

## Design and Implementation of the Prevention System for Side Effects of Polypharmacy Components Utilizing Data Queuing Algorithm

Jiwon Choi\*, Chanjoo Kim\*, Yunhee Ko\*, Hyeji Im\*, Yoo-Jin Moon\*, Reid McLain\*

- \*Student, Division of Global Business & Technology, Hankuk University of Foreign Studies, Gyeonggi, Korea
- \*Student, Division of Global Business & Technology, Hankuk University of Foreign Studies, Gyeonggi, Korea
- \*Student, Division of Global Business & Technology, Hankuk University of Foreign Studies, Gyeonggi, Korea
- \*Student, Division of Global Business & Technology, Hankuk University of Foreign Studies, Gyeonggi, Korea
- \*Professor, Division of Global Business & Technology, Hankuk University of Foreign Studies, Gyeonggi, Korea
- \*Professor, Division of Global Business & Technology, Hankuk University of Foreign Studies, Gyeonggi, Korea

### [Abstract]

In this paper, we designed and implemented the integrated system to prevent adverse drug reactions of polypharmacy components in medicine by supporting component-component information and disease-component information, through data queuing algorithm and vast amounts of pharmaceutical big data. In addition, by providing information for drugs, drug components, prohibited drugs, as well as suppliers and distributors, it could help ease anxiety about taking drugs not only for health-care professionals but also for general users. The representative information provided were side effects between two drugs, main components and effectiveness of particular drugs, drugs manufactured by the same pharmaceutical company, and drug component information for patients with chronic diseases. The future work is to update the database by collecting information on rare & new diseases and new drugs.

▶ **Key words:** Data Queuing Algorithm, Polypharmacy Components, Adverse Drug Reaction, Big Data

### [요 약]

이 논문은 데이터 큐잉 알고리즘과 의약품 빅데이터를 통해 약품 성분-성분 간의 정보와 질병-성분 간의 정보를 지원함으로써 의약품 다약제 복용 시 부작용이 발생 가능한 약물 정보를 사용자에게 제공하기 위한 시스템을 제안하고 구현한다. 또한, 의약품 성분에 더하여 복용이 금지된 의약품, 공급업체, 유통업체의 정보 등을 제공함으로써 의료 전문가뿐만 아니라 일반 사용자의 의약품 복용에 대한 불안감을 덜어줄 수 있다. 제공되는 대표적인 정보는 두 가지 약물 사이에서 일어나는 부작용, 특정 의약품의 주성분과 효능, 동일한 제약회사에서 제조된 의약품, 만성 질환 환자가 주의해야 할 약품 성분 정보이다. 앞으로, 희귀병 약이나 신약에 대한 정보를 수집하여 데이터를 업데이트하는 것이 필요하다.

▶ **주제어:** 데이터 큐잉 알고리즘, 다약제 성분, 약물 부작용, 빅데이터

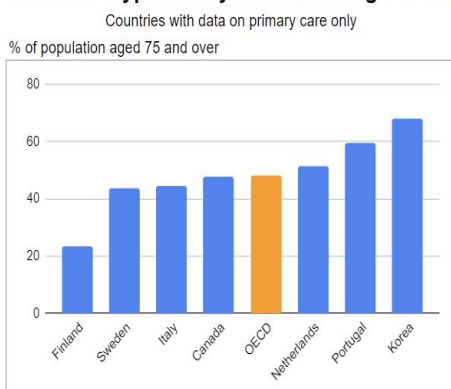
- First Author: Jiwon Choi, Corresponding Author: Yoo-Jin Moon
- \*Jiwon Choi (jw01031@naver.com), Division of Global Business & Technology, Hankuk University of Foreign Studies
- \*Chanjoo Kim (cksw520@naver.com), Division of Global Business & Technology, Hankuk University of Foreign Studies
- \*Yunhee Ko (un593@naver.com), Division of Global Business & Technology, Hankuk University of Foreign Studies
- \*Hyeji Im (dlagPw10630@gmail.com), Division of Global Business & Technology, Hankuk University of Foreign Studies
- \*Yoo-Jin Moon (yjmoon@hufs.ac.kr), Division of Global Business & Technology, Hankuk University of Foreign Studies
- \*Reid McLain (reidmclain@hufs.ac.kr), Division of Global Business & Technology, Hankuk University of Foreign Studies
- Received: 2021. 09. 27, Revised: 2021. 11. 02, Accepted: 2021. 11. 02.

## I. Introduction

### 1. Introductory Remarks

As the average life expectancy of people has increased with development of the modern medicine, the onset of chronic diseases such as diabetes, dementia and cancers is also skyrocketing [1]. It increases the occurrence frequency of various complicated diseases, leading to situations in which many kinds of doses of drugs are needed. In 2017, the ratio of polypharmacy to patients aged 75 or older in Korea was 68.1 percent, the highest among OECD countries as illustrated in Fig. 1 indicating that Korea's polypharmacy use was serious [2]. According to the Korea National Health Insurance Service [3], the polypharmacy prescription rate continued to increase, and as of 2018 more than 950,000 people had more than one kind of disease and took more than 10 kinds of drugs at the same time [4].

#### Ratio of Polypharmacy To Patients Aged 75 or Older



Note : Chronicity defined based on use above 90 DDDs/days in a given year, except in results for Turkey, Ireland, Denmark, Finland and Portugal which instead use number of prescriptions (four and over) in a given year. Dermatologicals for topical use are excluded.  
1. Three-year average.

Source: OECD Health Statistics 2019.

Fig. 1. Ratio of Polypharmacy to Patients Aged 75 or Older in Korea Comparing with OECD

Thus, people with chronic diseases, not only by component-component drug interactions, but also by disease-component drug interactions, can be worsen in the disease. Based on this situation, there has been awareness of the problem against side effects caused by chemical reactions in drugs and

adverse side effects caused by negative interactions of polypharmacy component use for diseases in possession [5, 6, 7]. Therefore, the paper analyzed polypharmacy data and the data between disease and drug, and developed the system for preventing side effects caused by chemical reactions in drugs and adverse drug reactions caused by negative interactions of polypharmacy components [8, 9, 10, 11, 12, 13, 14, 15, 16].

This paper is organized as follows: Section I describes introductory remarks, previous research and big data sources. Section II describes system architecture in this research including entity-relationship diagram of the system and composition of its attributes. Section III provides result analysis of the research model and representative useful information against adverse drug reaction. Finally, discussions and contributions are described in Section IV.

### 2. Related Studies and Big Data Sources

Recently various studies have been underway on side effects caused by drug reactions [7, 17, 18]. There was an existing study focusing on attitude and awareness of healthcare professionals regarding pharmacovigilance and experience for adverse drug reaction from a single university hospital [18]. The study showed that 65% of all respondents among healthcare professionals had confronted incidences of adverse drug reaction and most agreed on the necessities of the promotion and education about adverse drug reaction as well as improvement of the adverse drug reaction reporting. Thus, the integrated system for the adverse drug reactions is eagerly awaited, and even should be upgraded continuously by the reporting of the healthcare professionals and the new drugs.

And, Wang [19] suggested the Data Queuing Algorithm for vital data of reporting, as follows. "After collecting patients' physiological information from the node, various physiological sensors would continuously upload them to the coordinator." So the key to this research would be how to keep the

integrity and effectiveness of each node's information and then how to process it. The general algorithm of the data queuing is as follows:

Define priority function:  $f(x, y) = ax + by + \varepsilon$ ,

$x$ : semantic matching degree,  $0 \leq x \leq 1$

$y$ : a request arriving at the serial position,  $0 < y \leq 1$

$a$  is defined as the weight of semantic matching degree,  $0 < a < 1$

$b$  is defined as the weight of serial position of request arrives,  $0 < b < 1$ ,  $a + b = 1$

$\varepsilon$  is defined as the disturbance value,  $0 \leq \varepsilon \leq 0.1$

With the definitions above,  $f(x, y)$  can turn to be:

$$f(x, y) = ax + (1 - a)y + \varepsilon$$

$$\text{namely, } f(x, y) = y + a(x - y) + \varepsilon$$

Generally,  $a$  is close to  $\mu = 1/2$ ,  $\sigma^2 = 0$

unidimensional normal distribution  $N(\mu, \sigma^2)$ .

After all the messages in the queue would be calculated according to the above formula, they would be inserted into the existing waiting queue in descending order. This research utilized the Data Queuing Algorithm described above to process the vital data of reporting.

Based on the previously studied theories, this research focused on the system not only for health-care professionals but also for general users, about adverse drug reactions, drug-related information, safety-related drug stores, medication prescription information, and component quality [20, 21, 22, 23, 24].

This research carried out data modeling that could produce a variety of useful information in addition to adverse drug reactions by utilizing drug-related information, data of safety-related drug stores, medication prescription information, and component quality by DUR (Drug Utilization Review) type [20]. For drug information, drug ingredient information, drug manufacturer information, patient information for taking the drug, and prescription information for prescription drugs, it used data from Ministry of Food and Drug

Safety, Korea Local Information Research & Development Institute (LOCALDATA), Open Data Portal, and Korea Institute of Drug Safety & Risk Management. [25, 26, 27, 28]. It built data modelling by getting data from the portal described above.

According to Jang [29], who proposed ignoring the regularization of the relational database as one of the design methods in the database system, the research utilized some omitting among the normalization processes of data, for generating a flexible database system with limited memory capacity.

## II. System Architecture for the Adverse Drug Reaction Prevention

### 1. Entity-Relationship Model of the System

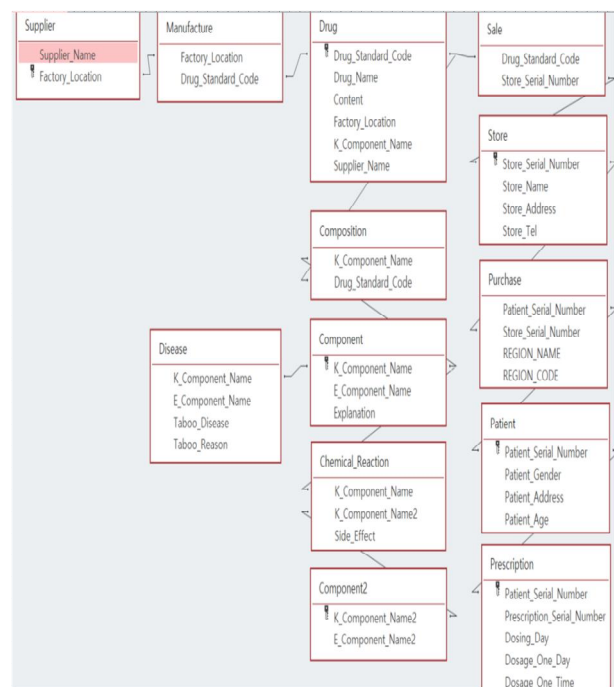


Fig. 2. Entity-Relationship Model of the System for Prevention of Adverse Drug Reaction

The suggested database system designed the entity-relationship diagram (E-R diagram) to provide the users with medical information for adverse drug reaction prevention of polypharmacy components [19, 30]. It used data from The Ministry

of Food and Drug Safety (Generic Data obtained through the Drug Bundle Information) [25], the Pharmacy and Safety Drug Store Data of LOCALDATA [26], the Open Data Portals' drug prescription information [27], and the Korea Institute of Drug Safety & Risk Management [28]. Furthermore, it processed the vital data of reporting from the healthcare professionals utilizing the Data Queuing Algorithm.

## 2. Description of Entity & Relation's Attribute Composition

The E-R Diagram was developed to design a database management system for preventing side effects of drug mixture using the data mentioned in the section 1.2. As shown in Fig. 2, Supplier, Drug, Component, Component2, Disease, Store, Patient, and Prescription were set as entities, and Manufacture, Composition, Chemical\_Reaction, Sale, and Purchase were set as relationships. The diagram differentiated itself by adding not only the detailed description of drugs in the entities Drug and Component with basic information on the pharmaceutical company that manufactured it, but also contraindications against concomitant use and contraindications when possessing underlying diseases. In addition, an entity Patient was added to provide useful information so that it could identify characteristics based on gender, age, and region.

The entity Supplier represented pharmaceutical company information, which set the attributes as Supplier\_Name and Factory\_Location, and the primary key as Factory\_Location. The entity Drug represented the drug information, which set the attributes as Drug\_Standard\_Code, Drug\_Name, Content, Factory\_Location, K\_Component\_Name and Supplier\_Name, and the primary key as Drug\_Standard\_Code. And, one-to-many relationship between the Supplier and the Drug entities was established, where the Supplier was a weak entity.

The entity Component represented component information, set the attributes as K\_Component\_Name, E\_Component\_Name, and

Explanation, and set the primary key as K\_Component\_Name. And, many-to-many relationship between Drug and Component entities was established. The entity Disease contained disease information for drug use contraindication, and set the attributes as K\_Component\_Name, E\_Component\_Name, Taboo\_Disease and Taboo\_Reason, where the relationship between Component and Disease entities was set to many-to-many.

Component2 is an entity for comparison with the entity Component. In the entity Component2, K\_Component\_Name2 and E\_Component\_Name2 were set as attributes except for Explanation, where the primary key is K\_Component\_Name2. The relation Chemical\_Reaction, with the Side\_Effect property added between the Component and Component2 entities, was set in many-to-many relationship.

The entity Store contained information on the stores of sale, set the attributes as Store\_Serial\_Number, Store\_Name, Store\_Tel and Store\_Address, and set the primary key as Store\_Serial\_Number. A relation Sale had many-to-many relationship between the Drug and Store entities, and Store is a weak entity. The entity Patient represented patient information, set attributes as Patient\_Serial\_Number, Patient\_Gender, Patient\_Address, and Patient\_Age, and set the primary key as Patient\_Serial\_Number. Here, Purchase, many-to-many relationship with Region\_Name and Region\_Code properties added between the Store and Patient entities, was set. As described above, the system schema was created for entities by setting the appropriate attributes and relationships between entities.

## III. Representative Information for Prevention of Adverse Drug Reactions

The implemented system provided the users with medical information for side effect prevention of

polypharmacy components. The representative information provided were side effects between two drugs, main components and effectiveness of specific drugs, drugs manufactured by the same pharmaceutical company, and drug component information for patients with chronic diseases.

### 1. Side Effects between Two Drugs

It was not easy for the general consumer to know what side effects occur between two drugs. So, the system was designed and implemented so that consumers could know the chemical reactions between the two drugs that might occur in case they took the ingredients of the two drugs. If an adverse reaction occurred between the drugs entered in Fig. 3, the side effect that might occur was returned to the result set, and if there were no side effects, no value would be returned to the result value.

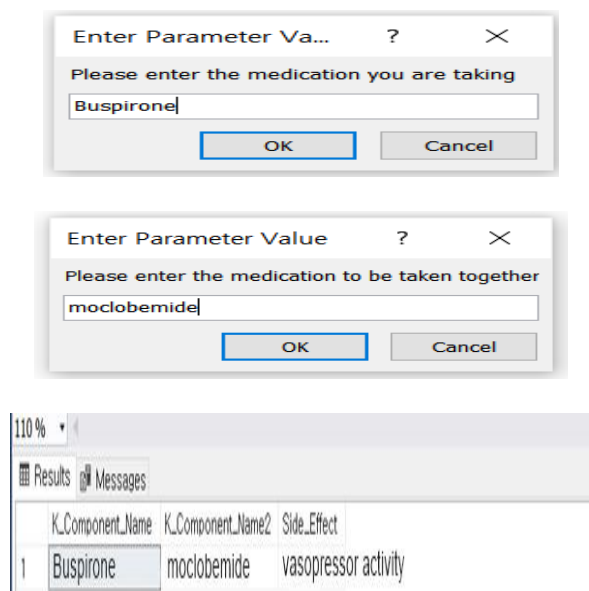


Fig. 3. Side Effects between the Two Drugs

### 2. Main Components and Efficacy of a Designated Drug

In general, when you took medicine you might know what its component worked for. But if you were prescribed with several kinds of medicine at a time, you might take it without knowing what their

effects were. Given this situation, the system searched for the name of the drug and printed out the main ingredients and efficacy of the detected drug. Fig. 4 illustrated the main ingredients and efficacy of the 'Parox CR Tab' by searching for it.

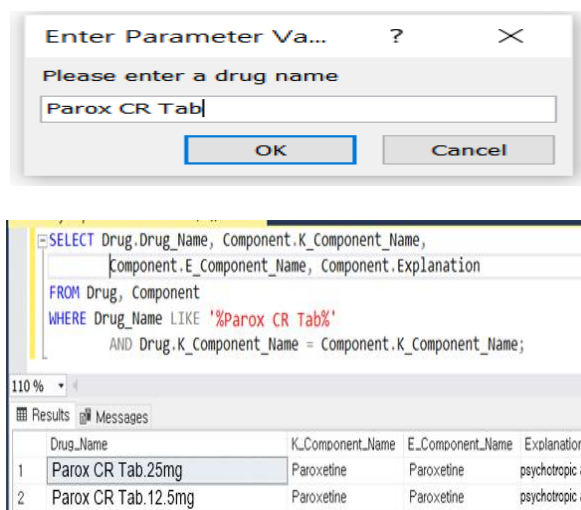


Fig. 4. Component Name and Efficacy of the Detected Drug 'Parox CR Tab'

### 3. Drugs Manufactured by the Same Pharmaceutical Company

Consumers' perception of the brand has a significant influence on purchasing drugs. Especially, consumers' perception of pharmaceutical companies has a moral standard that discriminates against other business organizations, and awareness that pharmaceutical companies should provide drugs to patients in need is expected or recognized. Consumers who experience positive effects on a drug are more likely to be interested in drugs manufactured by the same pharmaceutical company. Thus, the system was implemented to search for drugs manufactured by the designated pharmaceutical company.

When the user input the drug name, the manufacturer name was compared based on the entered drug, and only drugs with the same manufacturer were displayed as a result value set as illustrated in Fig. 5.

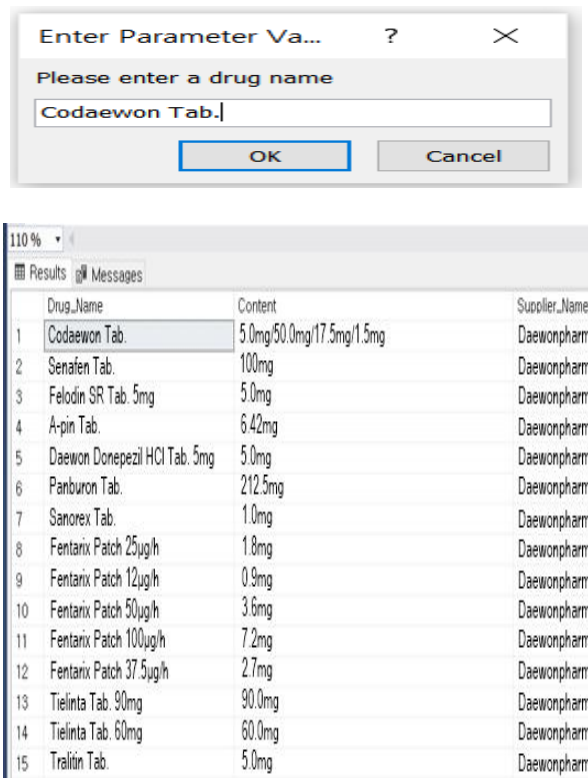


Fig. 5. Drugs Manufactured by the Same Pharmaceutical Company on Entering a Specific Drug Name.

#### 4. Drug Component Information for Patients with Chronic Diseases

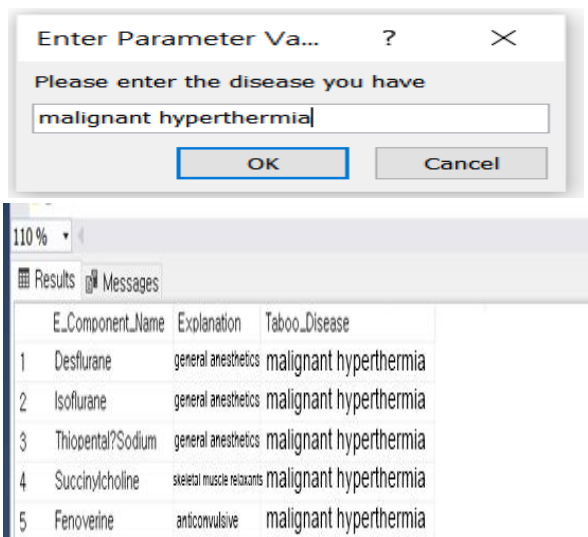


Fig. 6. Drug Components Which Patients with 'Malignant Hyperthermia' should be Careful of.

Patients with chronic diseases are especially susceptible to the possible negative interactions with their medications. If these patients could

search the drug components against chronic diseases they currently had, they could check the component name, and the component effectiveness of the medications they should be careful about. In Fig. 6, one of the chronic diseases, 'malignant hyperthermia', was entered to return the drug components that consumers with malignant hyperthermia should be careful about.

However, the entity Drug in this database mainly covers domestic drug information. Although imports of foreign medicines have been steadily increasing as illustrated in Fig. 7, there is a limitation that it is difficult to check information on imported drugs because mainly domestic drug information exists in the Korean big data sets. Through additional research, it is possible to obtain information on ingredients of the imported drugs.

Division	2019	the component ratio	2018	year on year
Active Pharmaceutical Ingredient	2,123,740	23.59%	2,028,754	104.68%
Medicinal Product	4,707,758	52.30%	4,441,313	106.00%
Sanitary Aid	182,297	2.03%	200,508	90.92%
Medicinal Herbs	145,385	1.62%	146,960	98.93%
	6,817,735	79.53%	6,817,535	105.01%

Fig. 7. Imports of General Drugs in 2019

## IV. Conclusions

### 1. Overall Conclusions

With the development of medical technology, the average life expectancy of people has been increasing, and so the number of patients with chronic diseases has also been increasing. As the desire to live a healthy life may include medical intervention, the number of drugs to be taken and the frequency of adverse reactions between drugs will increase. Clinicians with professional knowledge also have difficulty in identifying clinical trials and all side effects on thousands of drugs.

This research presented the integrated system for drug information that might prevent from generating side effects among diseases and drugs through the data queuing algorithm and vast

amounts of pharmaceutical data, not only for health-care professionals but also for general users. In addition, by providing information for drugs, drug components, prohibited drugs, as well as suppliers and distributors, it could help ease anxiety among users about taking drugs. Moreover, because everyone has a different physical structure, public data related to the gender, age, and taboo drugs of patients with chronic diseases were also collected, indicating the validity period of the drug, daily dosage, and a dose of medicine. By utilizing the system provided, users could expect to take the right medication, including current medication users. The system could provide useful information to users through the process of data modeling by integrating the Ministry of Food and Drug Safety, public data and research data.

In addition, the drug entity in this database mainly covered domestic drug information. Although imports of foreign medicines have been steadily increasing, it is difficult to check information on imported drugs because mainly domestic drug information exists in the Korean big data. The future work is to obtain information on the ingredients of imported drugs as well as more reporting from healthcare professionals.

## 2. Contributions and Limitations

Component-component data and disease-component data as well as the data queuing algorithm can help system users including medicine users who do not have knowledge of components and chemical reactions of polypharmacy components in medicine. Component-component data identify the ingredients of the two drugs to show side effect information, which can prevent ill effects that may appear in the users. In addition, the disease-component data specifies information about the chronic diseases that users have ever had, and about the ingredients of drugs that may have a negative impact on them. It also contributes to providing useful information to users who lack information

about drugs. The users can search for drugs that have positive reactions and drugs manufactured by the same pharmaceutical company, and use the drug's main component data to find out what actions they should take.

The system should try to continue to update the database in collecting information on rare diseases, new diseases and new drug information in this database because not all data on medicines and diseases exist nowadays. In particular, as the coronavirus emerged as a new infectious virus in 2019, the world is trembling with fear of disease. In the currently established database, information on prohibited drugs when infected with the coronavirus is not available, nor are the possible adverse reactions of the developed new drug rapidly known. Tamiflu, a flu virus treatment, has become a major social issue leading to suicide cases by hallucinations. However, the specific reasons for these anomalies and side effects are still unknown, which information on side effects is not specified: it should also be considered that the uncertainty of this information results in insufficient knowledge, and more work and reaearch is needed.

## ACKNOWLEDGEMENT

This work was supported by Hankuk University of Foreign Studies Research Fund of 2021.

## REFERENCES

- [1] H. Choi, S. Byeon, Y. Lee, S. Kim and Y. J. Moon, "Drone Functional Service System for Dementia Seniors in the Aging Society towards the Innovative Safe Welfare," *International Journal of Software & Hardware Research in Engineering*, Vol. 8, No. 7, pp. 34-42, July 2020.
- [2] Eun Jin Shin, Five or more "drug-taking Koreans" are the most in the OECD. *Medipana*, Nov. 2019. [http://medipana.com/news/news\\_viewer.asp?NewsNum=248753&MainKind=A&NewsKind=5&vCount=12&vKind=1](http://medipana.com/news/news_viewer.asp?NewsNum=248753&MainKind=A&NewsKind=5&vCount=12&vKind=1)

- [3] Medication Interaction Data, National Health Insurance Service, Oct. 2020. <https://www.nhis.or.kr/nhis/healthin/wbhace02500m01.do>
- [4] Seung Heon Shin, As the number of prescription drugs increases, the risk of hospitalization and death increases. Pharmaceutical News, Aug. 2019. <http://www.newsmpr.com/news/articleView.html?idxno=194799>
- [5] Yun Mi Kim, Consumer awareness of pharmaceutical companies “differentiating morality,” Medifonews, Dec. 2019. <https://www.medifonews.com/news/article.html?no=79419>
- [6] Hwan Woong Kang, More than 2 million polypharmaceuticals at high risk of hospitalization and death. Akomnews, Oct. 2020. [http://www.akomnews.com/bbs/board.php?bo\\_table=news&wr\\_id=41816](http://www.akomnews.com/bbs/board.php?bo_table=news&wr_id=41816)
- [7] Jinnie Rhee, Seyoung Park, Jihaeng Heo, Mihae Park, Jihye Ha, and Eui Kyung Lee, “Measuring the Seriousness of Adverse Drug Reaction: Comparisons between Korean Experts and WHO Working Group Members,” Korean Journal of Clinical Pharmacy”, Vol. 21, No. 3, pp. 237-242, 2011.
- [8] Bruce Lehrman, “Big Data’s Role in the Post-COVID Era,” Data Agility, Vol. 16, Issue 11, Sept. 2020. <http://www.pipelinepub.com>.
- [9] Jun Wu, Jian Wang, Stephen Nicholas, Elizabeth Maitland, and Qiuyan Fan, “Application of Big Data Technology for COVID-19 Prevention and Control in China: Lessons and Recommendations,” Journal of Medical Internet Research, Vol. 22, No. 10: e21980, Oct. 2020. doi:10.2196/21980.
- [10] Yong Chen, Hong Chen, Anjee Gorkhali, Yang Lu, Liqian Ma, and Ling Li, “Big Data Analytics and Big Data Science: A Survey,” Journal of Management Analytics, Vol. 3, No. 1, pp. 1-42, 2016.
- [11] Teradata, Big Data Analytics - Reveal the Best Opportunities for Big Data Companies, 2021. [https://kr.teradata.com/Solutions/Big-Data?utm\\_campaign=2020brand&utm\\_source=google&utm\\_medium=paidsearch&utm\\_content=TERAI\\_GS\\_Brand\\_APA\\_C-KR-EN\\_CV\\_NBKW\\_BMM&utm\\_creative=BigData-DataAtTheCenter|BigDataOverview&utm\\_term=big%20data%20science&gclid=EAIaIQobChMIwLiR4o6C7wIV2KqWCh0TEw13EAAYASAAEgLG0vD\\_BwE](https://kr.teradata.com/Solutions/Big-Data?utm_campaign=2020brand&utm_source=google&utm_medium=paidsearch&utm_content=TERAI_GS_Brand_APA_C-KR-EN_CV_NBKW_BMM&utm_creative=BigData-DataAtTheCenter|BigDataOverview&utm_term=big%20data%20science&gclid=EAIaIQobChMIwLiR4o6C7wIV2KqWCh0TEw13EAAYASAAEgLG0vD_BwE)
- [12] Sangho Kim, “A Study on Relationship of BDBA (Big Data Business Analytics) System and Supply Chain Management,” Journal of Korea Research Association of International Commerce, Vol. 19, No. 2, pp. 89-107, 2019.
- [13] N. B. Lassen, L. L. Cour, and R. Vatrpu, “Predictive Analytics with Social Media Data,” The SAGE Handbook of Social Media Research Methods, pp. 328-341, 2016. doi: 10.4135/9781473983847.n20
- [14] Y. Lu, R. Kruger, D. Thom, F. Wang, S. Koch, T. Ertl, and R. Maciejewski, Integrating Predictive Analytics and Social Media, 2014 IEEE Conference on Visual Analytics Science and Technology (VAST), 2014. doi: 10.1109/vast.2014.7042495
- [15] S. Hai-Jew, “Social Media Data Extraction and Content Analysis,” Hershey, PA: IGI Global, 2017.
- [16] F. Zeller, “Analyzing Social Media Data and Other Data Sources: A Methodological Overview,” The SAGE Handbook of Social Media Research Methods, pp. 386-403, 2016. doi: 10.4135/9781473983847.n23
- [17] Hyo Jung Jun, Hyun Soon Sohn, and Hyun Taek Shin, “Study on the Patients’ Perception on Adverse Drug Reactions Including Drug Allergy,” Korean Journal of Clinical Pharmacy, Vol. 20, No. 3, pp. 171-182, 2010.
- [18] Eun Jung Kyung, Ji Hyun Rew, Mina Oh, and Eun Young Kim, “A Survey on Attitude and Awareness of Health-Care Professionals Regarding Pharmacovigilance System and Experience for Adverse Drug Reaction from a Single University Hospital,” Korean Journal of Clinical Pharmacy, Vol. 23, No. 3, pp. 256-268, 2013.
- [19] Jia Wang and Hongwu Zeng, “Design and Implementation of Intelligent Medical System for Chronic Diseases,” American Journal of Computer Science and Technology, Vol. 3, No. 4, pp.86-91, 2020.
- [20] David Kroenke and David Auer, “Database Concepts,” Pearson, 2015.
- [21] C. W. Lee, H. S. Jeon, and Y. H. Noh, “A Design and Implementation of DB System for Providing Comprehensive Information Retrieval Service about Social Economic Information,” Journal of the Korea Society of Computer and Information, Vol. 22, No. 5, pp. 73-79, May 2017.
- [22] Byung-Jun Song, et al., Building and Application of Bicycle Transportation System Utilizing Public Big Data, Proceedings of the Korea Society of Computer and Information, Korea, pp. 432-433, Jan. 2019.
- [23] S. H. Shin, Y. J. Yoon, M. S. Yang, J. M. Kim, and K. R. Shon, “A Data Cleaning Strategy for Improving Data Quality of National R&D Information - Case Study of NTIS,” Journal of the Korea Society of Computer and Information, Vol. 16, No. 6, pp. 119-130, Jun. 2011.
- [24] J. H. Lee and K. S. Joo, “Development of the Unified Database Design Methodology for Big Data Applications -based on MongoDB-,” Journal of the Korea Society of Computer and Information, Vol. 23, No. 3, pp. 41-48, Mar. 2018.
- [25] Pharmaceutical Product Information List, DUR(Drug Utilization Review) Items, Ministry of Food and Drug Safety, Oct. 2020. <https://nedrug.mfds.go.kr/searchDrug>
- [26] Pharmacy and Safety Drug Store Data, Korea Local Information Research & Development Institute (LOCALDATA), Oct. 2020. [https://localdata.kr/datafile/each/01\\_01\\_05\\_P.xlsx](https://localdata.kr/datafile/each/01_01_05_P.xlsx)
- [27] Patient Data, Prescription Data, Open Data Portal, Oct. 2020.

<https://www.data.go.kr/data/15007117/fileData.do>

- [28] Drug Components and Explanations, Chemical Reaction, Effectiveness for Diseases, Korea Institute of Drug Safety & Risk Management, Oct. 2020. <https://www.drugsafe.or.kr/iwt/ds/ko/useinfo/EgovDurInfoSerIntegration.do>
- [29] Y. K. Jang, "A Database Design Using Denormalization in Relational Database," Journal of the Korean Institution of Industrial Engineers, pp. 172-178, April 1996.
- [30] H. H. Choi and Y. J. Moon, "Design and Implementation of Public Bicycle Transportation System Using Public Big Data," International Journal of Software & Hardware Research in Engineering, Vol. 7, No. 7, pp. 25-32, 2019.

## Authors



Jiwon Choi is a student of Hankuk University of Foreign Studies. She is studying Computer Engineering, Business and Statistics. Her interested research area is AI, big data and integrated software systems.



Chanjoo Kim is a student of Hankuk University of Foreign Studies. She is studying Computer and Business. Her interested research area is object-oriented programming, database systems and data analysis systems.



Yunhee Ko is a student of Hankuk University of Foreign Studies. She is studying Global Business and Technology. Her interested research area is big data and integrated software systems.



Hyeji Im is a student of Hankuk University of Foreign Studies. She is studying English, Computer Engineering and Business. Her interested research area is computer programming, translating and integrated software systems.



Yoo-Jin Moon is a professor and dean at Hankuk University of Foreign Studies. She received her Ph.D. from Seoul National University. Her interested area is artificial intelligence, natural language processing and database system.



Reid McLain is an Assistant Professor at Hankuk University of Foreign Studies. He has an MBA in Int'l Business from Regis University and a MET from Boise State University in USA. His research interests are the dimensions of human communication merging business, culture, and technology related to Korea.