ORIGINAL ARTICLE

Electrocardiogram Recording Results of Distilled Water, Jelly, NaCl and without Conductor: Evidence Based Practice

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ABSTRACT

Introduction: Evidence based practice is an approach to facilitating the transfer of evidence into quality clinical practice. Nurses as professional health workers should refer to evidence-based approach in providing nursing care. One of them is recording Electrocardiogram (ECG). ECG is a common test performed for patients with cardiovascular. However, in some regions in developing countries with limited facilities such as ECG conductors, ECG recording is difficult to be performed. This research aimed to investigate the possibilities of substitutions conductors for ECG that seek from the artifacts of ECG recording results using 0.9% NaCl, jelly, distilled water and without conductor in ECG tests. **Method:** This study employed a quasi-experimental design using a randomized post-test only control trial approach. The study was conducted on inpatients and outpatients who were performed ECG test by a cardiologist who is a member of the research team. A samples size of 81 people were obtained through purposive sampling technique and divided into three groups. The research instrument used for all groups was an observation guideline for the artifact images of ECG recording results. **Results:** The results showed that there was no significant difference of the artifact images resulted from using 0.9% NaCl, distilled water, and jelly as conductors in ECG tests. While ECG recording resulted between NaCl and without conductor showed that there was significant difference between two groups indicated by the p value of 0.010 (α=0.05). **Conclusion:** In conclusion, it was found that 0.9% NaCl and distilled water were effective to be used as conductors to substitute jelly to obtain a good recording result of ECG tests.

Keywords: Evidence based practice, Substitution, Electrocardiogram, Conductor

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INTRODUCTION

Electrocardiogram (ECG) recording is one of the important assessments in determining underlying problems in the cardiovascular system. The ECG recording results are essential for diagnosing and informing health workers, especially nurses, a change of patient conditions. However, ECG recording should be performed accurately as the errors in recording procedures and misinterpretation can lead to inaccurate diagnosis. Therefore, to avoid errors in recording ECGs, health workers including nurses must have a great understanding and knowledge concerning ECG (1).

ECG is an important diagnostic and monitoring tool in health care systems (2). ECG is a combination of three words, namely: electro means electrical signal; cardio means heart; and gram means recording. Thus, the electrocardiogram is the recording of the electrical signal of the heart. The instrument used to record the electrical activity of the heart is called electrocardiograph (3). There are three types of ECG recording, namely: (1) standard clinical ECG using twelve leads, (2) vector cardiogram (VCG), and (3) ambulatory ECG (monitoring). The VCG and monitoring types are used in bedside monitors in intensive room (4).

An artifact is a sight resembling a fine or fuzzy hair on an ECG image. According to Jevon and Ewens (1), this wave interference called artifact are caused by several factors including: the patient experiencing a seizure or shiver and anxiety due to the contact between the electrodes and the dirty skin, (c) the incorrect placement of electrodes, (d) the dry electrode jelly, (e) short circuit in the electrode cable, (f) interference from other electronic equipment near the patient (e.g.: mobile phone, watch battery). Wahab (5) argued that artifacts are baseline irregularities in ECG images caused by air conditioning interference, tremor muscles, variations in respiration, and improperly attached electrodes. The characteristic of the artifacts is that it is difficult to distinguish the peak of R waves (6) and the large baseline value of amplitude (7).

Studies related to the conductors used in ECG recording are limited. Several studies conducted in Indonesia reported that the ECG recording using jelly as a

conductor tends to be more effective than using water as conductors as identified by the presence of artifacts (8). This indicates that there are other conductors that can be used as electrical conductor in recording the ECG other than the frequently used jelly.

In the last two decades there has been several studies conducted related to ECG conductors and its alternatives. One of which related to the ECG recording using jelly and water as conductors for patients with coronary heart disease (CHD). A study carried out in the Intensive Cardio Vascular Care Unit (ICVCU) Hospital Moewardi reported that ECG recording using jelly as conductor tends to be no more effective than using water conductors as examined by the appearance of artifacts (8). Another study concerning the interferences of ECG signal recording found that signal interference could be eliminated by sub-heating each sub-band using iterative method (9). The study conducted by Beckman et al (2010) (10) which investigated on the use of electrodes and conductors made of special textile materials as an alternative of electrodes and conductors on dummy skins showed that the results of ECG recording provide a fairly good electromagnetic effect.

Nurses as professional health workers should refer to the evidence-based approach in providing nursing care related to the type of care and nursing treatments for the patients. ECG recording is a common test performed for patients with cardiovascular problems who requiring continuous observation (2). However, not all health services have the same facilities and equipment availability, for example the health services located in the District or Municipality and Type C health services. The most frequent obstacle encountered in ECG recording is the availability of conductors. Health services only provide jelly as a conductor, and this is often unavailable or runs out. Therefore, nurses are sometimes unable to perform the ECG recording even if it is required.

This study aims to examine the possibility of other materials to be used as conductors in ECG recording. The reference concerning the use of NaCl 0.9% and distilled water as replacement conductors has not been found to serve as evidence-based practice. Therefore, this research is important to be a reference for practice based on evidence obtained. Preliminary study of ECG recording using NaCl 0.9% conducted by nursing students in University of Riau showed that jelly can be replaced with NaCl 0.9% as a conductor. The recording graph was good, although artifacts were sometimes identified. The samples used in the preliminary study were healthy humans. Therefore, it is necessary to evaluate the results of ECG recording of patients with cardiovascular system disorders.

This study would like to address the research question "Can NaCl and Distilled water be used as alternate conductors of jelly in ECG recording and as evidence based nursing practice?" It is expected that results of this study can directly contribute to the health services by providing alternative evidence of conductors on ECG recording to avoid jelly dependency.

MATERIALS AND METHODS

This is a quantitative research employed Quasi Experimental design with Randomized Post-Test Only Control Trial approach. Ethical approval for this study was obtained from the Ethical Review Board for Medicine and Health Research Universitas Riau (Reference No 089/UN.19.5.1.1.8/UEPKK). The population of this study was on inpatient and outpatient undergoing ECG test for the purpose of the disease diagnosis, disease progression and treatment therapy decision. The purposive sampling technique was used to determine the sample of 81 people. The samples were then randomly divided into three groups. Twice ECG test were equally performed on the three groups. For the first group, an ECG was performed using a NaCl 0.9% conductor and then continued with jelly. For the second group, two ECG examinations were also performed; first examination was without using any conductor followed by using jelly. For the third group, an ECG examination was performed with jelly and then followed by using distilled water. The measurement instrument used in this study was the artifacts observation guideline created by the research team. The reliability of the instrument was tested by using inter-rater reliability techniques (11). The data was analyzed using univariate and bivariate analysis by employing chi square test and independent t-test (12).

RESULTS

The results of t-test in Table I reported that after ECG examination the mean of appearance of artifacts of the group patients using NaCl 0.9% solution was higher than the mean of the group using Jelly (M=0.200, SD=0.761 and M=0.167, SD=0.912 respectively). The results showed that p = 0.878 means p value > α (0.05) indicating that there is no significant difference of average artifacts in the group of patients using NaCl and group of patients using Jelly as conductor on ECG examination. Therefore, NaCl 0.9% is effective to be used as conductor to replace Jelly on ECG recording.

The independent t-test results in Table II illustrated that after the ECG examination the mean of artifacts in the

Table I: Mean Difference of the Number of Artifacts in NaCl Conductor Group and Jelly Conductor Group

Conductor Variable	N	Artifacts Appearance			
		Mean	SD	SE	P value
NaCl Group	30	0.200	0.761	0.138	0.878
Jelly Group	30	0.167	0.912	0.167	

Table II: Mean Difference of the Number of Artifacts in without Conductor Group and Jelly Group

Conductor Variable	N	Artifacts Appearance			
		Mean	SD	SE	P value
Without Conductor	30	1.500	2.501	0.456	0.003
Jelly Group	30	0.000	0.000	0.000	

group of patients without using the conductor were one and half times higher than the mean of artifacts in the group using Jelly (p=0.003). This indicates that there is significant difference of average of artifacts appearance in group of patients who do not use conductor and the group using Jelly as conductor on ECG examination. Therefore, it can be concluded that the conductor is required to obtain a clear recording result on the ECG examination.

The independent t-test results in Table III showed that the mean of artifacts after ECG examination in the group of patients without using the conductor was one and a half times higher than the average of artifacts in the group using NaCl 0.9% (M=0.200, SD=2.501). The result showed that p = 0.010 indicating p value < α (0.05). This means that there is a significant difference between the average of artifacts appearance in the group of patients who do not use conductor and group using NaCl 0.9% as conductor in ECG examination. Thus, it can be argued that NaCl 0.9% is required as a conductor to produce clear recording results on ECG examination. The results of independent t-test in Table IV showed that after the ECG examination the mean of artifacts appearance in the patient group using the Distilled water conductor was 0.570 higher than in the group of patients using Jelly (p=0.069). This indicates that there is no significant difference of average artifacts between the group of patients using Distilled water conductor and the group using Jelly as conductor on ECG examination. Thus, it can be inferred that Distilled water and Jelly are required as conductors to obtain good recording results on ECG examination.

Table III: Mean Difference of the Number of Artifacts in without Conductor Group and NaCl Group

Conductor Variable	N	Artifacts Appearance			
		Mean	SD	SE	P value
Without Conductor	30	1.500	2.501	0.138	0.010
NaCl Group	30	0.200	0.761	0.138	

Table IV: Mean Difference of the Number of Artifacts in Distilled Water Conductor Group and Jelly Group

Conductor Variable	N	Artifacts Appearance			
		Mean	SD	SE	P value
Distilled water Conductor Group	21	0.570	1.363	0.297	0.069
Jelly Group	21	0.000	0.000	0.000	

DISCUSSION

ECG recording requires a conductor to transmit the electrical current from the electrode to the skin. The conductor is a substance connecting the electrode to the skin surface. Conductor also serves to decrease the resistance effect caused by oil produced by glands present in skin tissue (13). That is why ECG recording without using conductor results in the appearance of artifacts even though the person's skin is elastic and not dry. This is due to the absence of mediator between the electrodes and skin. The use of conductors in ECG recording is compulsory as stated in ECG procedures established by the Institute of Indonesian Nursing Studies and Education and Research Board of ICU at Moewardi hospital. This procedure states that the use of conductors in ECG recording should be applied to the surface of the body where the electrode is installed and or to the electrode plate that connect the electrodes and skin (14).

ECG recording using jelly is as good as using NaCl 0.9% and distilled water as indicated by the indicator of artifacts. This is occurred as NaCl 0.9% and distilled water are physiological saline salts equivalent to body fluids and containing electrolytes Na + and Cl- and therefore they have the ability to conduct electricity. This is in agreement with Cree and Rischmiller (15) who argued that a liquid containing electrolyte is a good conductor. NaCl 0.9% as a normal saline fluid has the ability to remove impurities in the skin, thus reducing the effects of skin resistance due to oil gland production. NaCl 0.9% solution and distilled water are sterile physiological fluids and are effective for treating the wound and removing impurities as they have the same concentration (isotonic) as the body fluids and do not cause irritation. Therefore, it is safe to use on the body (16).

The sweep of Chlorine NaCl 0.9% solution and distilled water wetted gauze bandage during ECG recording will indirectly blend with the residual substances released by the body as they have the same atoms of Na and Cl. This increases the concentration of NaCl resulted in the lifting of oil produce by the skin (17). This is in line with the concept of the liquid density. A substance that has lesser density than water will float. The saline water density (1.03 gr/cm3) is greater than the density of the oil (0.845-0.905 gr/cm3) (18). In addition, NaCl and distilled water benefits to moisturize the skin as the wet or moist skin will provide less electrical resistance than dry skin. Electrical resistance in wet skin is 1000 ohm. A voltage of 1 volt can deliver a current of 1 Amp through a 1 ohm resistance. Thus, an object with small resistance will produce a larger electric current (15, 19).

Jelly is the most commonly used conductor in ECG recording. Some examples of ECG jelly are Ultrasound-ECG and Signa Gel contains polymer, humectants, water, perfume and ideal salt. This finding is in line

with the work of Anwar (2012) (20) that says jelly consists of water, humectant (moisturizers) and preservatives. The jelly is usually made of a polymer of a certain concentration forming a semisolid consistency. Polymers are large compounds formed from the combination of small molecules, such as the carbomer, a synthetic polymer compound widely used for topical preparations. The production of jellies from carbomers requires an inorganic base (NaOH, KOH) and Na2CO3 salt to obtain a near-normal pH value. The addition of 1% NaCl is then required to obtain the desired viscosity of jelly at neutral pH. The process of jelly formation is influenced by (1) cation concentration (Ca2 +, Ba2 +, Sr2 +), (2) the concentration of calcium salt (CaCl, Ca sulphate and Ca lactate), (3) pH balance influenced by NaOH, KOH, ammonia and others (20).

Based on the previous explanation that jelly consists of several ions including K, Ca, Na, Ba, Cl, O, H, and Si which are the salt forming atoms. The salt in the jelly acts as electrolyte conducting electricity. The jelly acts as a connector between the electrode and the skin to improve the quality of the signal transmitted to the galvanometer. However, jelly may harden and contaminate the electrode when it is not cleaned properly after ECG recording resulting in it being sticky on the skin surface reducing the patient's comfort and causing electrical disruption from the galvanometer to the skin (21). These cause artifacts on ECG recording. Other factor that may cause artifacts is patient's movement during ECG recording.

The results of this study indicate that the ECG recording using NaCl 0.9% is better than the recording without conductor as indicated by the artifacts appearance. ECG recording using jelly produces better result compared to recording without conductor as identified based on the indicator of artifact. Comparing the results of ECG recording using jelly and NaCl 0.9%, it is said that they are equally good as indicated by the artifacts. The ECG recording using distilled water is also as good as the recording using jelly and NaCl 0.9% based on artifacts as the indicator.

CONCLUSION

The results of ECG recording using NaCl 0.9%, jelly and without conductor showed that precordial electrode is not lost. Although artifacts still appear in the recording, they do not disturb the interpretation of results in ECG recordings. This means that NaCl 0.9% and distilled water are significantly effective as conductors to be used in ECG recording. Therefore, it can be concluded that NaCl 0.9% and distilled water can be used to substitute jelly during ECG recording.

The results of this study may contribute and provide more insight to hospitals and other health facilities by providing reference for the alternative conductor materials on ECG recording. It is expected that the results of this study can be used as evidence based practice in the effort of science development, especially in improving the service of ECG recording as one of supporting examinations.

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