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Effects of Health Informations System "Dosing Gama" on Time Efficiency in Dosage Adjustment Evaluation

Lilla Prapdhani Agni Hajma[1], Djoko Wahyono[2], Fita Rahmawati[2*]

[1.] Master of Clinical Pharmacy, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, Indonesia, Sekip Utara 55281

[2.] Department of Pharmacology and Clinical Pharmacy, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, Indonesia Sekip Utara 55281

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*Corresponding author
Fita Rahmawati

Email:
malihahanun@yahoo.com

ABSTRACT

Indonesian Ministry of Health shows an increase in patients with impaired kidney and liver function by 10-50% since 2007. The increase is a challenge for pharmacists in conducting pharmaceutical care, which is that dose adjustment for these patients takes a long time. Dosing GAMA, an application that has been developed in 2018, is expected to overcome these obstacles. This study aims to identify the use of the Dosing GAMA application to assist pharmacists in making dose adjustments evaluation more efficient and to assess pharmacist's acceptance of the application. This study was a quasi-experimental study using post-test with control group design. Respondents were recruited by selecting pharmacists according to the inclusion criterion. The control group consisted of 26 pharmacists who made dose adjustments manually, and the intervention group consisted of 26 pharmacists who made dose adjustments using the Dosing GAMA application. Data were obtained by measuring the time required by the pharmacist to make dose adjustments. The intervention group was then asked to complete a perceived acceptance questionnaire. The study indicated that Dosing GAMA could reduce the time needed for dose adjustment evaluation ($p<0.05$). An average time spent by pharmacists with Dosing GAMA was shorter than that spent by those who made dose adjustments manually without application (13.81±0.78 min vs. 27.5±1.23 min). Overall, the pharmacists have high perceived acceptance of the application. The study results can be used as the basis for developing the application. Furthermore, it is expected that the Dosing GAMA can improve pharmacists' performance in providing effective pharmaceutical care.

Keywords: Dose adjustment evaluation, Health information technology, Dosing GAMA application, time efficiency test.

INTRODUCTION

In the last few decades, many people are susceptible to decreased kidney and liver function. The data showed that the incidence has increased by 10-50% since 2007 (Indonesian Ministry of Health, 2017a, 2017b). Patients with decreased kidney and liver function have experienced changes in pharmacokinetics and pharmacodynamics in their bodies (Aymanns *et al*., 2010). The changes make them need a dose adjustment (Chertow *et al*., 2015; Delco *et al*., 2005). There was 23.2% of the total number of inpatient prescriptions with varying degrees of kidney damage requiring dosage adjustments, but only 45.5% of the dosages were adjusted (Riazi *et al*., 2012). A problem encountered while making dose adjustments is that it takes a long time because a pharmacist should follow some steps to determine dosage recommendations for the patient (Tumkur *et al*., 2012).

Various pharmaceutical software has been developed to help resolve problems in making decisions by minimizing drug selection errors and dosage calculation errors to increase patient safety (Ghibelli *et al*., 2013; Rezaei *et al*., 2013). Dosing GAMA, a Dosing Adjustments for Patients with Kidney and Liver Impairment software, was developed by the Laboratory of Pharmacology and

Clinical Pharmacy Faculty of Pharmacy, Universitas Gadjah Mada in 2018. Dosing GAMA was developed through several steps. The step began with mapping the drugs that required individualization of dosages in patients with kidney and liver failure. This process was followed by the development and testing of the application. This application provided features such as login and logout system, dashboard application, patient master setting, drug master setting (drug database), and patient visit data. It was also completed with some automatic calculation to make the dose adjustment evaluate easier such as a calculator for creatinine clearance (ClCr), body surface area (BSA), and body mass index (BMI). It could display the drugs that required dose adjustments based on the patient's creatinine clearance and liver function. The Dosing GAMA application can be accessed using a computer or a smartphone connected to the internet so that it is considered more practical for pharmacists with high mobility (Rahmawati *et al*., 2018). It has excellent potential for clinical practice at health facilities, especially in Indonesia, because this application also uses the Indonesian language. The application has been tested for its validity and trialed for patients' clinical outcomes in the hospital (Gunarsih, 2020).

Before it can be widely used to make pharmaceutical care activities efficient, this application needs to be tested to reveal respondents' acceptability. Previous studies indicate that health information systems can shorten the time of pharmaceutical care activities (Lapão *et al*., 2017). This study aims to prove that using Dosing GAMA software can reduce the dose adjustment time evaluation and to asses of pharmacists' acceptance of the application. To achieve this objective, an intervention study was conducted to compare the time spent to evaluate dose adjustments by using the application versus manually. The perceived acceptance questionnaire was used to assess pharmacists' acceptance of the application.

MATERIALS AND METHODS

Study design and subjects

This study was quasi-experimental using post-test with control group design. It was conducted in January-March 2020. It was approved by the Medical and Health Research Ethics Commission, Faculty of Medicine, Universitas Gadjah Mada, with the Ethical Clearance number KE/FK/1055/EC/2019.

Fifty-two pharmacists were involved in the study. The subject inclusion criterion was a pharmacist with a certificate of competence who were willing to participate in the study by signing informed consent. Participants were excluded if they could not attend the forum held by the researcher. The subjects were divided into two groups: the intervention group consisting of pharmacists who made dose adjustment evaluation using the Dosing GAMA application and the control group consisting of those who make dose adjustment evaluation without an application. The minimum samples were 23 per group that was determined based on the following equation (Lemeshow *et al*., 1997):

$$N1 = N2 = \frac{2\sigma\left(\frac{Z\alpha}{2}+Z\beta\right)^2}{(\mu1-\mu2)^2}$$

Σ	= standard deviation	= 35.3
$Z\alpha/2$	= type 1 error	= 1.96
$Z\beta$	= type 2 error	= 0.842
(μ1-μ2)	= clinical significance	= 5

This study involved 26 pharmacists for each group.

Instruments of the study

This study's instruments consisted of case scenario sheets, Dosing GAMA application, and a digital watch to assess time efficiency, computer literacy, and perceived acceptance questionnaire. Two medical records from hospitalized patients in the Academic Hospital of Universitas Gadjah Mada were selected for case scenarios. It contained patients' demographic data, a list of medications used during hospitalization, and laboratory tests for creatinine serum markers of kidney function, alanine aminotransferase (ALT), and aspartate transaminase (AST) as markers of liver function.

Pharmacists in the two groups completed the demographic data and computer literacy questionnaires. Computer literacy means knowledge and ability to understand and use basic computers, technology, and application efficiently in doing simple tasks (Jayawardena and Ratnayake, 2018). There is a correlation between computer experiences and computer skills (Maclure and Stewart, 2016). A study by Jayawardena and Ratnayake (2018) revealed that computer literacy has contributed to the well-functioning use of health information systems in hospitals. Researchers have developed a computer literacy questionnaire. This questionnaire consists of four questions: respondents' information about computer usage per day, years of computer experience, type of computer, and computer skills (Masrofin, 2019).

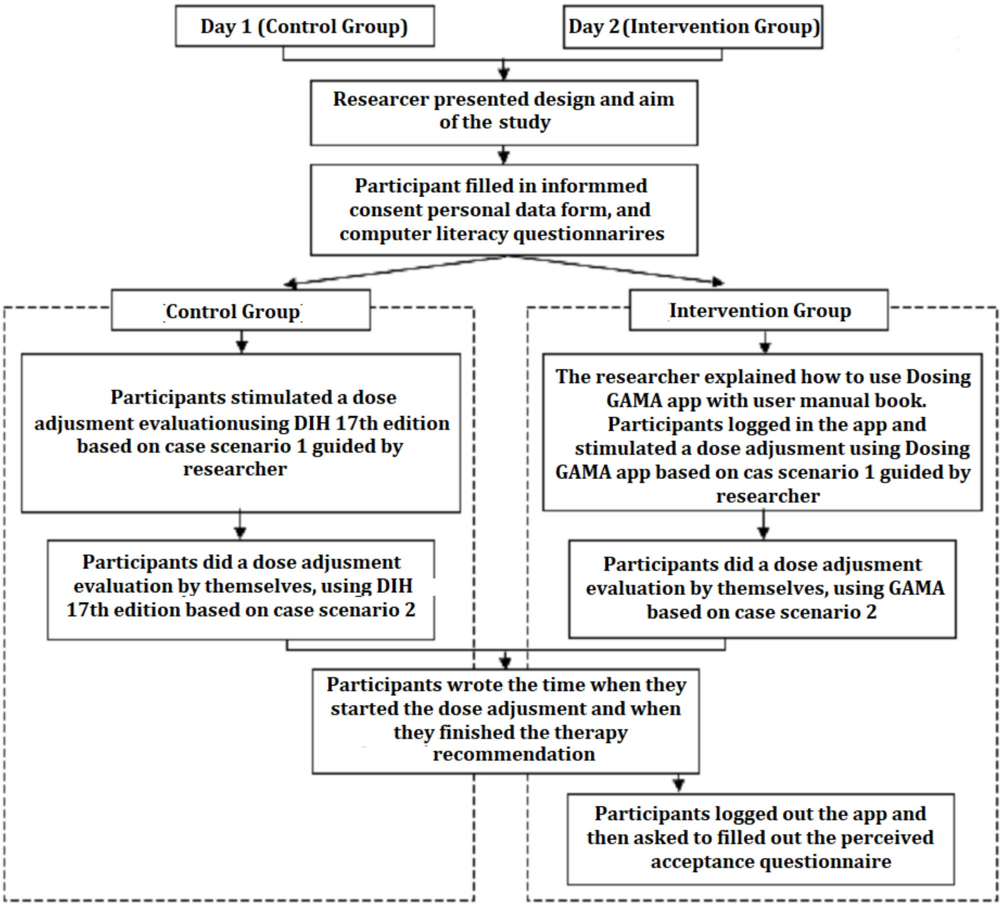

Figure 1. Data collecting process ([a]Drug Informational Handbook 17th Edition)

The categorization of computer usage per day was ranged from 1 to 10h. The time measured not only when the pharmacist respondent uses a computer during work hours but also when the respondent uses their personal computer at home beyond their work hour related to pharmacy. The 3h interval is based on pharmacist practice averaging 3h daily. The age characteristics of respondents were classified based on age groupings according to the Indonesian Ministry of Health (2009), 30 years are included in the category of early adulthood, while 40 years are included in the category of late adulthood. While the computer year experience category measured from their bachelor graduated. This questionnaire was validated through the face validity test by the expert to ensure the instrument appearance corresponding to the content to be measured.

Many drugs required dosage adjustments in patients with kidney and liver failure. There were 55 of 137 drugs that required dose adjustments based on decreased kidney and liver function in the Dosing GAMA application. Drug dose adjustment is a dosage individualization activity in order to improve patient safety. In Indonesia, the evaluation of dosage adjustment is one of the pharmaceutical care activities to prevent drug-related problems (Indonesian Ministry of Health, 2014). Mpila (2017) conducted a measurement of how long it took to find drug-related problems with and without the help of health information systems. The digital watch was used to measure the time of dose adjustment evaluation.

User acceptance affects the success of software development (Elnaem & Jamshed, 2017). Software acceptance evaluation is intended to reveal whether respondents can accept an application. The perceived acceptance questionnaire consists of 4 questions aimed at obtaining respondent information about how respondents perceive the application tested (Ammenwerth *et al.*, 2003). This questionnaire was also developed by researchers with questions on how to respond to health information systems for pharmacists, whether this application is easy enough to use, useful to help evaluating dosage adjustments, and whether they agree if the application is widely used. This instrument reliability was high, with the coefficient Cronbach's alpha of 0.80 (>0.70) and valid for all items with the Pearson correlation ranges from 0.71 to 0.85 (>0.5).

Data collection

The collecting data process (Figure 1) started after the participants were recruited. The researcher invited participants to attend the data collection forum according to the researcher and each participant's schedule. The data collection forum was conducted on two consecutive days. The first day took 4 hours and the second day took 3 hours. During the forum, both groups made dose adjustment evaluation from the case scenario. The intervention group used Dosing GAMA to evaluate the dose adjustment, while the control group evaluated the dose adjustment manually. Besides, the intervention group was then asked to complete the perceived acceptance questionnaire.

Data analysis

Data were analyzed quantitatively using SPSS software. The impact of Dosing GAMA application on reducing the time of dose adjustment evaluation was analyzed by using an independent sample T-test with a significant p-value of <0.05. Furthermore, this study confounding variables, such as computer literacy and perceived acceptance of the application, were controlled statistically using multivariate multiple regression with a significant p-value of <0.05. Meanwhile, the perceived acceptance for using the application itself was analyzed descriptively and presented in numbers and percentages.

RESULTS AND DISCUSSION

Characteristics of participants

The characteristics of participants, along with their level of computer literacy, were presented (Table I). It can be seen that the intervention group was similar to the control group in terms of age, gender, occupation, and computer literacy (p>0.05).

In each group, the number of female respondents (84.61%) was more extensive than male respondents. The difference is also strengthened by the evidence that more than 55% of pharmacists are women (Fitzgerald, 2018). Most respondents (84.61%) were 21 to 30 years old, categorized as early adulthood with average age 27 years old with the range of 24-37 years old. In both groups, most respondents were pharmacists taking graduate study in Clinical Pharmacy, while the next most were pharmacists working in hospitals.

In terms of computer literacy, respondents spent 7-10h per day and had been using computers for 7-10 years, and the most widely used computer type was a laptop. The results showed that the pharmacists' work is closely related to computers (Bandameedi, 2016). Subjective assessments by respondents regarding their computers skills indicated that most of respondents had ordinary skills in using computers.

Reduction of dose adjustment evaluation time by using dosing GAMA software

There are two reasons underlying pharmacists' obstacles when providing pharmaceutical care. The first is a lack of time for pharmacists because they must first look at references before determining patient therapy (Tumkur *et al.*, 2012), and the second is the barriers to start using computer-based information systems. Lack of skills in using computers makes the duration to provide pharmaceutical care even longer (Maclure & Stewart, 2016). Both of these can affect the performance of the pharmacy to perform other activities.

The study showed a difference in dose adjustment duration between the control and intervention groups (p <0.001) (Table II). The average time spent by the control group who made the dose adjustment without application was 27.50±1.23 mins (with the range of 17-38 min) or longer than the average time for the intervention group who made the dose adjustment by Dosing GAMA by 13.81±0.78min (with the range of 2-24min). This finding was consistent with the previous study, proving that health technology applications helped pharmacists find drug-related problems (DRP) more quickly than without using tools. The time difference between pharmacists with the tool's help was 31.0±26.4 seconds and pharmacists without tools 90.5±59.9 seconds (Mpila *et al.*, 2016). Research by Lapão *et al.* (2017) on e-Health applications revealed that the time needed by a pharmacist to provide a conventional one-patient service was 30 mins, but a pharmacist needed only 18 mins with the software.

Table I. Characteristics of pharmacists involve in the study

Characteristic	Control (n=26)	Intervention (n=26)	p-value[a]
Age (average years ± SD)	27.00 ± 3.59	27.35 ± 3.66	
21-30	22 (84.61)	22 (84.61)	0.648
31-40	4 (15.38)	4 (15.38)	
Gender (%)			0.249
Male	4 (15.38)	7 (26.92)	
Female	22 (84.61)	19 (73.07)	
Occupation (%)			0.386
Graduate student	18 (69.23)	15 (57.69)	
Pharmacy drugstore	2 (7.69)	2 (7.69)	
Hospital pharmacy	4 (15.38)	7 (26.92)	
General Medicine Clinics	2 (7.69)	1 (3.84)	
Academic staff	0	1 (3.84)	
Computer literacy Computer usage per day (%)			0.202
1-3 hours	5 (19.23)	4 (15.38)	
4-6 hours	11 (42.30)	8 (30.76)	
7-10 hours	10 (38.46)	13 (50.00)	
>10 hours	0	1 (3.84)	
Computer year experience (%)			0.249
1-3 years	0	1 (3.84)	
4-6 years	4 (15.38)	6 (23.07)	
7-10 years	9 (34.61)	12 (46.15)	
>10 years	13 (50.00)	7 (26.92)	
Computer type (%)			0.118
Laptop	26 (100)	23 (88.46)	
Desktop PC	0	3 (11.53)	
Computer skills (%)			0.283
Very great	1 (3.84)	1 (3.84)	
Great	11 (42.30)	7 (26.92)	
Ordinary	14 (53.84)	18 (69.23)	

[a] proportion of each category for both control group and intervention group balance (p-value >0.05) with Fisher's exact test, with a 95% confidence interval

Table II. Comparison of dose adjustment evaluation time between intervention and control groups

Adjustment dose time intervals (minutes)	Number of respondents per group				p-value[a]
	Control (n=26)	%	Intervention (n=26)	%	
1 – 20	4	15.38	25	95.15	
21 – 40	22	84.62	1	3.84	<0.001
Average ± SD	27.50 ± 1.23		13.81 ± 0.78		

[a] Test using independent sample t-test with a 95% confidence level and significance <0.05

This study used two case scenarios, with a total of 20 types of drugs. Fifteen drugs require dose adjustments based on decreased renal function, and eleven drugs require dose adjustments based on decreased liver function. Dosage adjustments are needed to prevent drug side effects and obtain optimal therapeutic outcomes (Riazi *et al.*, 2012). In the first case, the dose of metoclopramide and ketorolac was recommended for reduced by 50% from 10mg/8h and 30mg/8h to 5mg/8h and 15mg/8h respectively. In the second case, levofloxacin continued with a maintenance dose of 250mg once daily, ranitidine interval was becoming more longer (50mg/24h), and metformin was discontinued because of contraindications (Table III).

Table III. Type of drug which require adjustment dose on the case scenarios based on the Dosing GAMA Application

Drugs	Adjustment dose information on Dosing GAMA Application		Patient's clearance creatinine in the case scenario	Drug dose mention in the case scenario	Adjustment dose recommendation by pharmacists
	Renal Insufficiency	Liver disfunction			
Metoclopramide	Reduced by 50% from normal dose (ClCr[a] <40 mL/min)	No	25.84 mL/min	10mg/8h	5mg/8h
Gabapentin	Maximum use became 700 mg/day (ClCr[a] <60 mL/min)	No		300mg/ 12h	300mg/12h
Ketorolac	Reduced by 50% from normal dose	Yes		30mg/ 8h	15mg/8h
Levofloxacin	Reduced by 50% from normal dose every 24h (ClCr[a] <50mL/min)	No	33.39 mL/min	500mg/ 24h	250mg/24h
Ranitidine	Use every 24 hours (ClCr[a] <50mL/min)	No		50mg/ 12h	50mg/24h
Metformin	Contraindications (ClCr[a] <70mL/min or SCr[b] >1.4mg/dL)	Yes		500mg/ 8h	Switch to Insulin

[a] Creatinine Clearance; [b] Creatinine serum

Table IV. Correlation analysis between computer literacy and dose adjustment time

Variable	Adjustment dose time	
	t	p-value
Computer usage per day (n = 26)	-.843	.409
Computer year experience (n = 26)	1.032	.314
Computer skills (n = 26)	-.396	.696
Perceived acceptance (n = 26)	-.593	.596

Table V. Pharmacist acceptance response to the application

Characteristics	Number of subjects	% (N=26[a])
Response to the application of pharmaceutical information technology		
Very helpful	22	84.61
Helpful	4	15.38
Ease of using Dosing GAMA		
Very easy	10	38.46
Rather easy	14	53.84
Easy	2	7.69
Benefit of Dosing GAMA to help dose adjustment		
Very useful	16	61.53
Useful	10	38.46
Agreement of Dosing GAMA use		
Strongly agree	20	76.92
Agree	6	23.07

[a]Acceptance assessment was made in the intervention group after trying to use the Dosing GAMA

These drugs require a decrease in the dose due to regular doses can cause side effects to worsen decreased kidney or liver function.

The obstacles encountered when using a computer-based system can be a confounding factor. Pharmacists' intentions to use pharmacy information systems are affected by computer usage per day, computer year experiences, computer skills, and perceived acceptance of technology (Alanazi *et al.*, 2018). However, there was no effect of computer literacy and perceived respondents' acceptance of the application with the test of dose adjustment time efficiency in our study (Table III). It means that both pharmacists using a computer for a long time or briefly in a day, having experience of using a computer one year or more than ten years, having tremendous or ordinary skills in using a computer did not affect their speed in evaluating the dose adjustment using Dosing GAMA.

On the other hand, gender and age can affect computer literacy. Young men are more computer literate than women (Jayawardena & Ratnayake, 2018). There is also a correlation between computer experience and computer skills (Maclure & Stewart, 2016). Our study indicated that no significant effects of age, gender, duration of using a computer in a day, and length of time starting using a computer routinely on computer skills.

The use of software for pharmacy increases opportunities in providing clinical services and efficiency in doing their jobs, including improving patient safety (Dolovich *et al.*, 2019). The use of Dosing GAMA or manual methods to make dose adjustment evaluations has similar effectiveness and is expected to reduce human error. As Foord and Gulland (2006) said that technology can reduce human error; although the operation of the system is controlled by humans, human error can still occur. Therefore, it is proven to help pharmacists accelerate the dose adjustment time as part of the pharmaceutical care activities.

Perceived acceptance for using dosing GAMA

The acceptance of a new application by users is affected by positive perceptions of new technology (Kim & Kankanhalli,2015). Descriptive analysis was performed on the perception of acceptability data to see the frequency in each category (Tabel V). 84.61% of participants responded that the development of applications in the pharmaceutical sector was beneficial because no software could help evaluate dose adjustment automatically, and they had never used this kind of software before. Based on the Technology Acceptance Model (TAM), concerning the correlation between humans and the use of technology, the ease of using new technology and the perceived benefits are essential determinants for the acceptance of the technology by users (Durodolu, 2016). In this study, it was proven that 53.84% of respondents stated the ease of using the application, and 61.53% of respondents said Dosing GAMA was very useful in helping pharmacists evaluate dose adjustments. More than half of the respondents strongly agreed (76.92 %) with the use of Dosing GAMA, so that the user could accept the application. According to Quant *et al.* (2016), respondents agree if the health information system helps save time and improve therapy accuracy. The previous studies stated that the perceived acceptance of technology often overlaps with the subjective use of general technology. This is related to user variances, such as the user's computer experience, age, education, and gender (Yen, 2010). Our study revealed there was no effect of age, gender, computer usage per day, computer year experience, and computer skills on user acceptance.

Limitations of this study were the limited number of pharmacists working in hospitals interested in becoming respondents in the study so that the perceived acceptance of this application, if was used in hospitals, could broadly not be justified. Therefore, further research needs to be conducted with many respondents targeting pharmacist respondents who practice in hospitals and with more developed application.

CONCLUSION

The results of time efficiency testing revealed that Dosing GAMA Application as new software was proven to reduce the evaluation time of dose adjustment, and it had high acceptance for using the Dosing GAMA by pharmacists. The application of information technology in the health sector helps health workers to work more efficiently and so does the Dosing GAMA application for pharmacists.

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