hospital

CPOE Computer Provider Order Entry

DRF Dose, Route, Frequency

EMR Electronic Medication Record

HX History

LMR Longitudinal Medication Record

MA-SHARE Massachusetts SHARE (Simplifying Healthcare among Regional Entities)

MGH Massachusetts General Hospital

MI Missing Information

ONC Office of the National Coordinator

PADE potential for adverse drug events

PAML-Builder Pre-Admission Medication List

PBM Pharmacy Benefit Managers

PMR Study Partners Medication Reconciliation Study

RHIO regional healthcare information

List of Figures

Figure 1: Extract Gold standard medication history database	7
Figure 2: Extract PAML- database.....	7
Figure 3: Extract Blue Cross Blue Shield database	8
Figure 4: Extract Tufts Health Plan database	8
Figure 5: Example	9

List of Tables

Table 1: Individual Patients in Databases.....	15
Table 2: Patients in at least 2 sources.....	16
Table 3: Extracting medname +DRF from BCBS, PAML, GOLD STANDARD	16
Table 4: Discrepancies of records only in one medication history source	17
Table 5: Discrepancies of records only in two medication history sources	18
Table 6: Discrepancies in all three sources BCBS, PAML, GOLD STANDARD	19
Table 7: Patients in at least 2 sources.....	21
Table 8: Extracting medname + DRF from TUFTS, PAML, GOLD STANDARD	21
Table 9: Discrepancies of records only in one medication history source	22
Table 10: Discrepancies of records only in two medication history sources	23
Table 11: Discrepancies in all three sources TUFTS, PAML, GOLD STANDARD ..	24

1. Introduction

Medication reconciliation is a national patient safety goal, but its effects on important patient outcomes require further evaluation. The Joint Commission on Accreditation of Healthcare Organizations has defined the medication reconciliation as a “national patient safety” because medication discrepancies are a contributor to adverse drug events (ADEs) [Pippins JR, MD et al, 2008] and have the potential to cause harm. Discrepancies may have clinically significant consequences, especially in the elderly population. [Sturbaut S, et al., 2010]. This shows that medication reconciliation is the fundament of the healthcare but no method has been recommended yet. To improve the quality and safety in healthcare unintentional medication discrepancies, which are specified as differences between medication history sources should be considered.

More than a quarter of the prescribing errors in hospitals at the time of admission are ascribable to incomplete medication histories. The most common medication reconciliation errors are attributable to omitted medications and doses [Warholak TL et al., 2009]. Previous studies evaluating medication reconciliation have shown that discrepancies are common, since up to 67% of inpatients have at least 1 unexplained discrepancy in their prescription medication history at admission [Schnipper JL et al., 2009].

Clinical pharmacists are convenient to acquire medication histories for patients and also to identify discrepancies and problems regarding medications. This should bring down adverse drug events but this process poses a large burden on pharmacist resources and leads to question if the involvement of pharmacists in this process is recommended. Enabling them to take a more complete and accurate medication history should give pharmacists more possibilities in direct patient care. Patient safety and pharmacy practice could be improved by enhancing electronic medication reconciliation. With the aid of revised electronic medication reconciliation it should be easier to collect a more accurate medication history. Earlier studies have shown that information technology is helpful in the process of taking medication histories by providing access to integrated networks of retail pharmacies, pharmacy benefit managers (PBMs) and health plans. All healthcare organizations want to relieve the burden of medication reconciliation while being able to meet the requirements of the Office of the National Coordinator (ONC) which were published in the Meaningful Use Criteria and which claim medication reconciliation “at relevant encounters and transitions of care”.

This thesis is going to compare three different medication history sources and find out discrepancies between these sources and try to define reasons for the discrepancies. Previous studies have already compared medication history sources but none of them compared three sources, for example the recent study by Warholak, et al. compared medication histories which were acquired through patient interviews upon hospital admission with the medication history source obtained from health plan claims data. It resulted in more information in the claims database than in the patient interview database. Orrico, et al. also had a study comparing and categorizing medication discrepancies between the medications recorded in the electronic medical record (EMR) with medication history database obtained through patient interviews at admission. The most discrepancies in this case were listed in the EMR and those discrepancies resulted from medications that were still listed in the EMR although they were no longer taken by the patient.

In this thesis I will quantify and categorize the medication discrepancies that exist between medications that are listed in the ambulatory EMR and discharge records versus those obtained from two insurance claims databases versus those acquired from patient-interview.

This is a retrospective study comparing these three mechanisms which serve medication history information about a patient at the time of admission. The patient-interview data which was available was collected by trained pharmacists using extensive medication reconciliation procedures. Medications from the EMR and discharge records were available from a fully electronic medication reconciliation tool, called the Pre-Admission Medication List (PAML) Builder. The insurance claims databases were provided by the TUFTS Healthplan and Blue Cross Blue Shield insurance claims.

2. Methods

In order to determine the discrepancies between medication history sources regarding dose, route and frequency and to find out if utilizing electronic data sources can enhance the process of taking medication histories, three different mechanisms of obtaining medication history information for a patient upon admission were used.

In the following these 3 mechanisms, a gold standard medication history, medication histories from a fully electronic medication reconciliation tool and the external data from pharmacy claims, are going to be elucidated.

Efforts to improve the quality and safety of health care include attention to unintentional medication discrepancies because medication discrepancies are an important contributor to adverse drug events (ADEs) [Pippins JR, MD et al, 2008].

This chapter will explain how the sources were appointed to fulfill the aim of improving medication reconciliation.

2.1. Background

2.1.1. Partners Medication Reconciliation (PMR) Study

In a previous study a gold standard medication history was collected by trained pharmacists, which used medication reconciliation methods.

In this study called Partners Medication Reconciliation (PMR) Study, trained clinical pharmacists collected gold standard medication histories of patients by using all available sources of medication information: patient, family, pill bottles and/or medication lists from home, the outpatient medical record, previous discharge summaries, the primary care provider or other doctor's office, and the community pharmacy.

It was a cluster-randomized controlled trial, on medical inpatients at 2 academic hospitals, Brigham and Women's Hospital (BWH) and Massachusetts General Hospital (MGH) from May to June 2006 in Boston, Massachusetts. The PMR study attempted to measure the impact of an information technology-based medication reconciliation intervention on medication discrepancies with potential for adverse drug events (PADEs) [Schnipper JL et al., 2009].

Therefore 322 patients were admitted to 14 medical teams, involving physicians, nurses, and pharmacists and a computerized tool supporting medication reconciliation.

The medication history of those patients, who were general medical patients, was taken before discharge.

The gold standard medication history taken by study pharmacists was compared with medication histories of medical teams, admission and discharge orders.

The main outcome of this study was the amount of unintentional discrepancies between preadmission medication and admission or discharge medications which had potential for harm (PADEs) [Schnipper JL et al., 2009].

This study provided the gold standard medication history which was used for patient selection to compare the discrepancies.

2.1.2. Electronic Medication Reconciliation at Partners Healthcare

At Partners Healthcare there is a fully electronic, inpatient medication reconciliation tool, which is called the Pre-Admission Medication List (PAML) Builder. It is an application with access to outpatient Electronic Medication Records (EMR) and discharge records.

It is a web-based application that promotes the creation of a preadmission medication list from several electronic sources and it is responsible for extracting a patient's medication data from inpatient and outpatient medication sources.

Those medication sources are including Longitudinal Medication Records (LMR), ambulatory EMR and medication discharge information from the computer provider order entry (CPOE) at the 2 academic medication centers from Partners, the Brigham and Women's Hospital (BWH) and the Massachusetts General Hospital (MGH).

The PAML Builder documents a planned action on admission for each PAML medication and facilitates review of a completed PAML and admission medication. It also facilitates the reconciliation of the PAML with current inpatient medication when discharge orders are written.

As the medication reconciliation takes place at time of admission the PAML-BUILDER collects 18 months of data prior to the date of admission.

Each PAML corresponds to an individual admission event and contains information regarding patient demographics, medication brandname, generic name, therapeutic class, dose, route, frequency, dosage for, medication instructions etc.

In order to complete medication reconciliation at the time of admission and accommodate the PAML with admission orders, users are required to enter a planned action on admission for each medication record on the PAML [Turchin A et al., 2008]

In this thesis the PAML was used in order to compare medications from EMR and discharge records.

2.1.3. Medication data from insurance claims

The external data used in this thesis was the pharmacy claims information.

To get access to pharmacy claims data from two of the largest health plans in Massachusetts: Blue Cross Blue Shields and Tufts Health Plan the SureScripts integrated network was used. Partners Healthcare uses a regional healthcare information (RHIO) called MA-SHARE [Massachusetts SHARE (Simplifying Healthcare Among Regional Entities)] for inter-organizational exchange of healthcare data. MA-SHARE sends a patient query to SureScripts which extracts claims data for Blue Cross Blue Shields (BCBS) and Tufts Health Plan. The data used in this thesis for pharmacy claims data was received from MA-SHARE through pre-established secure electronic prescribing connectivity on the research sever of Partners Healthcare.

Data for the patients from the PMR Study who were enrolled in these health plans during the dates of October 15, 2007 through Feb 15, 2008 were used.

Providing access to integrated networks of retail pharmacies, pharmacy benefit managers (PBMs) and health planes can ease the process of taking medication histories. This also offers an additional source of medication history information to improve the process of medication reconciliation and was used as the third medication history source.

2.2. Databases

To be able to compare the different medication history sources they were provided as individual databases. Altogether I was allocated four databases.

2.2.1. Gold Standard Medication History Database

In total there are 1790 records in this database. The following table is just showing a small extract out of this database.

medhistorycaseid	medname	DRF	PRN	OTC	...
1034	protonix	40 mg BID	FALSE	FALSE	...
1034	Folic acid	1 mg PO QD	FALSE	FALSE	...

Figure 1: Extract Gold standard medication history database

Figure 1 is an extract out of the gold standard medication history database and there are in total 44 attributes in this database but in the final spreadsheet which was used to find out the discrepancies only three attributes were needed, the medicationHistoryCaseID, medication name and DRF (dose, route, frequency). Comparisons showed that there are 178 individual patients in the gold standard medication history database.

2.2.2. Pre- Admission Medication List Database

recordid	MedHistoryCaseID	PAML	MRecSource	factaudit	Seq	dose	doseunits	...
5630248	1001	1158776	Discharge	F	4	20	MG	...
5630245	1001	1158776	Discharge	F	1	325	MG	...
5630246	1001	1158776	Discharge	F	2	75	MG	...
5630247	1001	1158776	Discharge	F	3	100	MG	...

Figure 2: Extract PAML- database

The amount of all records in PAML-Builder database seen in Figure 2 is 530086 and much more than in the other databases. Out of 58 different attributes only seven were used to find out differences the medicationHistoryCaseID, medication

name, generic name, dose, dose units, route and frequency. 17074 individual patients are included in this database.

2.2.3. Blue Cross Blue Shield Database

medhistorycaseid	CLIENT_NAME	DIV	BPL	GRP	CONTRACT_NO	DRUG_NAME	...
328724	BCBS OF MASSACHUSETTS	MDX	50126	3108	8419391	LEVOXYL 75 MCG TABLET	...
328724	BCBS OF MASSACHUSETTS	MDX	50126	3108	8419391	LEVOXYL 75 MCG TABLET	...
...

Figure 3: Extract Blue Cross Blue Shield database

With 155778 records, the Blue Cross Blue Shield database from which an extract can be seen in Figure 3 was the second biggest database. The Blue Cross Blue Shield database includes 36 attributes and during the analysis five of them were needed. In this case the medicationHistoryCaseID was used again and the drug name. 155778 records included 1967 individual patients.

2.2.4. Tufts Health Plan Database

Medhistorycaseid	Date_of_Fill	Drug_name	Drug_strength	DoseFormAbbreviation	...
187550	07-Mai-10	DESMOPRESSIN ACETATE	0.2MG	TAB	...
187550	07-Mai-10	HYDROCORTISONE	5MG	TAB	...
...

Figure 4: Extract Tufts Health Plan database

The tufts health plan database seen in figure 4 has 43371 total medication records and 15 different attributes. Six out of 15 attributes were listed in the final spreadsheet which was used to compare the databases regarding discrepancies. MedicationHistoryCaseID, drug name, drug strength, dose form abbreviation quantity and days' supply were the attributes, which were used to determine the differences.

As for the insurance claims databases, bcbs and tufts health plan, which do not contain information about the frequency, the frequency had to be inferred by dividing the “Quantity Dispensed” by “Days’ Supply.”

For example in this case shown below in Figure 5:

Quantity_ TUFTS	DaysSuppl y_TUFTS	Frequency _TUFTS
20	5	4

Figure 5: Example

In a medication record 20 tablets were dispensed for a period of five days, this means that the frequency is four times a day.

2.3. Analysis

In this section the methods used to find out the discrepancies are explained.

First of all the mentioned databases were analyzed for which information they included and which could be expedient for the determination of discrepancies.

Among those databases there were many differences regarding the information, so the most useful contents out of the databases were aggregated to queries which were made to spreadsheets.

Whereas, two different medication history sources from insurance claims were provided, the Blue Cross Blue Shield Database and the Tufts Health Plan Database, two spreadsheets were needed.

The first spreadsheet contained information from three databases, gold standard medication history database, pre-admission medication list database and blue cross blue shield database. In the second spreadsheet there was information from gold standard medication history database, pre-admission medication list database and from the health plan database.

To obtain the most useful contents out of the databases I joined the medication history case ID’s with SQL commands in Microsoft Access. To get to know MS Access I had to participate in a MS Access web-based Training called “Get to know MS- Access Training”.

SQL Command for the first spreadsheet as follows:

Query for extracting the med name and DRF from BCBS:

```
SELECT DISTINCT dbo_medhistorybcbs.medhistorycaseId,
dbo_medhistorybcbs.DRUG_NAME, dbo_medhistorybcbs.STRENGTH,
dbo_medhistorybcbs.QTY, dbo_medhistorybcbs.DAYS_SUPPLY

FROM (dbo_medhistorybcbs INNER JOIN dbo_medhistorypamlmeds ON
dbo_medhistorybcbs.medhistorycaseId =
dbo_medhistorypamlmeds.MedHistoryCaseID) INNER JOIN
dbo_medhistoryschnippermedications ON
dbo_medhistorypamlmeds.MedHistoryCaseID =
dbo_medhistoryschnippermedications.medhistorycaseid

WHERE (((dbo_medhistorybcbs.medhistorycaseId) In
(514349,399212,285527,87329,377564,42812,295031,51491,487817,190223,548
273,545963,292325,140294)));
```

Query for extracting the med name and DRF from PAML:

```
SELECT DISTINCT dbo_medhistorypamlmeds.MedHistoryCaseID,
dbo_medhistorypamlmeds.medname, dbo_medhistorypamlmeds.genericname,
dbo_medhistorypamlmeds.dose, dbo_medhistorypamlmeds.doseunits,
dbo_medhistorypamlmeds.route, dbo_medhistorypamlmeds.frequencynemonic

FROM (dbo_medhistorybcbs INNER JOIN dbo_medhistorypamlmeds ON
dbo_medhistorybcbs.medhistorycaseId =
dbo_medhistorypamlmeds.MedHistoryCaseID) INNER JOIN
dbo_medhistoryschnippermedications ON
dbo_medhistorypamlmeds.MedHistoryCaseID =
dbo_medhistoryschnippermedications.medhistorycaseid

WHERE (((dbo_medhistorypamlmeds.MedHistoryCaseID) In
(514349,399212,285527,87329,377564,42812,295031,51491,487817,190223,548
273,545963,292325,140294)));
```

Query for extracting the med name and DRF from Gold Standard Medication**History:**

```
SELECT DISTINCT dbo_medhistoryschnippermedications.medhistorycaseid,  
dbo_medhistoryschnippermedications.medname,  
dbo_medhistoryschnippermedications.DRF,  
dbo_medhistoryschnippermedications.PRN,  
dbo_medhistoryschnippermedications.OTC  
  
FROM (dbo_medhistorybcbs INNER JOIN dbo_medhistorypamlmeds ON  
dbo_medhistorybcbs.medhistorycaseid =  
dbo_medhistorypamlmeds.MedHistoryCaseID) INNER JOIN  
dbo_medhistoryschnippermedications ON  
dbo_medhistorypamlmeds.MedHistoryCaseID =  
dbo_medhistoryschnippermedications.medhistorycaseid  
  
WHERE (((dbo_medhistoryschnippermedications.medhistorycaseid) In  
(514349,399212,285527,87329,377564,42812,295031,51491,487817,190223,548  
273,545963,292325,140294)));
```

Second spreadsheet:**Query for extracting the med name and DRF from TUFTS:**

```

SELECT DISTINCT dbo_medhistorytufts.Medhistorycaseid,
dbo_medhistorytufts.Drug_name, dbo_medhistorytufts.Drug_strength,
dbo_medhistorytufts.DoseFormAbbreviation, dbo_medhistorytufts.Quantity,
dbo_medhistorytufts.DaysSupply

FROM (dbo_medhistorytufts INNER JOIN dbo_medhistorypamlmeds ON
dbo_medhistorytufts.Medhistorycaseid =
dbo_medhistorypamlmeds.MedHistoryCaseID) INNER JOIN
dbo_medhistoryschnippermedications ON
dbo_medhistorypamlmeds.MedHistoryCaseID =
dbo_medhistoryschnippermedications.medhistorycaseid

WHERE (((dbo_medhistorytufts.Medhistorycaseid) In (194249, 118019, 99539,
350207, 256058, 381623, 460988, 193721, 220088)));

```

Query for extracting the med name and DRF from PAML (tufts):

```

SELECT DISTINCT dbo_medhistorypamlmeds.MedHistoryCaseID,
dbo_medhistorypamlmeds.medname, dbo_medhistorypamlmeds.genericname,
dbo_medhistorypamlmeds.dose, dbo_medhistorypamlmeds.doseunits,
dbo_medhistorypamlmeds.route, dbo_medhistorypamlmeds.frequencynemonic

FROM (dbo_medhistorytufts INNER JOIN dbo_medhistorypamlmeds ON
dbo_medhistorytufts.Medhistorycaseid =
dbo_medhistorypamlmeds.MedHistoryCaseID) INNER JOIN
dbo_medhistoryschnippermedications ON
dbo_medhistorypamlmeds.MedHistoryCaseID =
dbo_medhistoryschnippermedications.medhistorycaseid

WHERE (((dbo_medhistorytufts.Medhistorycaseid) In
(194249,118019,99539,350207,256058,381623,460988,193721,220088)) AND
((dbo_medhistorypamlmeds.MedHistoryCaseID) In
(194249,118019,99539,350207,256058,381623,460988,193721,220088)));

```

Query for extracting the med name and DRF from Schnipper (tufts):

```
SELECT DISTINCT dbo_medhistoryschnippermedications.medhistorycaseid,  
dbo_medhistoryschnippermedications.DRF,  
dbo_medhistoryschnippermedications.PRN,  
dbo_medhistoryschnippermedications.OTC,  
dbo_medhistoryschnippermedications.medname  
  
FROM (dbo_medhistorytufts INNER JOIN dbo_medhistorypamlmeds ON  
dbo_medhistorytufts.Medhistorycaseid =  
dbo_medhistorypamlmeds.MedHistoryCaseID) INNER JOIN  
dbo_medhistoryschnippermedications ON  
dbo_medhistorypamlmeds.MedHistoryCaseID =  
dbo_medhistoryschnippermedications.medhistorycaseid  
  
WHERE (((dbo_medhistorytufts.Medhistorycaseid) In  
(194249,118019,99539,350207,256058,381623,460988,193721,220088)) AND  
((dbo_medhistorypamlmeds.MedHistoryCaseID) In  
(194249,118019,99539,350207,256058,381623,460988,193721,220088)) AND  
((dbo_medhistoryschnippermedications.medhistorycaseid) In  
(194249,118019,99539,350207,256058,381623,460988,193721,220088)));
```

Finally having the spreadsheets I started comparing them regarding any discrepancies in medication name, route, dose and frequency.

Out of the discrepancies new spreadsheets were made called medication in all three sources, medication in two sources and medication in only one source.

They were quantified and categorized regarding the number and type of medication discrepancies that exist between medications reconciled using the spreadsheets.

To make this process of obtaining discrepancies easier it was the best to mark the same medication records for the same medication history case IDs in the same color to see the discrepancies at first sight. Some of those color-coded spreadsheets can be seen in the Appendix below.

3. Results and Findings

In this chapter the results of this thesis are going to be explained. First the amount of individual patients in the databases is going to be listed for both scenarios, and then the results for both scenarios are going to be explained separately.

In 3.1 the results for the first scenario comparing PAML, Gold Standard medication list and BCBS is outlined starting with the amount of individual patients listed in at least two sources. Additionally the number of medication records for individual patients and then the discrepancies which occur in one source, in two sources or in all three sources are going to be shown.

In 3.2 the same process like in 3.1 is going to be run for PAML, Gold Standard medication list and Tufts Health Plan.

PAML	17074
Gold Standard Medication History	178
BCBS	1967
TUFTS	632
PAML + Gold Standard Medication History	178

Table 1: Individual Patients in Databases

During the process analyzing the databases the first thing which occurs is that there are differences in the amount of individual patients in every database. Like shown in Table 1, there are 17074 individual patients in the Pre-Admission Medication List Database whereas there are only 178 individual patients in the gold standard medication history database.

Comparing the amount of individual patients in the insurance claims databases it is conspicuous that there is such a huge difference, while Blue Cross Blue Shield contains 1967 individual patients Tufts Health Plan only contains 632 individual patients.

3.1. Results regarding BCBS, PAML and GOLD STANDARD

Medication History Sources

BCBS + PAML + GOLD STANDARD	14 patients who had med hx in all three sources
BCBS + PAML	1867 patients had med hx in 2 sources
BCBS + GOLD STANDARD	14 patients

Table 2: Patients in at least 2 sources

In the process of determination it turned out to 14 individual patients which were in all three medication history sources, BCBS, PAML and Gold Standard medication histories like seen in Table 2. The focus was on these 14 patients and their medication histories.

Extracting medication name, dose, route and frequency from those three sources resulted in the table below.

BCBS	704 medication records (14 patients)
PAML	414 records (14 patients)
GOLD STANDARD	133 records (14 patients)

Table 3: Extracting medname +DRF from BCBS,PAML GOLD STANDARD

Table 3 shows that there are already discrepancies in the amount of medication records because 704 medication records for 14 individual patients in BCBS is a huge difference to only 414 records in PAML or 133 medication records for the same patients in Gold Standard.

Medication records in only one medication history source:

369 records (each record indicates a medication record but may not indicate an individual medication) only in one source either in PAML, GOLD STANDARD or BCBS:

Med Hx Case ID	PAML	GOLD STANDARD	BCBS	SUM
42812	MI	1	12	13
51491	5	MI	33	38
87329	3	MI	2	5
140294	9	1	18	28
190223	18	1	9	28
285527	5	MI	27	32
292325	5	MI	13	18
295031	13	1	12	26
377564	6	1	20	27
399212	4	MI	8	12
487817	8	1	30	39
514349	6	MI	19	25
545963	14	MI	32	46
548273	16	8	8	32
SUM	112	14	243	∑ 369

Table 4: Discrepancies of records only in one medication history source

Table 4 indicates that there are in total 112 medication records which are only listed in the PAML database, 14 of them are only in the Gold Standard medication history database, 243 of medication records are only included in BCBS database for 14 individual patients.

Medication records in two sources:

Med Hx Case ID	total medications	Discrepancy dose	Discrepancy route	Discrepancy frequency
42812	7	1	1 MI	3
51491	8	2	4 MI	3
87329	1	-	1 MI	-
140294	9	3	5 MI	2
190223	4	1 MI, 1	3 MI	1 MI, 1
285527	6	1	3 MI	2
292325	6	1 MI, 2	1 MI	1
295031	10	1	7 MI	2
377564	8	2	3 MI	3
399212	7	1 MI, 1	2 MI	1 MI, 1
487817	22	2 MI, 5	6 MI, 1	9
514349	8	2 MI	5 MI	2
545963	14	1 MI, 2	9 MI	1 MI, 4
548273	19	1 MI, 1	5 MI	5
SUM	129	31	55	41

Table 5: Discrepancies of records only in two medication history sources

Within 14 individual patients, whose records are at least in two medication history sources, this means in PAML, GOLD STANDARD or BCBS, there are in total 129 medication records like seen Table 5. Each of these records indicates a medication record but doesn't have to be individual medications.

Also in this case there are a lot of discrepancies especially regarding the route, which ends up with 55 differences. Most of the discrepancies arise as missing information but this also means a difference to the other medication history sources.

In-Depth analysis of the spreadsheet it resulted in the table shown below:

Medication records in all three sources

Med Hx Case ID	total medications	Discrepancy dose	Discrepancy route	Discrepancy frequency
42812	6	2	6 MI	2
51491	1	-	1 MI	-
87329	3	-	3 MI	-
140294	7	1	4 MI	1
190223	3	1	-	-
285527	1	1	1 MI	-
292325	-	-	-	-
295031	5	-	5 MI	2
377564	4	1 MI, 3	2 MI	3
399212	3	-	3 MI	1
487817	6	3	5 MI	4
514349	5	3	4 MI	2
545963	7	1 MI	7 MI	2
548273	1	-	-	-
Sum	52	16	41	17

Table 6: Discrepancies in all three sources BCBS, PAML, GOLD STANDARD

Table 6 shows the individual patients based on their medication history case IDs, their total medications in all medication history sources and the amount of discrepancies regarding dose, route and frequency.

It is conspicuous that there is one patient with the medication history case ID 292325, who doesn't have any medications listed in his records, which is in all sources. As appears from the table, there are in total 52 medication records for 14 individual patients and in total 74 discrepancies regarding dose, route and frequency when aggregated. This means there are more discrepancies than medication records. Comparing the discrepancies you can see the most discrepancies are in the route, because there is much missing information (MI) about the route in the sources.

3.1.1. Results regarding BCBS, PAML and GOLD STANDARD Medication History Sources

All in all the results show that there are lots of discrepancies regarding dose, route and frequency and also regarding the medication name.

In-depth analysis there are 369 records which are only in one source, 129 records in two sources and only 52 records are in all three sources for 14 individual patients.

This means 369 plus 129 discrepancies regarding the medication record, because those medication records are only included in one or two sources.

The result tables show lots of missing information which also should be seen as discrepancies, because they could be indicators for adverse drug events.

The next step in the analysis was like already described in the methods section the discussion why there are so many discrepancies and what is the main reason for them? The answer to this question follows in the reasons section of this chapter

3.2. Results regarding TUFTS, PAML and GOLD STANDARD

Medication History Sources

TUFTS + PAML + GOLD STANDARD	9 (8+1) patients
TUFTS + PAML	632 patients
TUFTS + GOLD STANDARD	9 patients

Table 7: Patients in at least 2 sources

In this case like seen in Table 7 there are only 9 individual patients which are in all three sources, so the focus was on these 9 patients and their information about medication name, dose, route and frequency as follows:

TUFTS	271 records (9 patients)
PAML	290 records (9 patients)
GOLD STANDARD	99 records (9 patients)

Table 8: Extracting medname + DRF from TUFTS, PAML, GOLD STANDARD

Also Table 8 makes clear, that there are discrepancies in the medication records, because there are 290 medication records for 9 patients whereas there are only 99 records for the same 9 patients.

Medication records in only one medication history source:

179 records only in one source either in PAML, GOLD STANDARD or TUFTS:

Med Hx Case ID	PAML	GOLD STANDARD	TUFTS	SUM
99539	MI	MI	11	11
118019	18	3	18	39
193721	8	MI	5	13
194249	8	1	2	11
220088	2	1	11	14
256058	6	5	5	16
350207	25	2	21	48
381623	5	MI	7	12
460988	3	1	11	15
SUM	75	13	91	Σ 179

Table 9: Discrepancies of records only in one medication history source

Among nine individual patients in total 179 medication records are only available in one source, either in PAML, Gold Standard medication list or Tufts Health Plan. As one can see in Table 9 out of 179 medication records 75 are only in PAML, 13 only included in GOLD STANDARD medication list and 91 only included in TUFTS Health Plan.

Medication records in two sources PAML, GOLD STANDARD, TUFTS

Med Hx Case ID	total medications	Discrepancy dose	Discrepancy route	Discrepancy frequency
99539	-	-	-	-
118019	13	3	1 MI	4
193721	5	1 MI	4 MI	1 MI, 1
194249	2	1	-	1
220088	9	-	2 MI	2
256058	6	1 MI , 1	-	3
350207	14	1 MI, 2	8 MI, 1	1 MI, 4
381623	2	-	1 MI	-
460988	6	2	1 MI	2
SUM	57	12	18	19

Table 10: Discrepancies of records only in two medication history sources

Table 10 shows that altogether there are 57 medication records in at least two of the medication history sources, PAML, GOLD STANDARD and TUFTS for 9 individual patients.

Among 57 medication records, 12 discrepancies in dose, 18 in route and 19 regarding frequency, are existing.

In the table below all medication records, which are listed in all three sources PAML, GOLD STANDARD and TUFTS medication histories are shown:

Med Hx Case ID	total medications	Discrepancy dose	Discrepancy route	Discrepancy frequency
99539	-	-	-	-
118019	7	3	-	4
193721	5	-	3 MI	3
194249	2	2	1 MI	2
220088	8	2	2 MI	3
256058	6	1	1 MI	2
350207	-	-	-	-
381623	4	1 MI, 1	2 MI	1
460988	7	2	-	3
Sum	39	12	9	18

Table 11: Discrepancies in all three sources TUFTS, PAML, GOLD STANDARD

In two cases, there are no medication records for those two patients which are in all three sources. Like one can see in Table 11 in total there are 39 medication records for 9 individual patients. Among those 39 records, there are 12 discrepancies regarding the dose, 9 discrepancies regarding route and 18 regarding the frequency, which is in total 39 discrepancies. This is a huge amount of failures either it is a difference or a missing information.

3.2.1. Results regarding TUFTS, PAML and GOLD STANDARD Medication History Sources

In this case the results are also like in the section above which described the results regarding the spreadsheet including BCBS, PAML and GOLD STANDARD medication history sources. In total there are nine individual patients which were analyzed thoroughly. 179 medication records only in one source, 57 records only in two sources and just 39 records in all three sources indicate that there must be lots of discrepancies and missing information. The reasons for these differences are discussed in the section below.

3.3. Reasons for the discrepancies

Previous studies have shown that 60% -67% of medication histories contain at least 1 error and that an estimated 11%-59% of these errors are clinically important.

[Orrico KB et al., 2008]

The most discrepancies in these studies turned out to be system-generated errors and the majority of the system generated discrepancies ensued from discontinued or expired medications that had been pursued on the medication list.

“True inaccuracies, such as the entry into the EMR of an incorrect dose or frequency or the entry of a duplicate order entry, were rare.” [Orrico KB, 2008]

Another study by Warholak, et al. employed claims data in the acute care setting for medication reconciliation [Warholak TL, 2009]. This study compared medication information obtained from patient interview upon admission to the history obtained electronically through health plan claims. It has shown that the most common medication errors are referable to omitted medications and doses. In this thesis there were in the first case BCBS, PAML and Gold Standard medication history sources in total 1251 records and 570 discrepancies regarding these medication records. In the second case TUFTS, PAML and Gold Standard medication history sources there were 660 medication records including 267 discrepancies in total.

The most missing information in both cases are in the claims data which could be seen as a hint that those medication records are missing in the TUFTS Health Plan and Blue Cross Blue Shield databases are over the counter medications. Over the counter medications are medications which do not need any prescription from a health care professional, as compared to prescription drugs, which only are sold to consumers possessing a valid prescription. Prescribed drugs are always listed in the claims data, so this could be a reason why there are so many missing medication records in the claims data.

4. Discussion

In this study four different medication history sources were given to compare and identify discrepancies between those sources. The sources were the Gold Standard Medication History database, PAML-Builder database, Tufts Health Plan database and the Blue Cross Blue Shield database. To determine discrepancies the most useful contents out of the databases were aggregated to queries which were made to spreadsheets which were used to compare the databases regarding the information for common patients. Two scenarios were implemented so two spreadsheets with the most useful information out of the databases were available.

They included a medication history case ID, medication name, dose, route and frequency in the first case for 14 individual patients and in the second spreadsheet for 9 individual patients.

The results have shown that there are many discrepancies regarding the medication name, dose, route and frequency.

For example in the first scenario there were 14 individual patients which had in total 550 medication records and only 52 medication records were listed in all three sources, BCBS, PAML and Gold Standard, which means that only 9.45 % of the records have no discrepancies regarding the medication name. 369 of 550 records are listed in only in one source either in PAML, BCBS or Gold Standard and 129 in two sources which are in total 498 medication records which are not listed in all three sources and in this way they are discrepancies because they are missing and there is no information about a medication which is taken by a patient. 498 discrepancies are 90.5 % out of 550 medication records which is a big amount that could lead to adverse drug events.

The second scenario which was implemented it turned out to 275 total medication records in all three sources PAML, Gold Standard and Tufts Health Plan for nine individual patients. Only 14.18 % of these medications were listed in all three sources which mean that there were 39 medication records for nine patients without discrepancies regarding the name of the medication. About 86 % medication records are not listed in all sources and it shows that there are 236 discrepancies concerning medication name.

This shows that neither the PAML-Builder database nor the Gold Standard medication history database nor the insurance claims database present a complete list of medications.

While considering the results regarding dose, route and frequency in the first scenario the results were as follows:

There were 36 discrepancies regarding the dose and 11 missing information about the dose, so in total 47 discrepancies regarding dose considering PAML-Builder, Gold Standard Medication List and the BCBS database. There was one discrepancy regarding route and there were 96 missing information about the route, in total 97 discrepancies regarding route. 54 discrepancies regarding frequency and there were two missing information about the frequency, so there was in total 56 discrepancies regarding frequency.

The second scenario considering discrepancies in dose, route frequency resulted in 20 discrepancies regarding dose and 4 missing information, 24 in total. One difference and 26 missing information about route, 27 discrepancies regarding route and there were 35 discrepancies regarding frequency and 2 missing information about the frequency, which means there was in total 37 discrepancies regarding frequency.

It was very difficult to find a way in which it is possible to gather information about the discrepancies because there was no verified guidelines available which showed how to compare different medication history sources. So I had to find a way how to determine the existing discrepancies. Like described in the Materials section I used Microsoft Access to build queries and filter to most useful information. It was also helpful to work with color-coded spreadsheets. Another difficulty was to determine medications which were the same but were called differently. Therefore the solution was to look the medications up in some drug guides. Also described in the Materials section above the most medication discrepancies were attributable to system-generated factors.

The limitation in this thesis was not being able to find out if the entries into the databases were incorrect entries in dose, route or frequency but the results show that if the entry into the database was an entry of incorrect information or the entry of a duplicate order entry, they were rare. The results show that there was more missing information than discrepancies which is a hint that the entries into the databases were incorrect in fewer cases.

The studies from Warholak and Orrico in which two medication history sources were available to compare have shown that the majority of discrepancies were the result of discontinued medications that were still listed in the history sources long after the patient stopped taking those medications. These entries into the databases resulted in unintentional discrepancies, so you might suppose that also the entries which have been made into the PAML-Builder, Gold Standard Medication, Blue Cross Blue Shield and Tufts Health Plan databases were medication records which still lasted in the lists although the patient quit the therapy already.

Another limitation in this thesis was not having any information about the accuracy of patient-interviews so it was not possible to find out if the discrepancies which were in the gold standard medication list accurate. If they were inaccurate those discrepancies were patient-generated errors. The Institute for Healthcare Improvement recommends encouraging patients to play a major role in keeping their medication lists up to date as they visit diverse providers in the outpatient setting. [Orrico KB et al., 2008]

All in all the focus of this thesis was to analyze the medication history sources: gold standard medication history, PAML and insurance claims data. They were compared by using aggregated medication lists which included the most needed information about the medication name, dose, route and frequency to identify discrepancies and categorize them. All this work was done to use those information about existing discrepancies to understand the pharmacists perspective in taking medication history. The results of this thesis are going to be used in a study with the aim to improve pharmacist-led electronic medication reconciliation.

5. Appendix

To make the process of obtaining discrepancies easier it was the best to mark the same medication records for the same medication history case IDs in the same color to see the discrepancies at first sight. On the following pages one of these color-coded spreadsheets can be seen as an example.

PAML_doseunits	PAML_route	PAML_freq	Schnipper_medihtorycaseid	Schnipper_medname	DRF_SCHNIPPER	medihtorycaseid_bobs	DRUG_NAME_bobs	STRENGTH_bobs	QTY_bobs	DAYS_SUPPLY_bobs	frequency_bobs
MG	PO	QD	42812			42812	ACETAMINOPHEN-COD #3 TABLET	300MG-30MG	45	11	4,03
MG	PO	QD	42812		50mg PRN TID	42812	ADVAIR 250-50 DISKUS	250-50MCG	60	30	2
MG	PO	BID	42812		daily	42812	AMLODIPINE BESYLATE 10 MG TAB	10 MG	30	30	1
MG	PO	QD	42812		top BID	42812	AMLODIPINE BESYLATE 5 MG TAB	5 MG	30	30	1
MG	PO	QPM	42812	Atenolol	100mg qam 50mg qpm	42812	ATENOLOL 100 MG TABLET	100 MG	45	30	1,5
MG	PO	QD	42812	Euproption SR	150mg BID	42812	ATENOLOL 100 MG TABLET	100 MG	60	30	2
MG	PO	TID	42812	Chlorthalidon	30mg daily	42812	ATENOLOL 100 MG TABLET	100 MG	90	45	2
MG	PO	QD	42812	Doxazosin	1mg qts	42812	AVAPRO 150MG TABLET	150 MG	30	30	1
MG	PO	QD	42812	Hydrochlorothiazide	25mg qday	42812	AVAPRO 300 MG TABLET	300 MG	30	30	1

6. References

Schnipper JL, Hamann C, Ndumele CD, et al. Effect of an electronic medication reconciliation application and process redesign on potential adverse drug events: a cluster-randomized trial. *Arch Intern Med* 2009 Apr 27;169(8):771-80.

Pippins JR, MD, Tejal K. Gandhi, MD, MPH, et al. Classifying and Predicting Errors of Inpatient Medication Reconciliation. *J Gen Intern Med*. 2008 September; 23(9): 1414–1422.

Orrico KB. Sources and types of discrepancies between electronic medical records and actual outpatient medication use. *J Manag Care Pharm* 2008 Sep;14(7):626-31.

Warholak TL, McCulloch M, Baumgart A, et al. An exploratory comparison of medication lists at hospital admission with administrative database records. *J Manag Care Pharm* 2009 Nov-Dec;15(9):751-8.

Turchin A, MD, MS et al., Evaluation of an Inpatient Computerized Medication Reconciliation System *J Am Med Inform Assoc*. 2008 Jul–Aug; 15(4): 449–452. Doi: 10.1197/jamia.M2561.

Steurbaut S, Leemans L, Leysen T, et al., Medication history reconciliation by clinical pharmacists in elderly inpatients admitted from home or a nursing home. *Ann Pharmacother*. 2010 Oct; 44(10):1596-603. Epub 2010 Aug 24.

Get to know MS- Access Training: <http://office.microsoft.com/en-us/training/get-to-know-access-RZ006118141.aspx>