Key words : Theoretical substruction, Fatigue, Cardiac arrhythmia

Theoretical Substruction: Fatigue in Cardiac Arrhythmia Patients

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I . Introduction

All human beings experience fatigue during their lives. Fatigue is a universal symptom and the most common complaint among people, whether they are healthy, physically or mentally ill. Understanding the nature of fatigue as experienced by various populations is significant to nursing because it is one of the most common problems associated with all health-related disorders (Schaefer & Potylycki, 1993). Although fatigue is one of the most common human responses and lots of studies on fatigue have been conducted in health related disciplines, the complex phenomenon of fatigue is neither well understood nor clearly delineated (Hart & Freel, 1982). Little is known about fatigue in clinical populations that can guide nursing assessments and interventions (Piper, Lindsey, & Dodd, 1987; Davis, 1984; Hart, 1978; Haylock & Hart, 1979). Clearly, there is a need to understand the nature of fatigue on the basis of clinical populations since most works on fatigue are conducted using the healthy population.

It is significant that no studies exist about fatigue in cardiac arrhythmia patients. The heart is the main organ pumping out enough blood to meet the demands of all of the organs and tissues; it supplies oxygen and other nutrients necessary to maintain the vitality of the body system, and eliminates carbon dioxide and other tissue's waste products in the human body (Guyton & Hall, 1996, Smith & Kampine, 1984). The primary function of the heart is executed by the regular contractions of cardiac muscle. In contrast to the importance of the heart, little is known about human response, a nursing area of interest, to cardiac arrhythmia.

Therefore, the theoretical framework of

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the relationship between fatigue and cardiac arrhythmia, theoretical structure, and empirical structure will be discussed and presented throughout this paper. At the end of the paper, research questions will be suggested and presented.

CARDIAC ARRHYTHMIA

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SHORTENED VENTRICULAR FILLLING TIME

↓

DECREASED END-DIASTOLIC VOLUME

↓

DECREASED STROKE VOLUME OUTPUT

↓

DIMINISHED CARDIAC OUTPUT

↓

DECREASED BLOOD (OXYGEN) SUPPLY TO TISSUE

↓

HYPOPERFUSION OF BOTH WORKING SKELETAL MUSCLE & VISCERAL ORGAN

↓

EARLY ANAEROBIC METABOLISM

↓

INCREASED PLASMA LACTATE CONCENTRATION (Increased lactic acid)

↓

FATIGUE

〈Figure 1〉 Theoretical framework of fatigue in cardiac arrhythmia

Ⅱ. Theoretical framework of fatigue in cardiac arrhythmia patients (Figure 1)

The heart is composed of three major types of cardiac muscle: the atrial muscle, the ventricular muscle, and the specialized excitatory and conductive muscle fibers. The atrial and ventricular types of muscle contract in much the same way as skeletal muscle except that the duration of contraction is much longer (Guyton & Hall, 1996). It is well known that the heart has four special characteristics: excitability, conductivity, contractility, and rhythmicity (Vanden Belt & Ronan, 1987, Guyton, Jones, & Coleman, 1973). These anatomical and physiological features of the heart are necessary in order to perform its function as a pump. The heart functions as a pump to supply blood to each of the body's systems and then, finally, to allow tissues to exchange various substances such as oxygen, carbon dioxide, nutrients, tissue waste materials, and other ions. Cardiac function is achieved by the integration of these four characteristics.

In case of cardiac arrhythmia, however, the physiologic characteristic of rhythmicity is interrupted. These causes may be not only from diseases such as cardiac muscle damage (myocardial infarction), abnormal nervous excitation/ depression, and so on, but also from a state without any pathological factors (Kelley, 1997). In cardiac arrhythmia, regardless of its causes or underlying pathophysiologic factors, the rhythm of contraction of the cardiac muscle is disturbed and its regularity and duration of contraction is changed. Arrhythmia can be classified by the speed of heart rate into two groups: a faster than normal rhythm and a slower than normal rhythm.

First, in a faster cardiac rhythm, the duration of each total cycle of the heart (including the contraction phase and the relaxation phase) decreases (Guyton & Hall, 1996). When the heart beats at such a very fast rate it often does not remain relaxed long enough to allow for a complete filling of the cardiac chambers before the next contraction. Especially, at rates exceeding 180 beats per minute, ventricular filling time is inadequate to maintain adequate stroke volume (Kelley, 1997, Smith & Kampine, 1984); that is, this inadequate time to relax and dilate cardiac muscles does not allow blood to flow down from the body's systems and pulmonary system into the atria, and from the atria into ventricles so that the *end-diastolic volume* (the volume filling the ventricles during diastole: normally 110-120 ml) becomes decreased (Guyton & Hall, 1996, Smith & Kampine, 1984, Guyton, Jones, & Coleman, 1973). As ventricles are not filled by enough blood to meet the demand of these systems, the heart pumps blood in a very irregular rhythm basis. Consequently, the *stroke volume output* (the volume as the ventricles empty during systole: about 70 ml) is diminished (Guyton & Hall, 1996).

In addition to a faster cardiac arrhythmia, a lower cardiac arrhythmia also causes a reduction in the cardiac output. Although the heart itself may have enough time to relax, dilate, and contract, the frequency of the cardiac contraction is not enough to supply an adequate amount of blood into the systems and so the tissue demands of oxygen and nutrients are not met. As a consequence of this slower cardiac rhythm and decreased cardiac output, the episodes of syncope and loss of consciousness are presented.

This decreased cardiac output affects the amount of blood supply to the cardiac muscle itself as well as to all of the tissues in the human body. Due to the lack of blood supply, both working skeletal muscles and visceral organs are hypoperfused. The hypoperfusion of both skeletal muscles and visceral organs leads to early anaerobic metabolism, which produces lactic acid in both skeletal muscles and visceral organs because of the paucity of oxygen concentration in tissues (Drexler & Coats, 1996). The increased plasma lactate concentration may induce fatigue (Drexler & Coats, 1996; Hart & Freel, 1982; Piper, 1991; Morris, 1982). Reduced oxygen supply due to the diminished cardiac output precipitates fatigue in cardiac arrhythmia patients. In addition, the cardiac muscle itself also may get fatigued because of the inadequate period of relaxation.

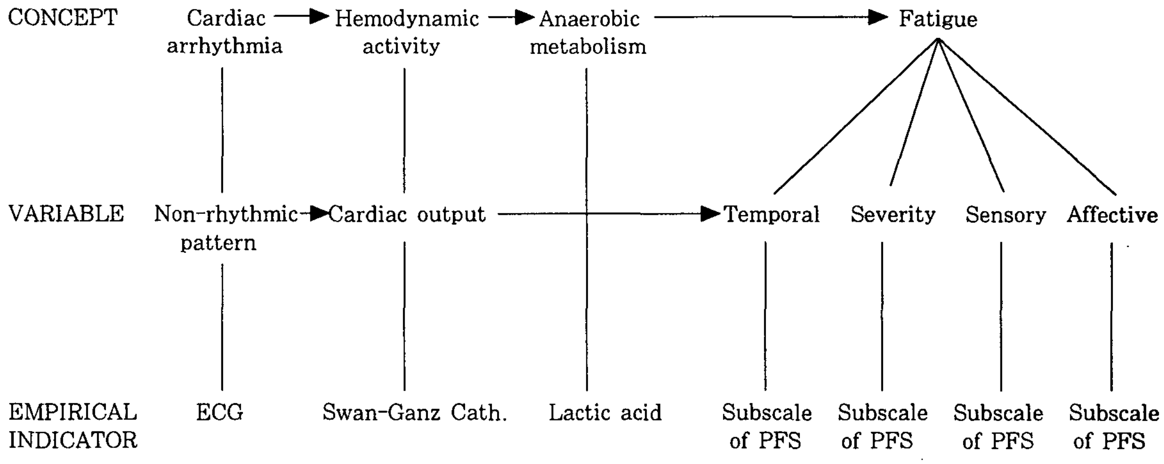
Therefore, irregular cardiac contractions, decreased ejection fraction of the heart, decreased strength of the heart muscle, and insufficient ejected blood may all contribute to fatigue (Lee, 1993).

Ⅲ. Concepts & their linkage

Three concepts, cardiac arrhythmia, hemodynamic activity, and fatigue, will be selected from the conceptual model of this study (Figure 2.), and discussed in the following section.

1. Cardiac arrhythmia

Cardiac arrhythmia literally means 'without rhythm in the heart', and is characterized by an abnormal rhythm or by breaks in the



〈Figure 2〉 The conceptual model of fatigue in cardiac arrhythmia & Substruction

regularity of a normal rhythm in the heart (Dubin, 1975).

2. Hemodynamic activity

Hemodynamic activity refers to the movement of forces involved in circulating blood through the body (Thomas, 1993).

3. Fatigue

Fatigue is theoretically defined as an individual, subjective feeling or perception of an overwhelming and sustained sense of exhaustion (Piper, Lindsey, & Dodd, 1987, Jensen, & Given, 1991, Lee, 1993). This exhaustion is caused by physiological or psychosocial stress or pressure; fatigue affects human-environment interaction in diverse ways, such as the inability to keep ones usual life pattern.

These three concepts (cardiac arrhythmia, hemodynamic activity, and fatigue) are linked together as follows: cardiac arrhythmia affects hemodynamic activity. The affected hemodynamic activity by cardiac arrhythmia finally induces fatigue in human beings.

Ⅳ. Variables & their linkage

From the theoretical definition of each concept, six variables can be epistemio-logically narrowed down (Table 1).

1. Non-rhythmic pattern

From the concept of cardiac arrhythmia, non-rhythmic pattern can be narrowed down as variable of cardiac arrhythmia. The meaning of the term 'rhythm' in the heart is "the regular occurrence of impulse" (Thomas, 1993, p.1724). Thus, non-rhythmic pattern refers to the irregular occurrence of impulse, which affects the duration of each total cycle of the heart including the contraction and the relaxation phases. Non-rhythmic pattern in the heart can be specified as "irregular heart action caused by physiological, or pathological

〈Table 1〉 Definitions and Measures of Concepts & Variables

	Concepts	Variables	Measures
Definitions	Cardiac arrhythmia: Without rhythm in the heart and characterized by an abnormal rhythm or by breaks in the regularity of a normal rhythm in the heart.	Non-rhythmic pattern: The irregular occurrence of impulse in the heart.	Electrocardiogram (ECG)
	Hemodynamic activity: The movement of force involved in circulating blood through the body.	Cardiac output: The volume of blood ejected from the left or right ventricle to each system per minute.	Swan-Ganz Catheter
	Fatigue: An individual, subjective feeling or perception of an Overwhelming and sustained sense of exhaustion.	"Temporal, severity, sensory and affective" dimensions of fatigue	Subscales of the Piper Fatigue Scale (PFS)

disturbances in discharge of cardiac impulses from the sinoatrial node or their transmission through conductile tissue of the heart" (Thomas, 1993, p.149). The non-rhythmic pattern is the main characteristic of cardiac arrhythmia and is based on the theoretical definition, "without rhythm; abnormal rhythm, or breaks in the regularity of a normal rhythm in the heart" (Dubin, 1975).

2. Cardiac output

Undoubtedly, one of the most basic cardiovascular measurements is the output of the heart. Cardiac output is defined as the volume of blood ejected from the left or right ventricle to each system per minute (Thomas, 1993, Smith & Kampine, 1984). Cardiac output is a hemodynamic activity in the heart. In the resting human adult, mean flow to the entire body is about 80 ml/kg/min so that total flow or cardiac output in an average sized subject (70 kg) is about 5.6 L/min. Cardiac output is correlated with both body mass and body surface area (Smith & Kampine, 1984).

In the concept 'fatigue', there are four different characteristics: temporal, severity, sensory, affective (Piper, 1991). These are explained in order.

3. Temporal

The 'temporal' dimension of fatigue is related to the timing, onset, and duration of the fatigue (Piper, 1991).

4. Severity

The 'severity' dimension of fatigue is related to the intensity, distress and degree of interference in activities of daily living (Piper, 1991).

5. Sensory

The 'sensory' dimension of fatigue is related to the physical, emotional & mental symptoms of fatigue (Piper, 1991).

6. Affective

The 'affective' dimension of fatigue is

related to the emotional meaning of the fatigue (Piper, 1991).

V. Empirical indicators

1. EKG

Non-rhythmic pattern in the heart can be measured by electrocardiogram (ECG). ECG is defined as a record of the electrical activity of the heart and shows certain waves such as P, QRS, T, U waves, and so on (Thomas, 1993).

2. Swan-Ganz catheter

Cardiac output has been measured using a variety of techniques in which an indicator is injected into the circulation and subsequent dilution of the indicator is the basis for the determination of cardiac output. The introduction of the Swan-Ganz pulmonary artery catheter made the thermodilution method widely available (Bowdle, Freund, & Rooke, 1991). Swan-Ganz cathether is a soft, flexible catheter that contains a balloon near its tip. The catheter is passed through the vein to the right heart, being carried along by the blood returning to the heart. Once the catheter reaches the pulmonary artery, the balloon can be inflated to occlude the artery and allow the downstream pulmonary venous pressure to be measured from the distal lumen of the catheter. The methodology for determination of cardiac output by thermodilution with the Swan-Ganz catheter is as follows. The cold liquid (colder than the patient's blood; usually saline solution or 5% dextrose in water) is injected, via the pulmonary artery catheter, into the right atrium, where it mixes with venous blood and causes the blood to cool slightly. The cooled blood is ejected by the right ventricle into the pulmonary artery, where it passes by a thermistor near the tip of the pulmonary artery catheter. The thermistor measures the change in blood temperature as the cooled blood travels past on the way to the lungs. The extent of cooling is inversely proportional to cardiac output (Bowdle, Freund, & Rooke, 1991).

3. Subscales of Piper Fatigue Scale (PFS)

The Piper Fatigue Scale is developed to measure subjective fatigue. It has been tested and shows good reliability and validity estimates (Piper et al., 1989). This scale has four subscales for measuring four dimensions of fatigue: temporal, severity, sensory, and affective. The PFS contains 41 visual analogue scale items.

VI. Statement of research questions

From the substruction of the concepts, four research questions are derived. These are as follows.

1. Does cardiac arrhythmia affect the hemodynamic activity in the heart?
2. What is the relationship between cardiac output and four dimensions (temporal, severity, sensory, and affective) of fatigue?
3. Does cardiac arrhythmia predict fatigue through hemodynamic activity and anaerobic metabolism?
4. What are the severity and the pattern of fatigue experienced by cardiac arrhythmia

patients?

Ⅶ. Summary

Throughout this paper, three concepts from the study of fatigue in cardiac arrhythmia patients were identified and described. The linkage between concepts was explained. Through the process of substruction, more concrete levels of abstractness, variables and empirical indicators, were identified and discussed. Finally, four research questions were suggested for the future study.

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국문초록

Theoretical Substruction: 심부정맥 환자의 피로감

강 윤 희*

모든 질병에서 피로감은 환자가 경험하는 매우 흔한 증상으로서 임상간호현장에서 쉽게 간과 되어져 왔다. 최근까지 건강관련 학문분야에서 피로감에 관한 수 많은 연구가 진행되어져 왔지만, 임상간호현장에 도움이 될 만한 연구결과, 즉 임상 간호사의 간호사정과 간호중재에 지침이 되는 연구는 부족한 현실이다. 구체적인 연구 계획에 앞서, 연구의 이론적인 배경과 근거, 이론에서 추출된 개념, 변수와 연구 도구들간의 전체적인 일관성이 매우 중요하다. 추상적인 이론으로부터 개념과 변수를 거쳐 연구에 직접 사용될 구체적인 연구도구를 일관성 있게 선택하는 일련의 과정을 'Theoretical Substruction' 이라 한다. 심부정맥환자가 지각하는 피로감에 관한 연구에 앞서, 본 글을 통해 심부정맥과 피로감의 이론적인 연관성과 이 연구를 위한 개념과 변수, 구체적인 연구도구를 선택하는 과정, Theoretical Substruction에 대해 토의될 것이며, 이에 따른 연구질문도 제의 될 것이다.

주요용어 : Theoretical Substruction, 피로감, 심부정맥

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