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Development of Antibiotics Usage Monitoring System in Critical Care Unit of Tertiary Hospital in Thailand

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Abstract. Since antibiotic use in the today's world is exceedingly high, it has finally led in the global development of antibiotic resistance, affecting patient treatment and outcomes. If antibiotic therapy fails, critically ill patients admitted to intensive care units (ICUs) are at a higher risk of significant morbidity and mortality. Despite the hospital's development of the "Antibiotic smart use team" to manage antibiotic consumption to make it more cost-effective and safer, the number of antibiotics used in intensive or critical care unit wards keeps rising. In this independent study, we will focus on developing a reproducible automated process to extract and transform antibiotic prescription data from critical care units into appropriate transactional data, allowing for analysis and visualization and revealing significant insights from antibiotic usage in critical care units, and which will be able to supply as supporting data for the Antibiotic Controller's Board of Directors' quarterly meeting to improve antibiotic safety.

1 Introduction

The massive overuse and inappropriate use of antibiotics has led to the global development of antibiotic resistance, impacting patient treatment and outcomes [1]. This issue has been particularly problematic in developing countries including Thailand, where antibiotics can be purchased without a prescription and any clinician can prescribe broad spectrum antibiotics [2]. Critically ill patients admitted to Intensive Care Units (ICUs) are at greater risk of serious morbidity and death if antibiotic therapy fails [3,4]. Despite the establishment of the "Antibiotic smart use team" at the Maharaj Nakorn Chiang Mai hospital to make antibiotic use more cost-effective and safer, antibiotic use in intensive and critical care unit wards continues to rise. Pharmaceutical sector and Antibiotic smart use team have a problem that the prescription volume increased over time in critically care unit ward are the appropriate prescription or not

However, the diagnostic of patient data, prescription data, culture result and drug response or resistant results data are complex, incomprehensible, and cannot be used immediately. Therefore, this independent study aims to develop monitoring system by transforming data into more understandable form and use visualization with interactive dashboard to help related stakeholder gain insight from this dataset. This system is a fundamental step to data-driven decision making which can improve ETL, or Extract

Transform Loading, will be the most important option for converting daily antibiotic data into transaction data and keeping all data together before creating a dashboard that would make it much easier for users to visualize data.

2 Methodology

This study adapt methodology mainly from the KDD framework process which is widely accepted and use for data mining project.[5] KDD is a multi-step method that involves gaining an understanding of the problems and data, selecting the target data gathering, data cleaning and preprocessing, data transformation, determining data mining tasks and algorithms to deal with the problems, interpreting the patterns, and integrating the information discovered. The primary objective of this study is to reveal new information from the cultured-antibiotics matrix data of restricted antibiotic prescriptions between October to December 2020 from SMI (Suandok Medical Information) which is a relational database with several sub-databases. The overview of study process was showed in Figure 1.

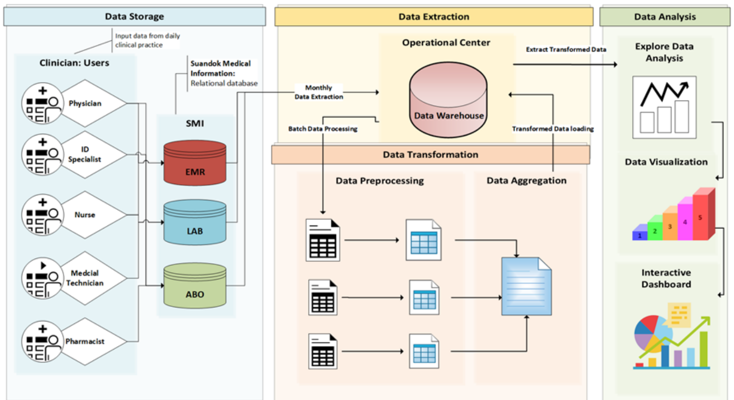

Figure 1 Proposed process to create interactive dashboard antibiotic

Following that, the data is pre-processed to convert it into transactional data and to modify any necessary adjusted columns. Then, utilizing data science techniques to deal with multiple diagnoses and develop a logic classification flow to determine the concordance status of each antibiotic ordering. Then, begin the analysis and visualization process by contacting the stakeholder and medical specialists' representatives to ensure that all requirements are fulfilled. After reviewing the details of the demand and determining the probable scope of the analysis, proceed with visualization and presentation

3 Analysis and Visualization Result

From the interviewing with Critical care and Antibiotic smart use authority team, which are our key stakeholder, we can conclude their concrete requirement into 3 aspects of visualization:

1. Visualization chart that represents the proportion of site of infection diagnosis and highlights organisms from each site of infection to improve understanding of where the most common site of infection is in the critical care unit. Figure 2 illustrates the proportion for bloodstream infection diagnosis as well as the fraction of organism.

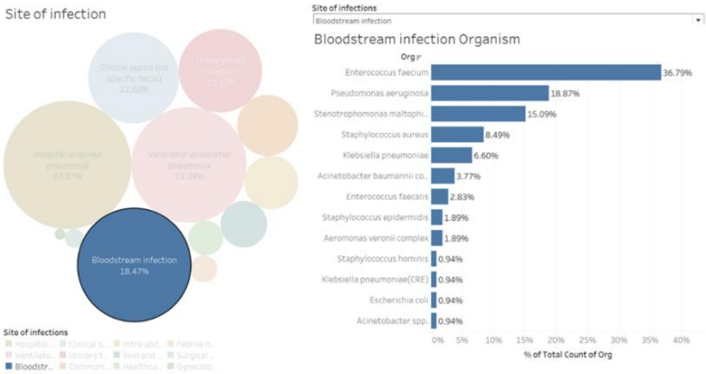

Figure 2. visualization chart of organism percentage for bloodstream infection.

2. Visualization chart that represents antibiotic usage and their indication of each diagnosis or each organism to improve understanding what is most commonly antibiotic used in each infection disease. Figure 3. illustrates the proportion of antibiotic use for bloodstream infection.

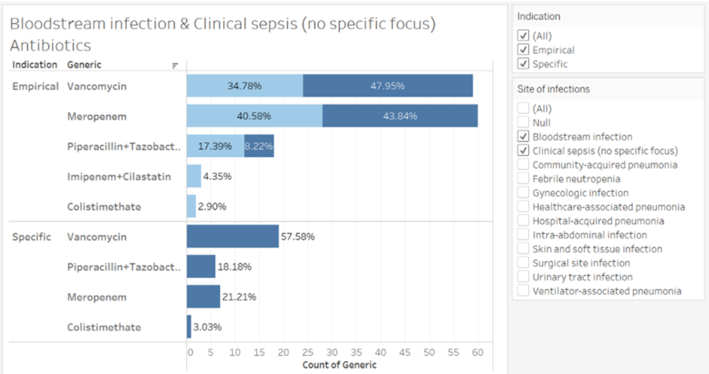

Figure 3. visualization chart of organism percentage for bloodstream infection.

3. Visualize bar chart and discovered knowledge on concordance ordering from the sample data using aggregated data of laboratory and antibiotic data frame to help pharmaceutical sector and antibiotic smart use team whether the critical care unit's high volume restricted antibiotic use is concordance with organism culture result or not. Figure 4. Illustrate concordance status of each antibiotics.

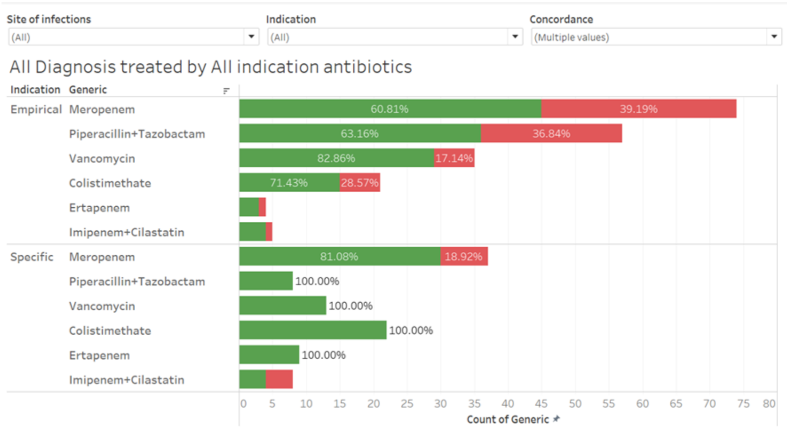

Figure 4. Concordance antibiotic ordering chart

4 Discussion

This independent study intends to provide an understanding of the data by combining data science knowledge with the author's domain expert in clinical medicine and the evolution of visualization techniques. According to our data analysis discussion with the Critical Care and Antibiotic Smart Use Authority team, we determine data mining goal from their requirements. Our result hightlight four key finding including most common site of infection in our critical care unit is hospital-acquired pneumonia, the most common pathogen was Pseudomonas aeruginosa. Meropenem was the most used empirical antibiotic, while Colistimethate was the most used specific antibiotic and Meropenem is the most concerned restricted antibiotic. However, we cannot conclude that the antibiotic was given inappropriately since, in clinical practice, several factors must be taken into account at the same time while making a treatment decision. Despite the fact that urinary tract infection is the most suspicious condition related to Meropenem misuse, accounts for roughly 38% of non-concordance in specific indications, the goal of our study was not to determine the sensitivity of each organism to each antibiotic in intended to assist physicians in making better treatment decisions, which is known as a "Antibiogram." On the other hand, Our stakeholders are the antibiotic smart use team and the pharmaceutical leadership sector, both of which have executive-level authority to develop and implement antibiotic-control strategies. As a conclusion, an understandable visualization dashboard offers an acceptable solution to the stakeholder problem.

5 Conclusion

To summarize, we launched our study by knowing and understanding the stakeholder problem, which is to get insight from their data in order to improve antibiotic management strategy planning. Then, from the data warehouse, we retrieve relevant datasets. The translation of complicated data into transaction data is carried out using a reproducible pipeline based on Python programming. The transaction data is then converted into an interactive dashboard (also known as an antibiotic monitoring system) that can be accessed online. The monitoring system can provide insight into antibiotic usage in the critical care unit, such as the proportion of diagnosis or site of infection and organism in each site, the proportion of restricted antibiotic use and their indication, and the status of concordance with the organism's resistant/sensitivity profile. As a result, by effectively utilizing visualization approach of restricted antibiotics data from the critical care unit of a tertiary hospital in Chiang Mai, Thailand, this study can reveal root cause problems and revise antibiotics utilized strategies.

6 References

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