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The Effectiveness of Interventions Using Electronic Reminders to Improve Adherence to Hypertension Medication: A Systematic Review

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Abstract--- *Hypertension is a global health problem and a major risk factor for cardiovascular diseases such as ischemic heart disease and stroke. Increasing the prevalence of hypertension causes morbidity and premature mortality as well as rises the burden of health costs. One of the most important treatments is adherence to medication and lifestyle modification, but those interventions need to be enhanced. The study was aimed to evaluate the effectiveness of electronic reminders to improve adherence in patients with hypertension. This systematic review used the related elements to content chosen by the PRISMA statement. Four databases were used to collect the data, SCOPUS, PUBMED, CINAHL, and MEDLINE with articles published between 2010 and 2019. Only randomized control trials (RCTs) with hypertension patients without any acute complications and healthcare professionals have been collected on this study. The intervention was an electronic reminder to evaluate adherence and quality study should have been conducted. The primary outcomes were changes in mean systolic and diastolic blood pressure values and patients' compliance. Fourteen articles were included to assess adherence and blood pressure as outcomes. The most effective types of intervention were short message services (SMS), nurse-led email reminders, portal-based assessment, and electronic pillbox. An education session was conducted in each intervention. Medication adherence and hypertension control were improved after 24 weeks with reminders twice a day. Although different interventions had a different effect on blood pressure and adherence, overall, an SMS method can potentially improve adherence to hypertension. The majority of studies reported beneficial approaches to low cost and safety.*

Keywords--- *adherence; electronic reminders; hypertension*

I. INTRODUCTION

Hypertension is a global health problem that can result in morbidity and increased mortality rates and a higher burden of health costs [1], [2]. Many studies explain that hypertension significantly increases the risk of cardiovascular diseases such as ischemic heart disease and stroke [3], [4]. Hypertension is a silent killer which has varied symptoms

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for different individuals, almost the same with other diseases [5]. According to the American Heart Association (AHA), the number of Americans over the age of 20 who suffer from hypertension has reached 74.5 million, but almost 90-95% of the cases are unknown [6]. In Indonesia, the prevalence of hypertension reached 34.1% in 2018 and showed an increase of 8.3% in prevalence compared to 2013 [7].

One of the essential treatments is adherence to medication and lifestyle improvement, but those still lack good outcomes [8]–[10]. Adherence to treatment is a complex phenomenon and contributes significantly to improve blood pressure control in hypertensive patients. Low medication adherence is a major challenge, especially in cases of asymptomatic hypertension that requires long-term treatment [11]. Some studies estimate that overall treatment adherence in hypertensive patients only reaches ≤50% [12]–[14]. Noncompliance has high consequences not only for uncontrolled blood pressure but also for increased mortality and morbidity due to cardiovascular diseases. Patients who had high adherence showed 45% more ability to achieve controlled blood pressure compared to those who had moderate or low adherence [15]. Observational studies conducted in the Lombardy region showed that the use of antihypertensive drugs reduced by 37% the risk of cardiovascular disease [16]. Although many interventions have been carried out to improve treatment compliance [17]. Direct or indirect methods are available to measure compliance, including biochemical measurements, but most of these interventions are not feasible and have limitations [11].

Technological advances in the globalization era have resulted in the implementation of various technologies in the health sector meant to improve patient clinical outcomes and health care effectiveness [18], [19]. Technology creates a simple, inexpensive and effective intervention in the health sector [20]. One application of technology in the health field is a reminder system. This is an intervention that can be implemented as an effort to control hypertension [17]. Its use has been shown to improve patient health outcomes such as reduced frequency of doctor visits and hospitalizations as well as reducing prescribed medication over time that is associated with controlled patient conditions due to medication adherence [21], [22]. Although most studies agree that the use of technology can improve patient health, the effectiveness of appropriate reminder system interventions for controlling hypertension has not been tested in groups of adults [23], [24]. Effective control of hypertension has become a global health policy priority, so a deeper study is needed regarding the health care system in providing appropriate interventions to solve hypertension cases. This study aimed to evaluate the effectiveness of electronic reminders in improving adherence in patients with hypertension.

II. METHODS

- Search and strategy

This systematic review used elements related to content chosen by the PRISMA statement. Four databases were used for collecting the data, SCOPUS, PUBMED, CINAHL, and MEDLINE with articles published between 2010 and 2019. Only randomized control trials (RCTs) with hypertension patients without any acute complications and healthcare professionals were included in this study. Two reviewers developed the following basic search strategy including: "electronic reminders OR reminder systems OR information systems * OR communication" AND "adherence OR therapeutic adherence OR compliance OR treatment adherence OR medication adherence" AND "hypertension OR blood pressure". A comprehensive search strategy was shown in Figure 1. There were restrictions used in terms of the type of articles and languages.

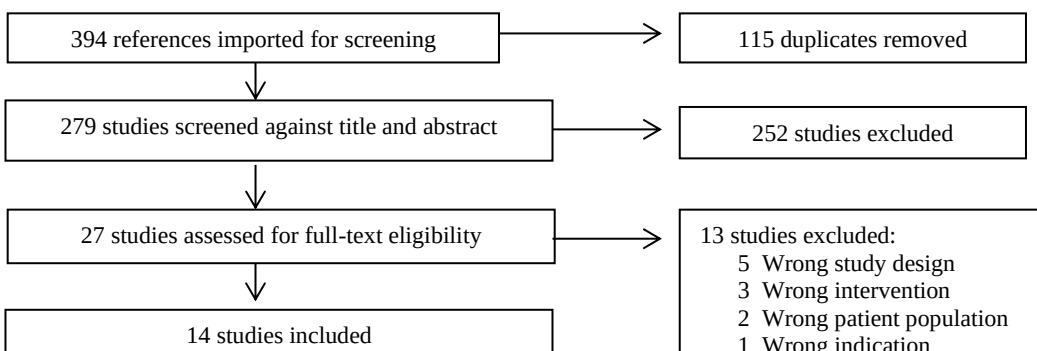

Figure 1 – Flow chart of the study identification process (Liberati in 2009) [25]

- Inclusion and exclusion criteria

The studies that met the following criteria were included in the research: a) Adult (≥18 years) patients with hypertension (over 140/90 mmHg), b) Randomised controlled trials (RCTs), c) Undergoing treatment with antihypertensive medication at least one year, d) No acute hypertension complications such as heart failure, stroke, renal failure, and visual impairment, e) Type of interventions: electronic reminder to evaluate adherence, valid materials should have been used, f) Healthcare professionals in conducting the studies. While the exclusion criteria were: a) Unwillingness to cooperate, b) Participants with mental conditions such as depression or schizophrenia and lack of cognitive impairment, c) Non-validated methods for measuring medication adherence, d) The absence of a control group or the presence of a comparator group receiving another intervention. The intervention was an electronic reminder to evaluate adherence and reliable research tools should have been used. The primary outcomes were changes in mean systolic and diastolic blood pressure values and patient compliance.

- Data extraction

The data from each study were extracted independently by two reviewers based on a) Characteristics of the study (title and year of publication), b) Participants (inclusion and exclusion criteria), c) Interventions (electronic reminder system), d) Results (blood pressure and compliance patient). Disagreements in the extracted data will be resolved by the third reviewer.

- Quality assessment

This study used the Cochrane collaboration tool to assess the risk of bias from the studies conducted [26]. For each study, some items evaluated included sequence generation, blinding of participants and personnel for all outcomes, blinding of outcome assessors for all outcomes, incomplete outcome data for all outcomes, and selecting outcome reporting. Executing an assessment of the method and description of each domain showed a low risk of bias.

- Synthesis

Using analytical content, the results of all the research were presented narratively based on each outcome.

III. RESULTS

Study selection

The initial search returned 394 matches that were potentially relevant; after removing duplicate files, 279 files remained. Using the inclusion and exclusion criteria as well as screening titles and abstracts, 27 articles were left for full-text screening. Finally, 14 eligible RCTs were included in the systematic review (Figure 1).

Study characteristics

Fourteen articles were published between 2010 and 2019, with 4 (28.6%) published from 2010 to 2015[27]–[30], while 10 (71.4%) articles were published from 2016 to 2019 [31]–[40]. All the studies used were published in Science

Citation indexed journals; the impact factor of these journals ranged from 0.76 to 1.65. The respondents were adults who were over 18 years old.

Intervention

Interventions vary in type, including frequency and duration. The types of electronic reminders used include electronic compliance monitoring, email alerts, and phone calls, SMS reminders, electronic pillboxes, and telemedicine. The interventions were given by nurses, pharmacy, or doctors. The duration of the intervention given varies, 7 days [31], 3 months [33], [37], [39], 6 months [28], [30], [32], [35], [38], 9 months [40], and 12 months [27], [29], [34], [36]. In some studies, there were reports that the reminder was used one to two times each day. More specific details on each study were given in Table 1.

Outcomes

The primary outcomes measured in this study were medication adherence and blood pressure. Fourteen studies conducted a review that showed that electronic reminders can significantly improve medication adherence which included taking, dosing, timing, and holiday compliance. Besides, this intervention increased blood pressure control, and it can reduce blood pressure. Several studies analyzed also showed that electronic reminders could improve lifestyle habits and cardiovascular risk factor management [28], [30]–[32].

Table 1. Summary of selected studies

Author (year)	Design	Sample Size	Intervention Group	Control Group	Outcome
Christensen et al., (2010)	RCT	398	Type: electronic compliance monitoring Frequency: 5 times/3 months Duration: 12 months	Standard therapy	Significant improvement in compliance: taking (p=.019), dosing (p=.037), timing (p=.011), holiday (p=.038). Insignificant differences blood pressure: SBP (p=.785), DBP (p=.066)
Cicolini et al., (2014)	RCT	198	Type: email alerts and phone calls from the NCM (nurse care manager) Frequency: once/week Duration: 6 months	Usual care	Significant improvement in both lifestyle habits and CVD risk factor management. Reduced blood pressure (p=.001)
Jha et al., (2017)	RCT	3702	Type: mWellcare system (health records electronically and SMS reminders) Frequency : - Duration: 12 months	An enhanced care arm (doctor's decision on management plan based on standard guidelines)	Effectiveness of the nurse-based mHealth intervention for integrated management of hypertension and diabetes at the primary care level
Bailey et al., (2017)	RCT	1505	Type: SMS text message reminders Frequency : 2 times/day Duration: 6 months	Usual care	Support medication adherence. Helping patient remember when to take the medication
Zhai et al., (2019)	RCT	184	Type : SMS text message reminders + health consultation + standard pharmaceutical care Frequency: once/3 days Duration : 3 months	Standard pharmaceutical care	SMS reminders and consultation are an effective way to improve medication adherence and manage blood pressure in community settings. Low-cost approaches and can be easily integrated into daily practice.
Bobrow et al., (2014)	RCT	1215	Type: SMS Text-message Adherence suppoRt trial (StAR) Frequency : - Duration: 12 months	Usual care	Support patients in treatment adherence and improve blood pressure control. StAR trial uses a novel, low-cost system based on widely available mobile phone technology.
Kronish et al., (2016)	RCT	100	Type: An Electronic Adherence Measurement Intervention (a brief how to	Usual care	Improved clinical management of uncontrolled hypertension.

			interpret the adherence report + electronic pillbox) Frequency: 10 minutes of training Duration: 7 days		Improved adherence in intervention and control group (56 % versus 26 %; p = 0.01)
Ashoorkhani et al., (2016)	RCT	132	Type: BPMAP application (reminders for dose and time of drug intake, date of clinical visit, and other reminders will be activated) Frequency : - Duration: 6 months	Usual standard care	Reduce many of the nonadherence factors of hypertension treatment. Therefore, the findings may contribute to a rise in adherence to treatment.
Xu et al., (2017)	RCT	210	Type: telemedicine-based hypertension interventions including a BP telemonitor and a mobile app Frequency: every 3 months Duration: 12 months	Usual care	Improve hypertension care and impact a greater number of patients with uncontrolled hypertension.
Haramiova et al., (2017)	RCT	300	Type: daily SMS reminders of antihypertensive medication Frequency : once/day Duration : 3 months	Standard pharmaceutical care (sPhC)	Efficient and cost-effective intervention. The results may identify new possibilities and capacities in healthcare with low additional costs and high value to patients
Varleta et al., (2017)	RCT	314	Type: SMS text messages Frequency : 2 times/day Duration: 6 months	No SMS	Adherence improved significantly in the SMS text message group from 49% to 62.3% (*p*=.01). Blood pressure was 134.6/77.5 mm (Baseline mean BP was 142.7/81.1 mm Hg) in the SMS group.
Chandler et al., (2019)	RCT	54	Type: Smartphone MA Stops Hypertension (SMASH) program Frequency : 2 times (morning + evening)/3 day Duration: 9 months	Standard care	No statistically significant differences in improved adherence between the SMASH and ESC groups at baseline (p = .604)
Schoenthaler et al., (2015)	RCT	148	Type: Counselling with Health Coaches using an electronic medical record system- embedded adherence script. Frequency: 9 sessions Duration: 6 months	Usual care	Provide salient information on the translation of culturally tailored, evidence-based interventions targeted at medication adherence and blood pressure control into practice-based settings for this high-risk population
Maslakpak et al., (2016)	RCT	123	Type: short message service (SMS) to reminder cards Frequency: 6 times/week Duration : 3 months	Standard education of the clinical center	Statistically significant differences in adherence to treatment (p<0.001). Text messaging and reminder cards can encourage the patients to adhere to their treatment plans

RCT: Randomized Controlled Trial; CVD: Cardiovascular Disease; SMS: Short Message Service

IV. DISCUSSION

In this review, several electronic reminders interventions have been proven to improve medication adherence and blood pressure control in hypertensive patients. The World Health Organization defined compliance as the extent to which a person's behavior in taking medication, following a diet and carrying out lifestyle changes was in accordance with the treatment program of the health care provider [41]. In clinical practice, electronic reminders help patients to follow treatment program recommendations and have several advantages including saving time and energy, and being easy to use in a variety of patient cases [42]. In reviewing the types of interventions studied, those with the most consistently positive findings were SMS reminders. The use of SMS services was an interesting reminder and easy to use in modern medical practice [38]. The majority of studies reported beneficial approaches to low cost and safety. Text messages can convey simple information with some repetitions potentially leading to a change in behavior [43]. SMS has consequently been incorporated into daily life [38]. Therefore it can be trusted that SMS can help the management

of heart disease and some studies even show that this intervention can be used in cases of smoking and weight loss [44]–[46].

Although some studies showed statistically significant results that SMS reminders can reduce blood pressure, the overall effect was very small (decreasing 8.1/3.6 mmHg) [29], [38], [39]. Vollmer's study showed that even a small decreasing percentage point of blood pressure can have important public health implications. For example, a decrease in blood pressure of 2 mmHg can reduce long-term cardiovascular risk [47]. An increase in blood pressure control is one of the most beneficial steps in increasing life expectancy and the quality of life for patients with hypertension.

The review results in this study also recommended several other types of electronic reminder interventions that can be used, including electronic compliance monitoring, email alerts, and phone calls, electronic pillboxes, and telemedicine. An educational session was conducted in each intervention. This is consistent with studies conducted by Anderson et al. that measured compliance in several ways including pill count, self-report, pharmacy refill data, electronic monitoring, drug blood levels, and observation by healthcare professionals [48]. Regarding the role of healthcare professionals for patients with chronic diseases such as hypertension, most studies highlighted the important role of nurses in health education in various care settings [28], [34]. Nurses can be case managers who can conduct coordinated follow-up visits and data, record data collection, and implement educational programs [28]. This result was supported by a review conducted in 2010 which analyzed the effectiveness of interventions in increasing adherence to antihypertensive treatment showing that the nurse/pharmacist management program and the combination of reminder systems were effective interventions, both in terms of outcomes and cost [49].

V. Conclusion

Lack of adherence to treatment is a challenge that cannot be avoided in the management of hypertension. Electronic reminder interventions, including electronic compliance monitoring, email alerts, and phone calls, SMS reminders, electronic pillboxes, and telemedicine can be a solution to these problems. Although different interventions have a different effect on blood pressure and adherence, the overall SMS method could be promising in improving adherence to hypertension medication. The majority of studies reported beneficial approaches to low cost and safety of this type of intervention.

Conflict Of Interest

No conflict of interest was disclosed**.**

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