CHAPTER 3

Methods

3. Methods

3.1 Subjects

Patients who had been diagnosed with ESRD receiving hemodialysis at the Chiang Mai Kidney Clinic voluntarily participated in this study. Subjects were medically screened by a nephrologist. Patients were selected under close supervision of an expert physician who was one of the investigators. Sample size was calculated based on the results of Monteon et al. (9). G*Power 3.1 for an ANOVA repeated within factor test was used to calculate the sample size at mean ± SD = 0.97 ± 0.10, a power of 0.8, and $\alpha = 0.05$. Therefore, 15 hemodialysis patients were required for the study. Patients who met the inclusion and exclusion criteria were intervened during hemodialysis with a non-invasive telemetry gas analyzer (Oxycon) and hemodynamic (Physioflow) methods (9). The study protocol was submitted for approval by the Human Ethical Review Board of the Faculty of Associated Medical Sciences, Chiang Mai University, and informed consent was obtained from each participant prior to commencement of the study.

The inclusion and exclusion criteria were as follows:

Inclusion criteria

1. Hemodialysis patient aged of 40 – 60 years.

2. Received hemodialysis treatment 3 times/ week for at least 3 months.

3. Had stable medical condition, including hemoglobin ≥ 10 g/dl and Kt/V urea ≥ 1.2.

4. Had normal thyroid function, including TSH of 0.27- 4.20 uIU/mL.

5. Had body mass index (BMI) of 18.5–24.9 kg/m^2.

Exclusion criteria

1. Had cardiopulmonary disorders, such as coronary artery disease, unstable angina, and recent myocardial infections prior to or within 6 weeks.

2. Had diabetic mellitus, COPD, or uncontrolled hypertension.

3. Had active infectious disease.

3.2 Equipment

1. Personal data collection form

2. Sphygmomanometer (HM-1100, Japan)

3. Stopwatch

4. Pulse oximeter (MASIMOTM, CA, USA)

5. PhysioFlow® Hemodynamics Redefined (Manatec, France): PhysioFlow® Enduro is an original system for noninvasive cardiac monitoring, which provides hemodynamic parameters using analysis of thoracic electrical bioimpedance signals (TEB) (112). More precisely, PhysioFlow® Enduro allows the assessment of the

hemodynamic state and the ventricular function of patients by determining hemodynamic parameters (113). PhysioFlow® Enduro computes the following parameters: stroke volume/index, cardiac output/index, systemic vascular resistance, systemic vascular resistance index (systemic vascular resistance multiplied by the body surface area), left cardiac work index, ejection fraction, and end diastolic volume. PhysioFlow® provides enhanced sensitivity and better correlation with invasive methods compared to analogic and similar conventional impedance cardiology (ICG) technologies (114). Moreover, the previous study validated the PhysioFlow® thoracic bioimpedance monitor for the non-invasive determination of cardiac output against the thermodilution method as a reference standard. There is good agreement between the PhysioFlow® monitor and pulmonary artery catheter for determination of the CO. A comparison of the PhysioFlow® monitor to cardiac output by the Fick method is in progress (112, 114).

6. Telemetry gas analysis (Oxycon, SensorMedics, USA): Oxycon Mobile is a battery-operated, portable, wireless metabolic system measuring gas exchange breath-by-breath and attached to the body in a vest system (115). A flow sensor unit is connected to a face mask detecting air flow by the rotation of a low resistance, bidirectional turbine. Therefore, it allows the determination of for both inspiration and expiration ventilation. Via a sampling line connected to the flow sensor unit, the expired air is analyzed for O_2 and CO_2 concentrations in a sensor box using a microfuel cell and thermal conductivity, respectively (115). Oxycon Mobile measures important ergospirometric key parameters, such as ventilation (VE), oxygen consumption (VO_2),

carbondioxide product (VCO_2), anaerobic threshold, respiratory exchange ratio (RER), and heart rate (HR) (116).

3.3 Procedures

The experimental procedures of this study are presented in Figure 1. Patients who met the inclusion and exclusion criteria were received information about the study. After patients understood and decided to participate in the study, they signed an informed consent form. Next, the patients were asked to enter their personal information concerning the history of CKD, frequency of hemodialysis, and duration of hemodialysis. Vital signs, including heart rate, blood pressure, and respiratory rate, were measured. If the vital signs were considerably not in their usual resting ranges, the test was postponed. Weight and height were measured and recorded. Resting energy expenditure was evaluated, including oxygen consumption, carbon dioxide production, and respiratory exchange ratio. Next, the measurement of hemodynamics, which included stroke volume, heart rate, cardiac output, end-diastolic volume, ejection fraction, total peripheral resistance, systolic blood pressure and diastolic blood pressure, were continuously monitored.

Instrument preparation was started with Oxycon Mobile for baseline oxygen consumption and carbon dioxide production. Systemic telemetry gas analyzer consisted of a face mask with a turbine, integrated O_2 and CO_2 electrodes, and a pulse oxymeter, was attached to a subject. Before each test, after 15 min of acclimatization, temperature, humidity, and barometric pressure were determined and two-point calibrations of turbine and gas analyzers were performed. The calculation of REE was based on the observation that the oxidation of quantities of carbohydrate, fat, and protein each generates an amount of energy and carbon dioxide and consumes a quantity of oxygen that was characteristic and predictable (70). The ratio of the oxygen consumed to the carbon dioxide produced indicates the relative oxidation of fat, carbohydrate and protein (71). From these relationships, it was possible to estimate REE according Weir's equation, (72) without using urinary urea nitrogen level. Basal metabolic rate (BMR) (kcal / min) = 3.9 [VO_2 (L / min) + 1.1 [VCO_2 (L / min)], was estimated where VO_2 was the volume of oxygen, and VCO_2 was the volume of carbon dioxide (72). After BMR values were calculated for the REE, which was equaled to the REE: REE (kcal /d) = BMR × 1,440 min (72). Next, the instrument preparation of PhysioFlow® applies to patients' chest wall with six pre-gelled electrodes on the thorax that were connected to an electronic processing unit, which was in turn connected to a laptop computer running via Microsoft Windows 95/98 for the acquisition and analysis of data. The calibration phase was performed over 30 heart beats, and subsequent continuous measurements can be taken, beat by beat or averaged over several beats (113). Recommended electrode placement involves six electrodes: two on the left lateral aspect of the neck (Z1 and Z2), two on the chest (ECG1 and ECG2), and two near the xiphisternum (Z3 and Z4/ECG3/neutral) (113). The subjects were fast from the end of dinner until the test, meal was allowed or until the resting energy expenditure studies are terminated the following day. REE and hemodynamics were measured by indirect calorimetry using a Telemetry Gas Analyzer (Oxycon, Sensor Medics, USA) and PhysioFlow®, respectively. REE measurements were started at 7:00 a.m. Subjects ate a light meal with predetermined components approximately 1 h before initiation of the study protocol. All measurements were performed by a trained investigator. Subjects were instructed and encouraged to lay supine on bed and breathe normally into a face mask. The whole process takes approximately 5 hours, including pre-hemodialysis, during which data were collected for 30 minutes; during hemodialysis, during which data were collected for 4 hours and recorded every 30 minutes; and post-hemodialysis, during which data were collected for 30 minutes. During the process, patient was in sight and cared by investigators, including a medical doctor and physical therapist.

3.4 Independent and dependent variables

3.4.1 Independent variable

Subjects (CKD patients) during different phases of hemodialysis procedure including at rest, during, and after hemodialysis procedure condition.

3.4.2 Dependent variables: continuous changes of the following variables were recorded.

Resting energy expenditure parameters: oxygen consumption, carbon dioxide production and respiratory exchange ratio.

Hemodynamic parameters: stroke volume, heart rate, cardiac output, end-diastolic volume, ejection fraction, total peripheral resistance, systolic blood pressure and diastolic blood pressure

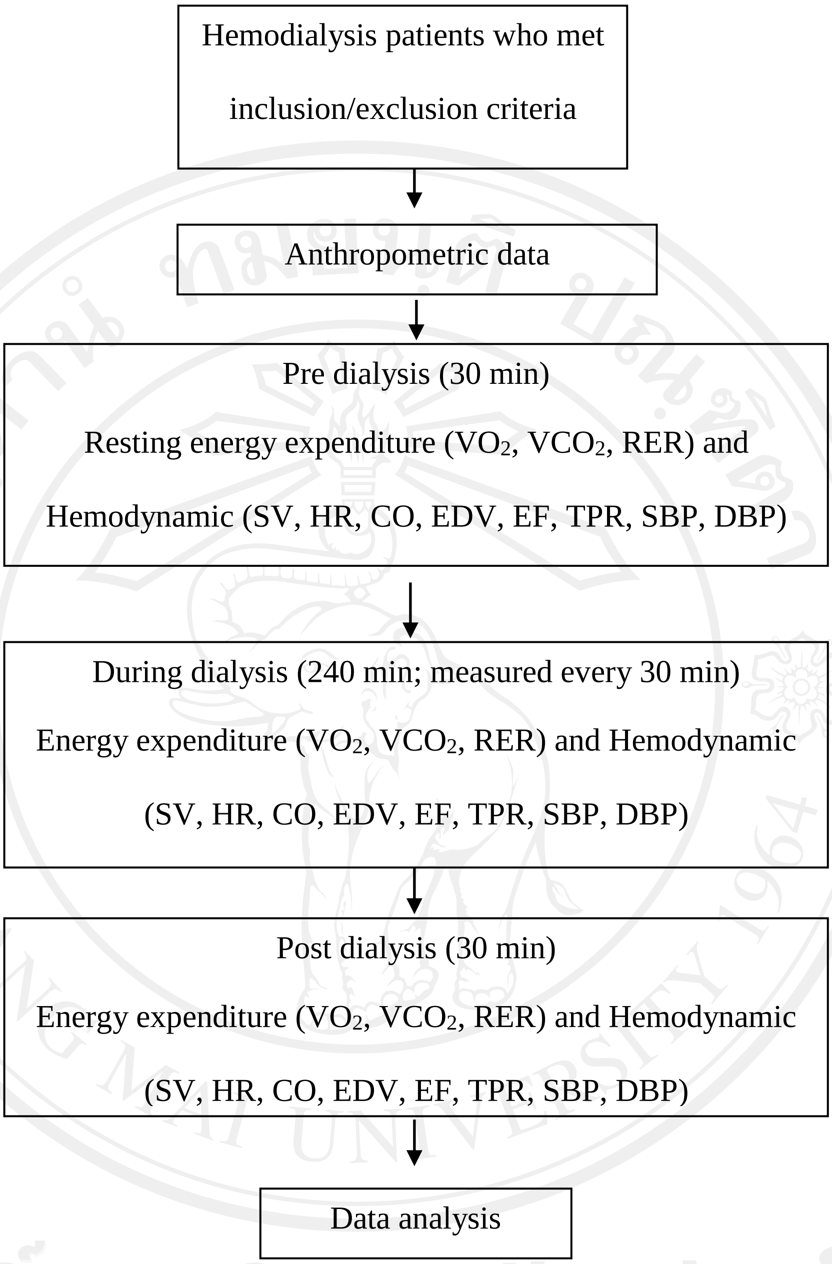

Figure 1 Experimental procedure

3.5 Location

3.5.1 The data collection was performed at Chiang Mai Kidney Clinic, Chiang Mai.

3.5.2 The data analysis was performed at the Department of Physical Therapy, Faculty of Associated Medical Sciences, Chiang Mai University.

3.6 Statistical analysis

Descriptive statistics were used to report demographic data. One-way repeated measures ANOVA test was used to compare for 30-min time series on the differences within the CKD patients. After that, LSD was used to compare differences between parameter within the CKD patients. All statistical analyses were use SPSS version 11.5 for data analysis. A level of 0.05 was set to denote significance.

3.7 Assumption of the study

Since there were limited numbers of CKD patients met the criteria of this study. It is necessarily assumed that there is no gender different among subject. Thus, all dependent variables will be grouped and analyze at ones.