Implementation of Extemporaneous Preparation Using Bar Coding Technology

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ABSTRACT

Extemporaneous Preparation (Drug Compounding) - the creation of a drug product by mixing ingredients - is an important part of ensuring that medications are available to meet individual patient needs, the quality and extent of drug compounding have surfaced as important issues in recent years. For example, several compounding cases in the last several years have resulted in critical diseases and deaths, raising concern about observation to ensure the safety of compounded drugs.

This paper lays the groundwork for the development of Extemporaneous Preparation system. This system facilitates compounding process in systemic approach in the pharmacy of king Faisal Specialist Hospital and Research Centre -non profit tertiary care hospital- to prevent manual errors and improve patient safety and quality by using bar coding technology.

Indexing terms/Keywords

Extemporaneous Preparation, Drug Compounding.

Academic Discipline and Sub-Disciplines

Computer science; software engineering.

SUBJECT CLASSIFICATION

Information systems

TYPE (METHOD/APPROACH)

Software implementation.

BACKGROUND

Medication errors are popular in hospitals, and dispensing errors made in the pharmacy engaged extremely to these errors. Overall, dispensing error rates are relatively low, but because of the high volume of medications dispensed, more than 100 undetected dispensing errors may occur in a busy hospital pharmacy every day [1]. Because only about one-third of these dispensing errors are intercepted by nurses before medication administration [2], many errors reach hospitalized patients, especially during preparation, mixing and labeling of medication before dispensing.

In details: **Extemporaneous Preparation** - a small scale pharmaceutical compounding as it related to pharmaceutics - includes preparation, mixing, packaging and labeling of certain medicines for internal or external use for human being in response to prescription that written by health care practitioner. For example, some of oral drugs are formulated for adults and presented as solid dosage forms or as liquids of unsuitable concentration for certain conditions or for children. Pharmacist prepared these formula by checking out references and doing calculation manually, which is usually consuming time and cannot role out of human errors. Therefore; dispensing errors are a significant target for patient safety intrusions.

It is worth to be mentioned; barcode technology became a committed strategy to prevent medication errors. Barcode technology has been widely adopted in healthcare fields, because of it's a quick, easy to use and high reliability. In case to increase the accuracy of pharmacy dispensing, if all medications in pharmacy had a barcode that is scanned to ensure that right medication in its right dosage and formulation is being dispensed, dispensing errors will be ultimately reduced. On the basis of the theoretical benefits for patient safety, the U.S. Food and Drug Administration (FDA) has mandated barcodes for all medications used in hospitals by April 2006 [5]. Many hospitals adopted this technology to increase the accuracy of the dispensing and administration processes.

LITERATURE REVIEW

There are many studies have emphasized the effect of barcode technology on medication dispensing errors.

Eric G et al. preformed direct observation - pre and post study - to evaluate whether implementation of barcode technology reduced dispensing errors. They performed their study over a twenty-month period in a 735-bed tertiary care academic medical center, where around 5.9 million dosages of medications were dispensed per year from inpatient pharmacy. They applied a bar coding dispensing system in 3 areas. In 2 areas, all dosages were scanned once through the dispensing process. In the third area, only one dosage was scanned if several dosages of the same medication were being dispensed. Of the three areas of bar code technology studied, the authors observed that the two areas that required staff to scan all dosages had a 93% to 96% relative reduction in the incidence of target dispensing errors. However, the area

that did not require scanning of every dosage had only a 60% relative reduction in the incidence of target dispensing errors. [3]

Michael et al. performed a cross-sectional survey of pharmacy directors at Canada's 100 largest acute-care hospitals; to determine the uptake of technologies designed to improve medication safety, plans for endorsing technologies, attitudes towards technology use, and perceptions of medication error.

They found that 78% of surveyed hospitals responded. Responding hospitals averaged 499 beds and 29% were teaching facilities. Hospitals infrequently used bar coding (9% of hospitals) and computerized physician order entry (9%). A majority of respondents and hospitals favored expanded use of new technologies and planned for increased uptake. Respondents chose as their hospital's next investment: automated dispensing (33%), bar coding (25%) and computerized physician order entry (12%).[4]

PROBLEM DEFINITION

While drug compounding is an important and useful for patient care, problems that have occurred during preparation raise concerns about the quality and safety of compounded drugs. Therefore; there is a need to implement Extemporaneous Preparation system that automates compounding manual process.

OBJECTIVES

To develop a system that will be able to organize compounding process in a systemic approach in terms of preventing human errors during the compounding preparation, avoiding time wasting for both pharmacist and patient and ensuring that the right medications were being dispensed by using **bar-coding** technology.

METHODS

- Using direct observation of compounding workflow - as defined below - at Pharmacy of King Faisal Specialist Hospital and Research Centre.
- Reviewing formula registration form.
- Collecting information by Interviewing with outpatient pharmacy manager

WORK FLOW

When prescription of formula was presented to pharmacist or pharmacy technician, it follows several steps as following:

1. Pharmacist\technician check out available references to review how the formula can be prepared.
2. Calculating formula depends on the quantity needed
3. Preparing the quantity needed by adding specific ingredients which checked again by another pharmacist\technician
4. Documenting the prepared formula in a special form which signed by the one who prepared it and checked by another one
5. Checking formula stability and calculating expiry date (considering near expiry date of ingredients)
6. Filling the prepared compounding in a jar\bottle
7. Printing label that contains formula's information (lot number, name, expiry date, storage method, instructions.)
8. Adhesive the label on the jar.

SCENARIO

S.A is four years old, girl, diagnosed with hypertension two years ago and she was on Captopril 2.5 mg oral twice daily ,but still her blood pressure uncontrolled. Her\ his doctor decided to increase dose to 5 mg twice daily. According to that, Her\ his doctor prescribed for her Captopril 5 mg twice daily, for three months.

Her mother took the prescription and went to the pharmacy to take her daughter's drug.

At the Pharmacy, Pharmacist\ technician received prescription, checked the dose, after that, he/she start to prepare the drug.

The stock of Captopril available in the pharmacy is 25 mg and 50 mg tablet while the dose in the prescription is 5mg. The patient is a baby who cannot swallow tablet, so pharmacist\technician must follow compounding references to prepare Captopril syrup to dispense the required dose.

By Checking out preparation he/she found that; Captopril syrup final concentration is 1mg/ml ; prepared by 4 tablets of Captopril 25 mg which are dissolve in 50 ml of water , add 1tablet of ascorbic acid 500mg, then complete volume to 100 ml of water. Stability of preparation is 30days, that must be kept in refrigerator and shake before take it.

The patient needs 900 mg (900 ml) for three months, but the preparation stability is only 30 days, so pharmacist\technician will do the calculation to prepare one month only and give refill card for the other two months.

I S S N   2 2 7 7 - 3 0 6 1
V o l u m e   1 6   N u m b e r   4
I n t e r n a t i o n a l   J o u r n a l   o f   C o m p u t e r s   &   T e c h n o l o g y

SYSTEM SCOPE

The main features of Extemporaneous Preparation project include the   following:

1. Keeps tracking of formulas, where each formula will affix with a barcode of Type EAN-13.It will use picture17 - screenshot - as shown in Appendix A

2. Recalls medications form existing legacy system, which will use picture 18 - screenshot - as shown in Appendix A

3. Keeps tracking of formula references. Reference will use picture19 - screenshot - as shown in Appendix A

4. Keeps tracking of prepared formula

5. Provides statistical reporting based on pharmacy area workload

6. Print human-readable labeling with barcode as picture 20 - screenshot - shown in Appendix A and

7. The system must be accessed over all pharmacy divisions- web based application -.

SYSTEM ANALYSIS
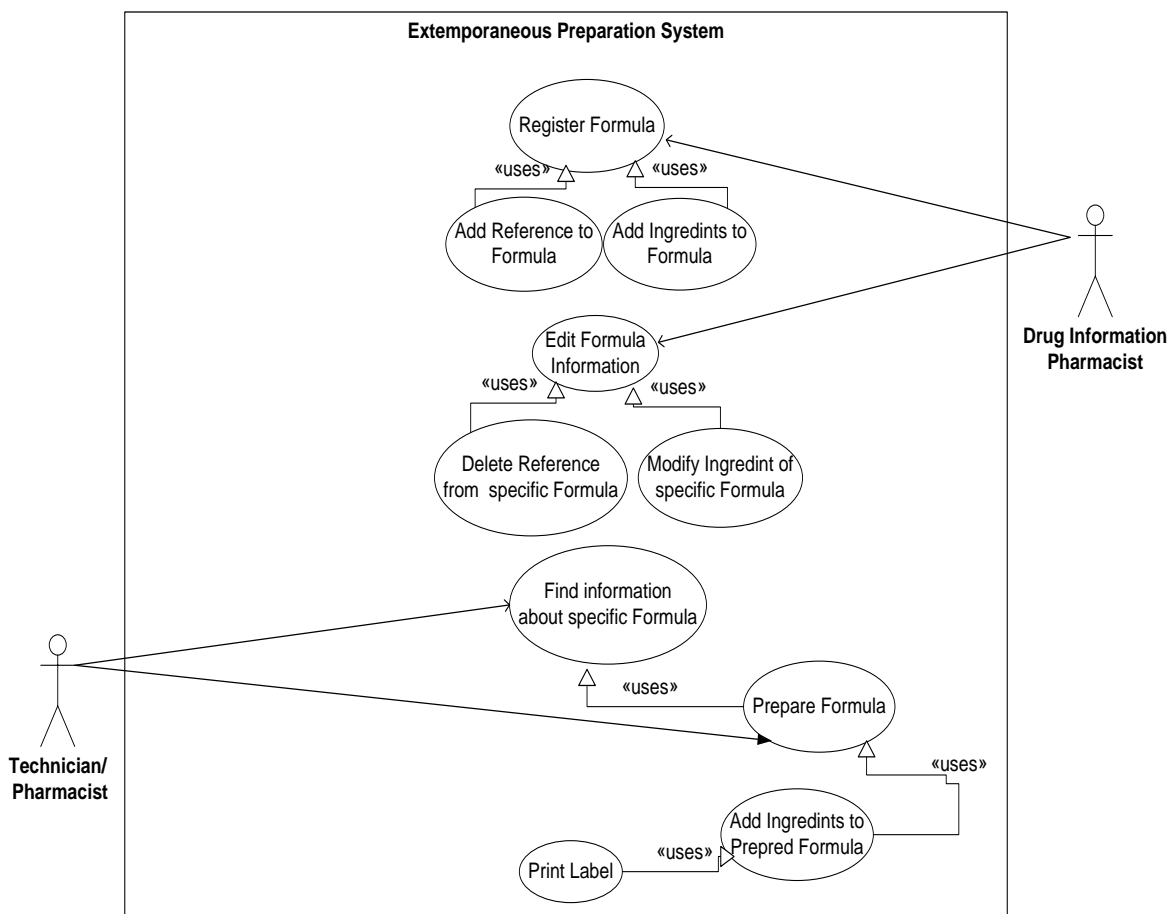
1. USE CASE MODEL

Use Case Model

Figure 1 Use case model

I S S N 2 2 7 7 - 3 0 6 1
V o l u m e 1 6 N u m b e r 4
I n t e r n a t i o n a l J o u r n a l o f C o m p u t e r s & T e c h n o l o g y

Use Cases Describing Processes

1. Use Case: Register Formula

Actor: Drug's Information Pharmacist.

Goals: To record formula with its information.

Steps:

Actor actions	System Responses
1. Enter formula's information	
2. Confirm information by selecting add command.	
	3. Display confirmation that the formula has been recorded.*

* Error message will be displayed if an error occurs while entering data.

1.1 Related Use Cases:

Use case: Add ingredients to formula (inclusion)

Steps:

Actor actions	System Responses
1. Enter ingredients information	
2. Confirm information by selecting add command.	
	3. Display confirmation that the ingredients has been recorded to the formula.*

* Error message will be displayed if an error occurs while entering data.

1.2 Related Use Cases:

Use case: Add Reference to formula (inclusion)

Steps:

Actor actions	System Responses
1. Enter reference information	
2. Confirm information by selecting add command.	
	3. Display confirmation that the reference has been recorded to the formula.*

* Error message will be displayed if an error occurs while entering data.

2. Use Case: Edit formula information

Actor: Drug's information pharmacist.

Goals: To modify formula information as required.

Steps:

Actor actions	System Responses
1. Select Specific formula	
	2. Display formula information

I S S N   2 2 7 7 - 3 0 6 1
V o l u m e   1 6   N u m b e r   4
I n t e r n a t i o n a l   J o u r n a l   o f   C o m p u t e r s   &   T e c h n o l o g y

3. Change formula information as required.

4. Confirm change information by select update command.

5. Display confirmation that the formula information has been updated*

* Error message will be displayed if an error occurs while entering data.

2.1 Related Use Cases:

Use case**:** Modify ingredient information (inclusion)

Steps:

Actor actions	System Responses
1. Change ingredient information as required	
2. Confirm change information by selecting update command.	
	3. Display confirmation that the ingredient information has been Updated.*

* Error message will be displayed if an error occurs while entering data.

2.2 Related Use Cases:

Use case: Delete Reference from formula (inclusion)

Steps:

Actor actions	System Responses
1. Select specific reference.	
2. Select delete command.	
	3. Display message if you are sure to delete reference from formula
4. Confirm deletion	
	5. Display confirmation that the reference has been deleted from formula

2.3 Use Case: Find Information about Specific Formula

Actor: Pharmacist /Technician.

Goals: To help pharmacist or technician to find formula information if he/she want to prepare it.

Steps:

Actor actions	System Responses
1. Enter formula name/part of name and select search command	
	2. Display formula information if it's exist*.

* Message will be displayed if it does not exist.

2.3.1 Related use cases:

Use case**:** Prepare Formula (inclusion)

I S S N 2 2 7 7 - 3 0 6 1
V o l u m e 1 6 N u m b e r 4
I n t e r n a t i o n a l J o u r n a l o f C o m p u t e r s & T e c h n o l o g y

Steps:

Actor actions	System Responses
1. Select Prepare formula	
2. Enter quantity needed and confirm by select add command.	
	3. Navigate to ingredients preparation page.

2.3.2 Related use cases:

Use case: Add ingredients to prepared formula (inclusion)

Steps:

Actor actions	System Responses
1. Enter ingredient's information to prepared formula.	
2. Confirm by selecting add command.	
	3. Display confirmation that the ingredient's information has been added to prepared formula.

2.3.3 Related Use Cases:

Use case: Print label (inclusion)

Steps:

Actor actions	System Responses
1. Select show label command.	
	2. Display label information
3. Select print command	
	4. Print label

SEQUENCE DIAGRAM
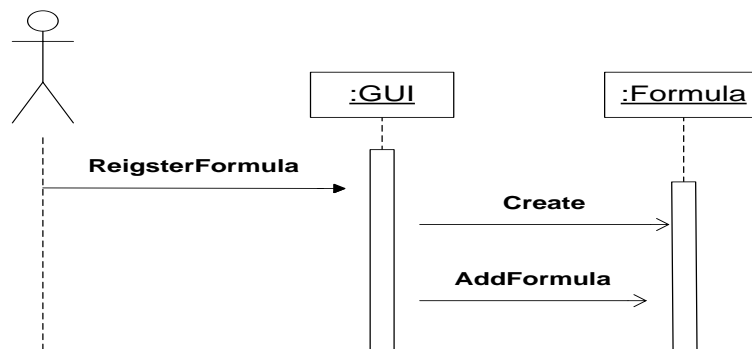
Figure 2: Sequence Diagram showing Formula Registration Process
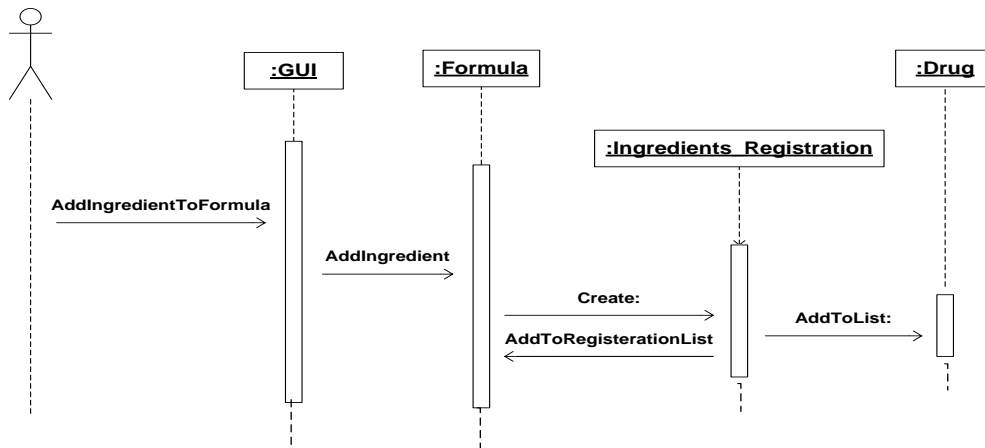
Figure 3: Sequence Diagram showing Add Ingredient to Formula
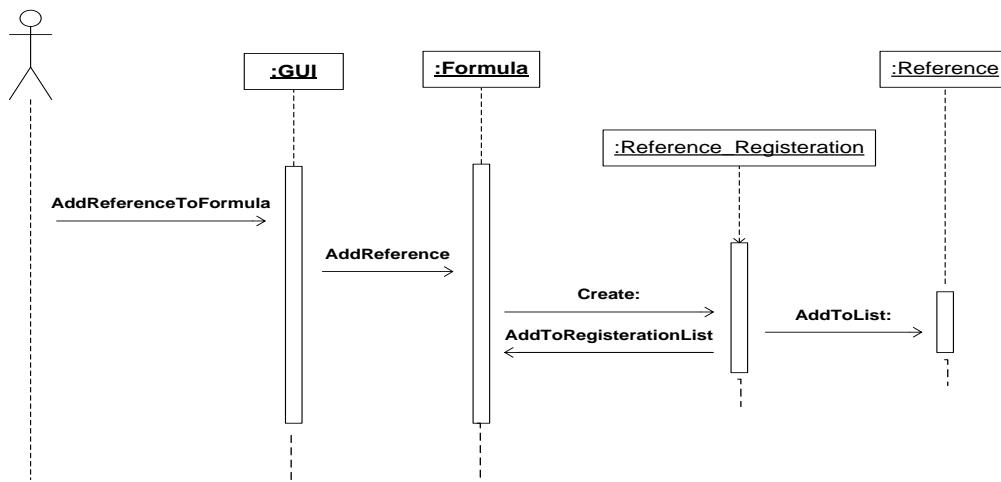
Figure 4: Sequence Diagram showing Reference registration to Formula Process
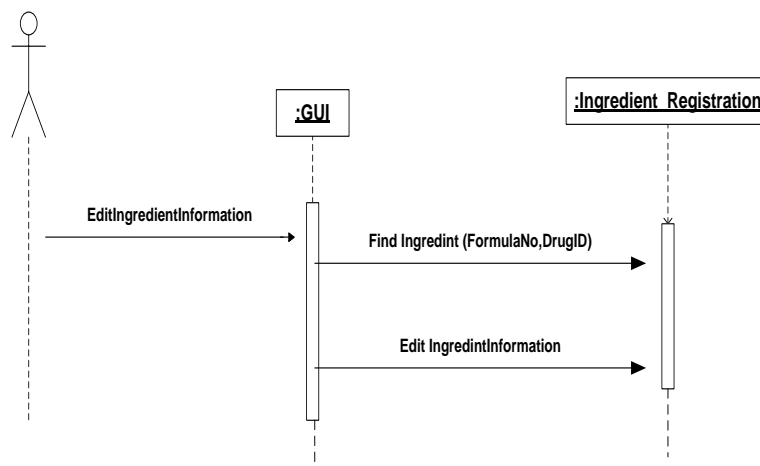
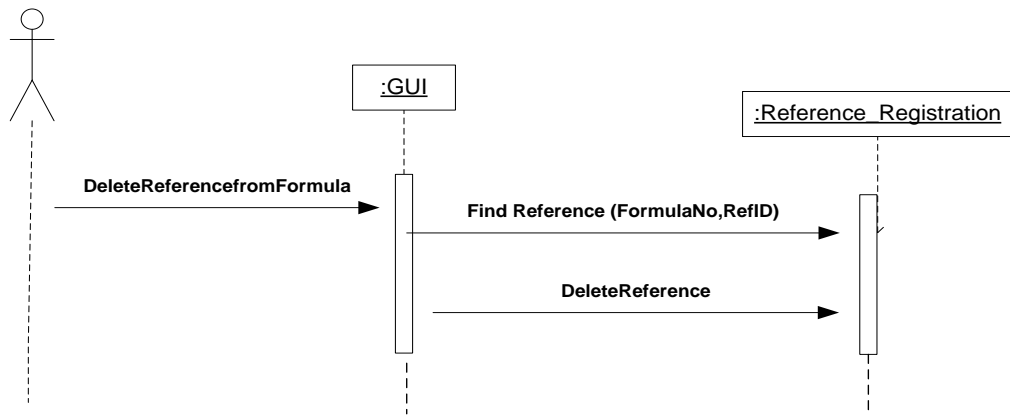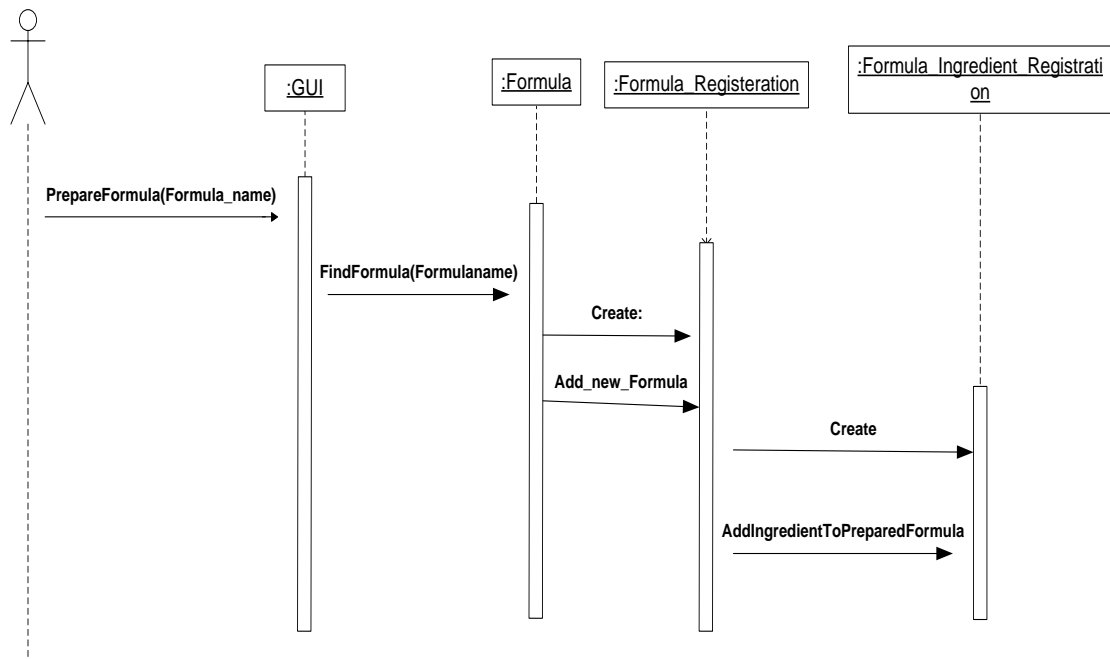**Figure 5: Sequence Diagram showing Modify Ingredient of specific Formula**

I S S N 2 2 7 7 - 3 0 6 1
V o l u m e 1 6 N u m b e r 4
I n t e r n a t i o n a l J o u r n a l o f C o m p u t e r s & T e c h n o l o g y

Figure 6: Sequence Diagram showing Reference deletion from Formula Process

Figure 7: Sequence Diagram showing Prepared Formula Process

COMMUNICATION DIAGRAM

RegisterFormula →   1:create() →

:GUI   F:Formula

2:Add(F) →
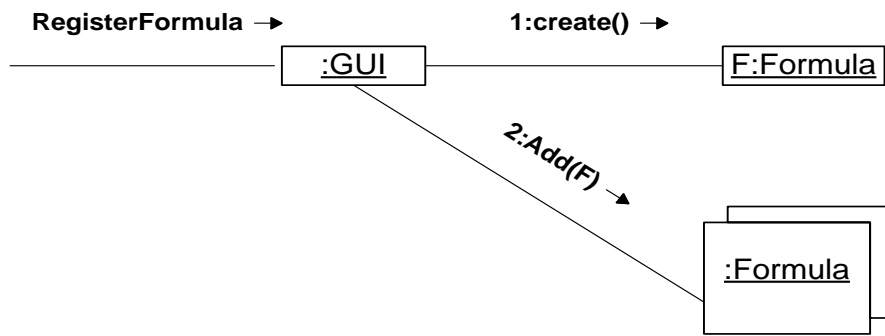
:Formula

Figure 8: Communication Diagram showing Formula Registration Process

1:create() →   2:AddToList() →

:Formula   :IngredientRegistration   :Drug

← 3:AddToRegisterList()

Figure 9: Communication Diagram showing Ingredient's Registration Process

1:create() →   2:AddToList() →

:Formula   :ReferenceRegistration   :Reference

← 3:AddToRegisterList()

Figure 10: Communication Diagram showing Reference's Registration Process

I S S N   2 2 7 7 - 3 0 6 1
V o l u m e   1 6   N u m b e r   4
I n t e r n a t i o n a l   J o u r n a l   o f   C o m p u t e r s   &   T e c h n o l o g y

2:delete(Ref) →

:GUI ——— Ref:Reference_Regestration

1:Ref:Retreive(RefNo) →

:Reference_Regestration
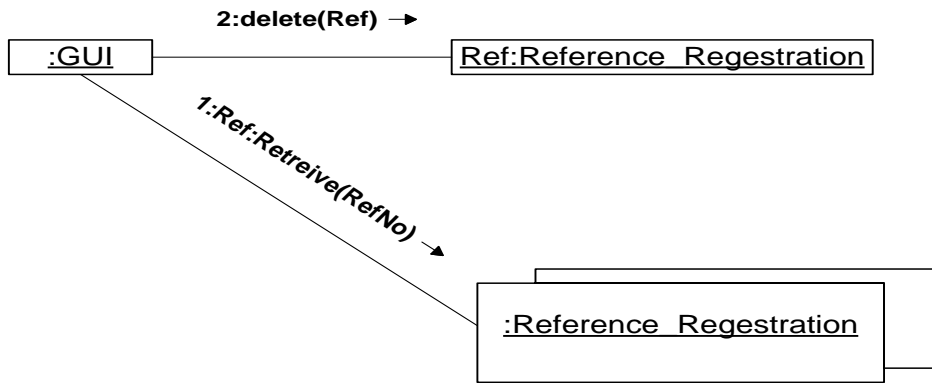
Figure 11:   Communication Diagram showing Reference deletion Process

Ing=1:Find(FormulaNo,DrugCode)

:Ingredient_Regestration

:GUI

3:EditIngredientInfo()

Ing:Ingredient_Regestration
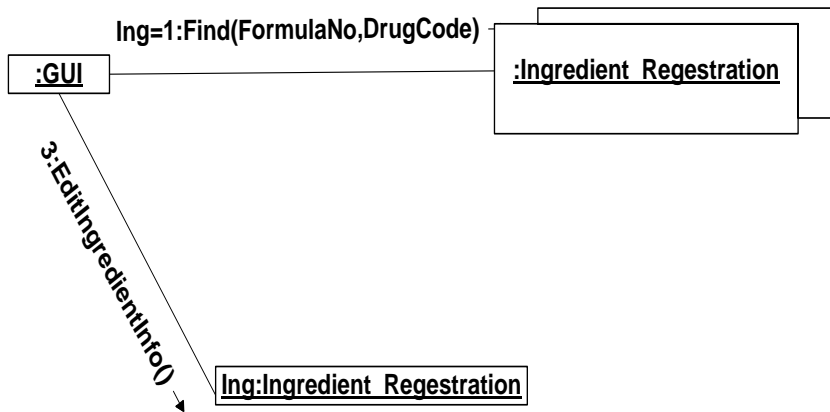
Figure12:   Communication Diagram showing Modify Ingredient of specific Formula

1:Create →

3:create() →

:Formula

Reg:Formula_Regestration

Ing:Formula_Ingredient_Registration

2:add_new_Formula(Reg) →

4:addIngredient(Ing) →

:Formula_Ingredient_Registration

:Formula_Regestration
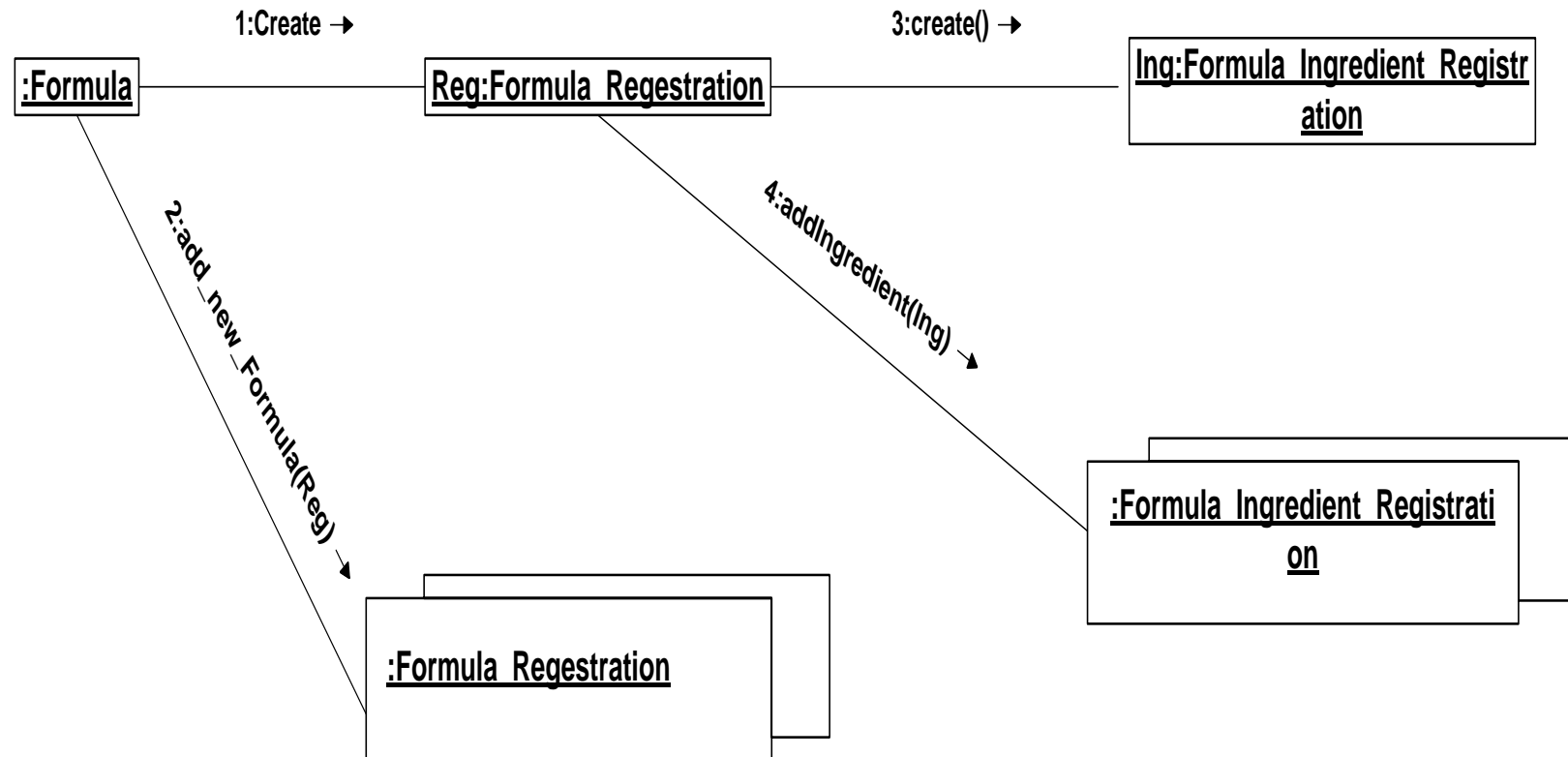
Figure13: Communication Diagram showing Prepare Formula Process

ENTITY RELATIONSHIP (ER) DIAGRAM
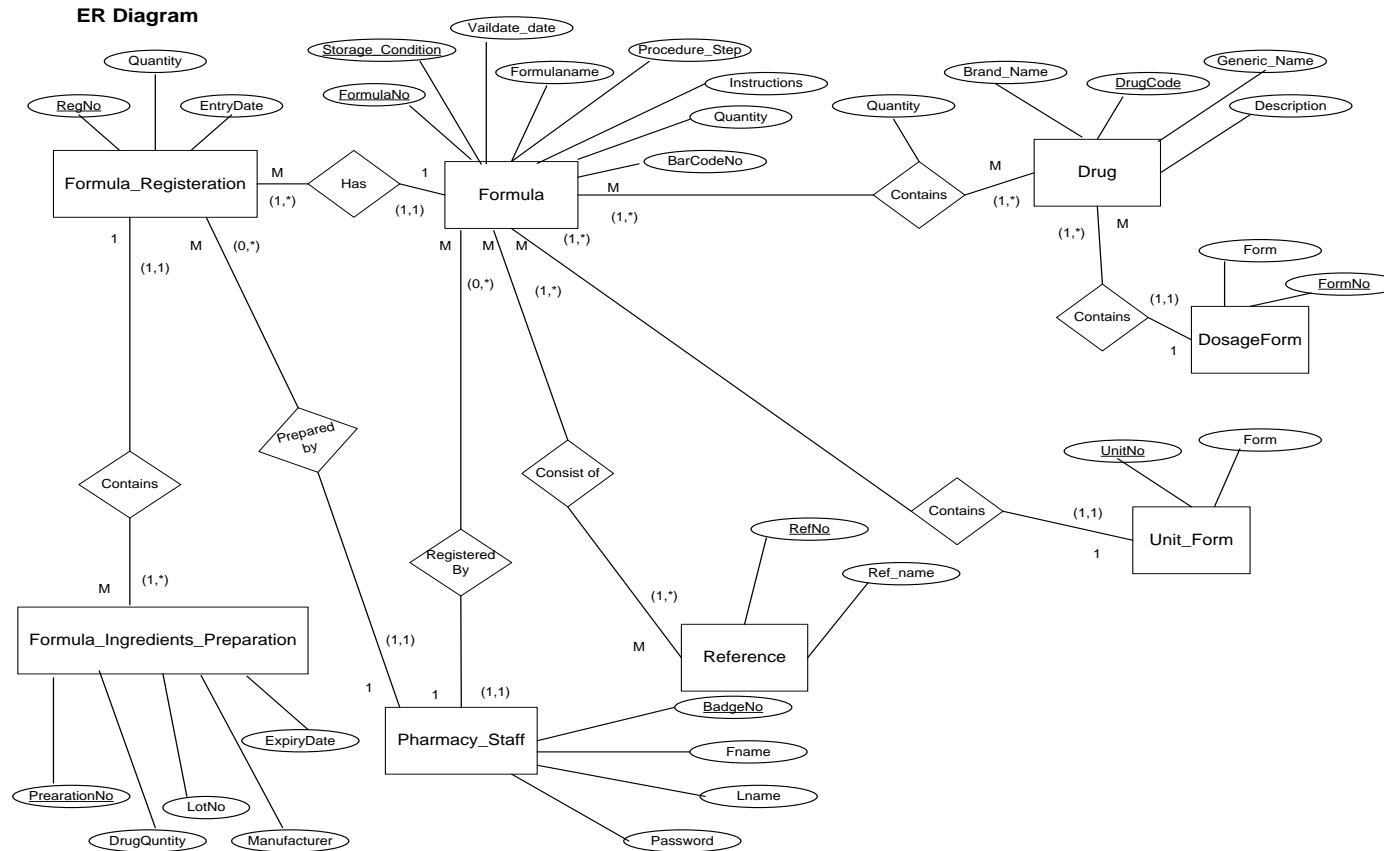
Figure 14: Entity Relationship (ER) Diagram

CONCEPTUAL MODEL
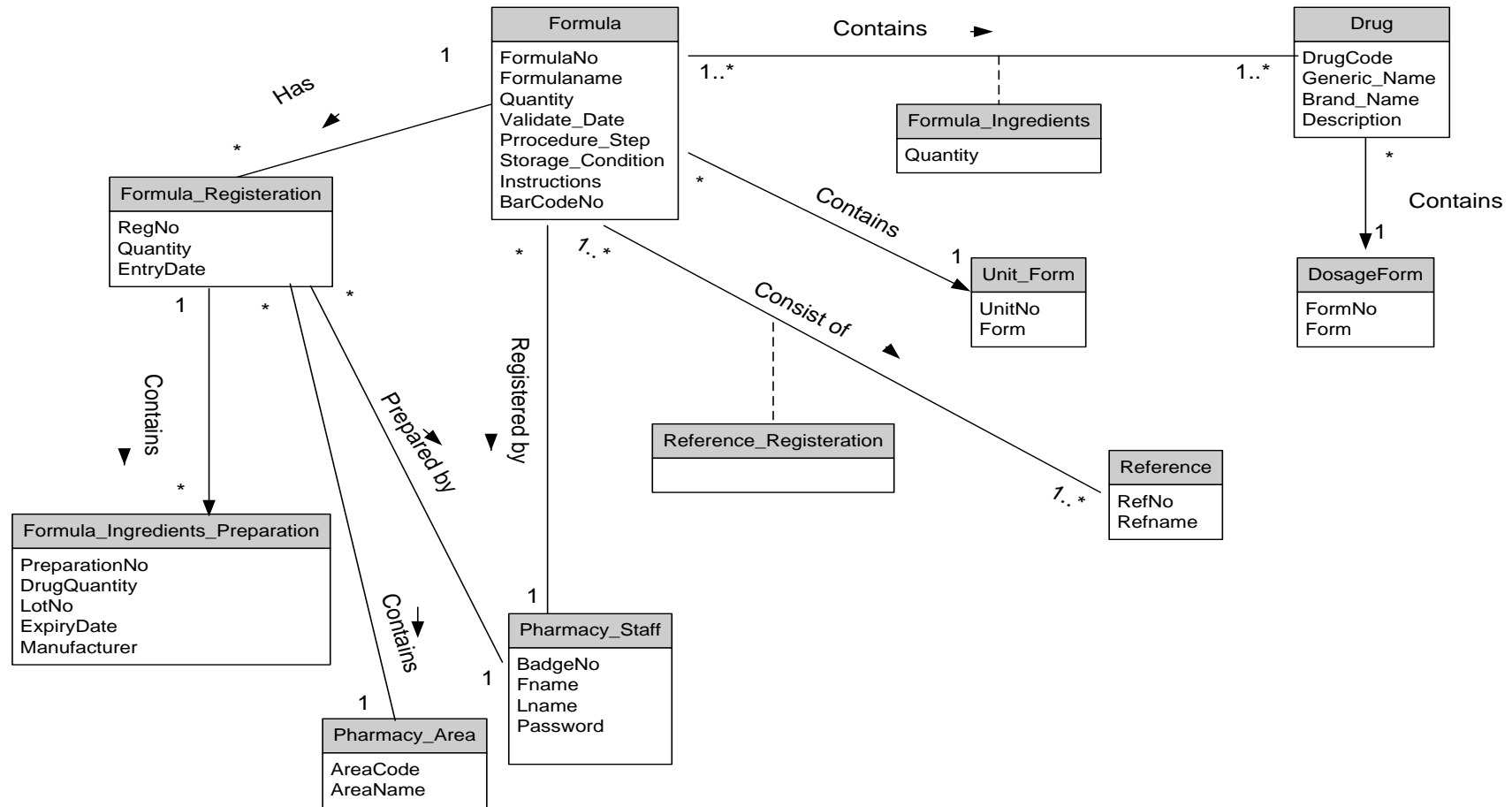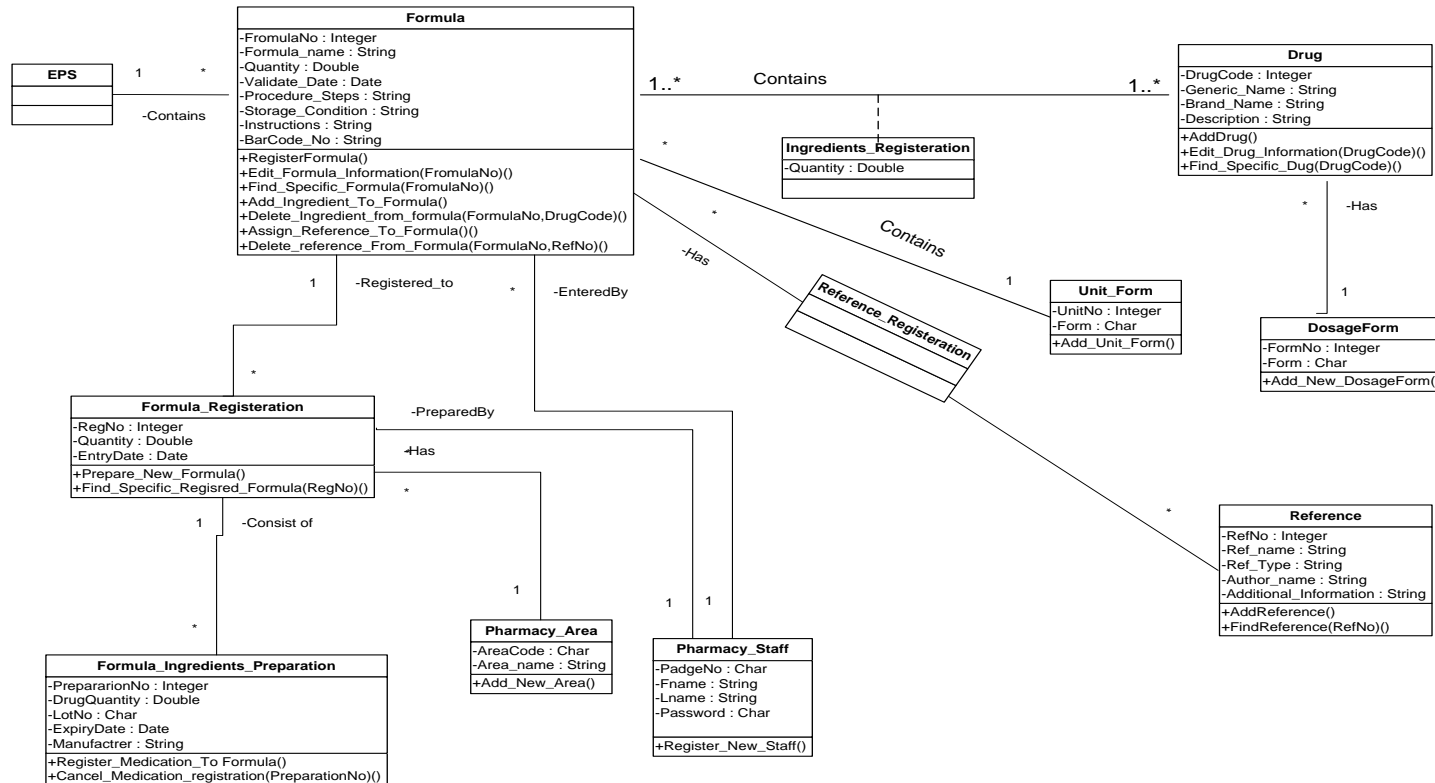

Figure 15: Conceptual Model

CLASS DIAGRAM

Figure 16: Class Diagram

IMPLEMENTATION

Visual Basic.Net has been used for implementing the system.

CONCLUSION

As noted earlier Extemporaneous preparation system was developed to prevent human errors during the compounding preparation, avoid time wasting for both pharmacist and patient and ensure that the right medications were being dispensed by using **bar coding** technology.

Developing the system goes throw three stages: First, implementing new system that automates the repetitive and manual process of Drug compounding. Then Building database by recalling medications from existing legacy system and adding formulas information's where each formula affixed with a barcode.Finally, integrating between new system and existing ScriptPro Robotic (Dispensary machine) which apply a barcode scanning technology along the way of dispensing to ensure that pharmacist is dispensing the right medication, strength, and dosage form to the right patient.

APPENDIX A

Figure 17: Formula's form

Figure 18: Medication's form

Figure 19: Reference's Form

CAPTOPRIL 1 MG/ML ORAL SOLUTION
PHARMACY LOT # 240
EXPIRY DATE 1/1/2020
STORAGE: REFRIGERATE
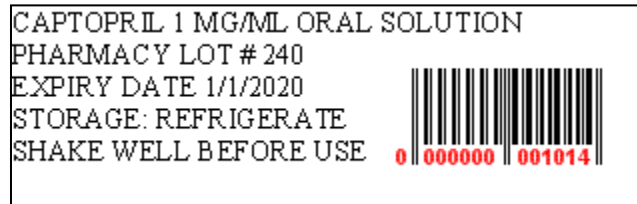SHAKE WELL BEFORE USE

0 000000 001014

Figure 20: Formula's Label

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