IMPAIRMENT OF TIMED UP AND GO COMPONENTS IN ELDERLY WITH CHRONIC NECK PAIN

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IMPAIRMENT OF TIMED UP AND GO COMPONENTS IN ELDERLY WITH CHRONIC NECK PAIN

TANAPAT THONGPRONG

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IN ELDERLY WITH CHRONIC NECK PAIN

BY

TANAPAT THONGPRONG

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Elderly patients with chronic neck pain (CNP) showed impaired dynamic balance as indicated by longer duration during the Timed Up and Go (TUG) test. The TUG contains several components including sit-to-stand (STS), walk, turn, turn-to-sit (TTS), but it is unclear which component of TUG was markedly impaired among elderly patients with chronic neck pain (CNP). This study aimed to identify which component of the Timed Up and Go test was impaired in elderly patients with CNP as compared with those without neck pain. This cross-sectional study compared the duration used to complete the TUG task between 15 healthy elderly patients, aged 64.57 ± 4.03 years and 15 elderly patients with CNP, aged 64.00 ± 4.05 years. Each TUG component was identified using inertial sensors attached to the body. The elderly patients with CNP were classified further into mild and moderate disability categories, using the Neck Disability Index. The duration of STS, TTS, and total TUG were significantly longer in CNP with mild disabilities ($p < 0.05$). CNP with moderate disability showed larger peak angular trunk velocity in all TUG components than the healthy with CNP with mild CNP. The STS and TTS components of the TUG test were markedly impaired among elderly patients with chronic neck pain. These impairments can reflect the longer duration of STS and TTS components or a larger peak angular trunk velocity.

Keyword : Musculoskeletal pain, neck disability, dynamic balance, functional activity

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CHAPTER 1
INTRODUCTION

Chronic musculoskeletal pain is one of the health conditions that receive a lot of concern worldwide[1]. One of the most common chronic musculoskeletal pain is neck pain. The definition of chronic neck pain was based on its anatomical location and duration of symptoms. Chronic neck pain is defined as pain perceived at any area in the posterior region of the cervical spine, from the superior nuchal line to the first thoracic spinous process, for the duration of 3 months or more[2]. The prevalence of chronic neck pain is higher in female (20%) than male (16%)[3]. Chronic neck pain can lead to physical impairment as well as activity limitation. The global age-standardized point prevalence of chronic neck pain that results in at least 1 day of activity limitation was estimated to be 4.9%[4]. Chronic neck pain leading to diminished physical activities is more pronounced in ageing, as the above global age-standardized point prevalence of neck pain increased to 8.0% in people with age more than 60 years[4].

Signs and symptoms of people with chronic neck pain (CNP) include neck pain, dizziness, impaired body structure and body function of the neck, and limitation of physical activity. Decreased neck range of motion in all planes and reduced neck muscle strength were commonly found in people with chronic neck pain[5, 6]. Elderly with CNP also complained of dizziness and unsteadiness regarding eye-head movement and postural control. These symptoms could be due to alteration of somatosensory function originating from the cervical spine, which may mismatch with information from vestibular system[7]. The sensorimotor test by electro-oculography was used in the smooth pursuit neck torsion (SPNT) test to assess disturbances in the eye movement control in elderly with CNP. Results demonstrated the deficits of smooth pursuit control during neck torsion test and difficulty in perceiving the vertical linear when the reference frame was rotated to 10o and 15 o anticlockwise. Such findings supported that there was impairment of the receptor in the cervical region that connected to the visual, vestibular and the central nervous system[8]. Furthermore, it was also found that the duration of inflammation and severity of pain were associated with sensorimotor impairment and decreasing physical function.

With regard to gait and balance impairment, it was found that elderly with CNP took longer time to complete the Timed Ten Metre Walk Test and performed smaller steps than the healthy elderly[9]. Previous literature also demonstrated the relationship between neck pain and the decrease in physical performance leading to higher fall risk in elderly with CNP[10]. It was found that elderly with CNP showed disturbance of balance and gait characteristics such as decreased self-selected gait speed, step length, stride length and step width during walking with head turn[11]. Another study supported dynamic balance deficits during walking in elderly with CNP such that they took longer time to complete the Timed Up and Go (TUG) test and they received lower scores in the Dynamic Gait Index (DGI) test, as compared to healthy elderly[12]. Impaired static balance was also evident in elderly with CNP as they were unstable when standing in comfortable stance foot position with eye closed on firm surface, eye open on soft surface, and eye open on soft surface with narrow stance[9, 12]. It was suggested that impaired static balance could be due to impaired proprioceptive information from the neck that connected with vestibular system used in maintaining postural stability during eye closed stance. Therefore, impaired static standing balance was evident during the standing condition where there was the need for vestibular or proprioceptive system such as standing on foam surface or standing with eye closed[12].

Timed Up-and-Go (TUG) test is the clinical scale that was developed to identify person with dynamic balance deficits by measuring the time they took to complete the test. The test includes 4 complex components of activity; sit-to-stand, walk 3 meters, turning, walk back and turn to sit on the chair[13]. Total time of TUG has been commonly used to assess dynamic balance and mobility in individuals including elderly people with CNP[9]. Older adult with CNP demonstrated impairments in the total time of TUG. This may be due to the decrease in musculoskeletal proprioceptive recruitment in the elderly, so that they relied more on the vestibular system for postural stability[12]. However, each component of TUG represents different functional activity which underlies different movement control mechanism. For example, turning is a demanding activity and it has been suggested that this task requires greater cognitive ability and sensory information processing than walking in a straight line[14-16]. A previous study also showed that not all components of TUG were affected equally in the elderly with neurological disorder. Elderly with stroke revealed that longer TUG total time was caused by impairment in the turning, turn-to-sit and walking components, but not during sit to stand components, as compared to healthy elderly[17]. Such impairments consisted of reduced peak angular velocity during turn and turn-to-sit, decreased stride length and stride velocity, and increased single leg stance time during walking. Detailed information regarding TUG components will help clinician in adding useful information for planning task-specific training for persons with dynamic balance problems. Nevertheless, there is no information regarding which TUG components are impaired in elderly with CNP, even though it was found that the total TUG time was longer than those without CNP.

Research question

Which postural control parameters in each component of Timed Up and Go Test are impaired in elderly with chronic neck pain.

Objective

To identify postural control parameters in each component of Timed Up and Go test that are impaired in elderly with chronic neck pain as compared to those without neck pain.

Hypothesis of the study

This study hypothesizes that the postural control parameters in the “turning” phase of the Timed Up and Go component would be the component that is significantly impaired in elderly with CNP when comparing to the elderly without neck pain.

Benefit of the study

This study provided information on the extent of dynamic balance deficits during walking in elderly with chronic neck pain as measured by the Timed Up and Go (TUG)

Test. It will raise the concern for balance problem in elderly who have chronic neck pain. Results will also support the need for specific assessment of TUG test; focusing on impaired TUG component, in order to plan task-specific training which could lead to effective balance intervention program for elderly with chronic neck pain.

Conceptual framework

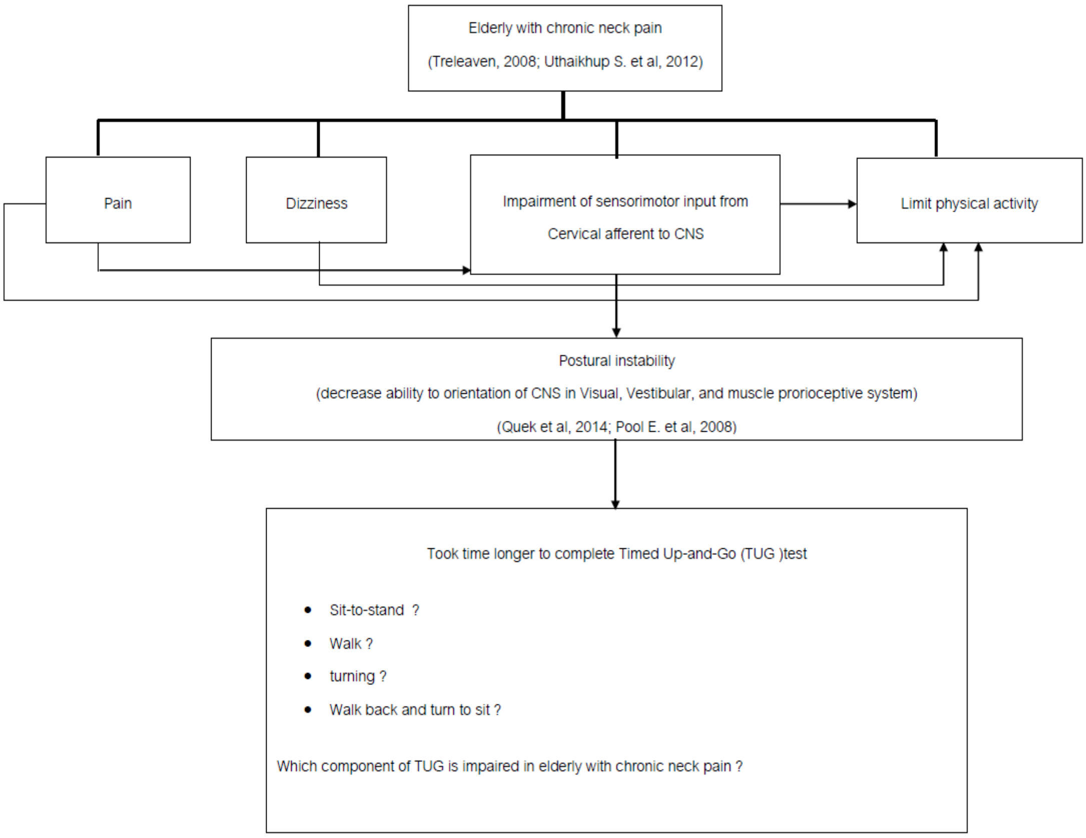

Figure 1 Conceptual framework

CHAPTER 2
REVIEW OF LITERATURES

1.Definition of Chronic neck pain

Chronic Neck Pain (CNP) was presented in the previous literature in different types of definitions based on anatomical location and duration of symptoms[2]. The neck pain was defines based on anatomical location as pain perceived at any area in the posterior region of the cervical spine, from the superior nuchal line to the first thoracic spinous process[18]. Furthermore, neck pain can subdivided into upper cervical spinal pain and lower cervical spinal pain reference from the transverse line passing through C4[19]. The upper cervical pain usually involves many components of headaches. For example, suboccipital pain where the pain is located between the superior nuchal line and C2 is the source of cervicogenic headache. The lower cervical pain includes the pain that is radiating to the scapular region, anterior chest wall, shoulder, or upper limb. The CNP can also be described as an hypersensitivity sensation with hyperalgesia in the skin, ligaments, and muscle during palpation and movements in neck and shoulder area[20]. Duration of symptoms is another type of classification of neck pain. The International Association for the study of Pain (IASP) and the Bone and Joint Decade 2000-2010 used the duration of pain to describe acute neck pain or transitory neck pain which usually lasts for less than 7 days, subacute neck pain or short-duration neck pain lasts more than 7 days but less than 3 months, and chronic neck pain or long-duration neck pain has duration of 3 months or more[21].

In CNP patients, the local structures could be altered from pain, disuse, or trauma[22, 23]. Previous study in people with chronic whiplash-associated disorder showed structural infiltration in deep neck muscle with fat, especially the rectus capitis, posterior minor and major, deep cervical multifidi, and deep neck flexors[22]. Furthermore, several studies reported a transformation of cervical muscle fiber type from type I to II, adaptation of motor unit synchronization, and long-lasting muscle spindle activation[23-25], increased sensitivity and perception of movement, resulting in excessive cervical afferent inputs[26].

Moreover, local changes can lead to a worse adaptation in motor control. In other words, awareness of pain during movement can lead to inhibition of the neck muscles performing a movement and subsequent complex reorganization of the motor pattern[27, 28]. For example, during standing balance task, chronic whiplash-associated subjects have shown a high level of superficial cervical muscle activity and decreased synergetic activity between longus colli and capitis as well as overactivation of the sternocleidomastoid[29]. In addition to altered motor control, neck muscle fatigue that directly distorted the sensory inputs has been found to create adverse effect to postural control[30, 31].

2. Prevalence of chronic neck pain

The pain and disability associated with neck pain occurs commonly throughout the world and have a large impact on individual health condition and their families, communities, and healthcare systems. The global-age standardized focus on prevalence of neck pain (from 0 year to 100 years of age) in 2010 was estimated to be 4.9%. This prevalence was the highest in the North America (mean 6.5%), followed by South-East Asia (mean 3.8%), and the lowest in South Asia (mean 3.3%). The prevalence of neck pain was higher in women (mean 5.8%) than in men (mean 4.0%)[4]. Previous study in Thailand[32] demonstrated the percentage of musculoskeletal pain and disability were 99.7 and 94.2% respectively from 2,463 participants aged 15 years to over 90 years. The result revealed musculoskeletal pain in 36.2% of respondents, including 6.5% had neck pain. Out of 458 people with musculoskeletal pain, the disability rate was 3%, comprising 3.3% in women and 2.6% in men.

3. Sign and symptoms of chronic neck pain in elderly

In general population, 50-85% of people who have experience neck pain will report neck pain one to five years later[33]. This information supported that most neck pain patients do not recover completely. A variety of symptoms have been reported in people with chronic neck pain (CNP) including decreased range of cervical motion in one or more directions, headache, ache and radiating pain to shoulder and the upper limb. Weakness, numbness and tingling may be present in the upper limb. Dizziness, nausea, balance disorders, emotional problem and also irritation are sometimes related with neck pain[34]. Previous studies also reported the presence of 40-90% symptoms of unsteadiness and impairment of balance in whiplash-associated persistent beck pain and 21% of them had fall experiences[35, 36]

Pain RoM and Dizziness

The elderly with CNP always report the experience of pain in their neck region. The pain that persists for long time led to restriction of functional ability in the elderly or impairment of neck movement due to fear of pain or movement. Previous study compared patients with whiplash associated disorders (WAD), non-traumatic neck pain (CNP) and healthy controls in relation to cervical range of motion (ROM), conjunction motion, joint position error and ROM-variability[5]. Results showed that those with neck pain from WAD and CNP had the reduction in functional motion and maximal cervical range of motion as compared to the healthy control. It is also observed that stiffer movement pattern in the pain group were found during cervical rotation, as cervical rotation demands more complex physiological coupled motions due to the anatomic structures, such as the orientation of cervical zygapophysial joints that changes in motor control due to chronic pain[37]. Furthermore, The changes in musculoskeletal structure of the neck affected sensory information from cervical muscle region in term of disturbance to the afferent input from the cervical region in those with neck pain such as dizziness, unsteadiness, and visual disturbances including altered postural stability[38].

The symptom of dizziness in elders with CNP is another common symptom associated with neck pain. It has been well documented that cervical afferent can influence postural control. Dizziness associated with neck pain can be caused by several different pathophysiological processes, including irritation of the sympathetic vertebral plexus, vertebrobasilar insufficiency, and sensorimotor disturbances from the cervical spine structures[39]. Impairment of sensory input, especially the structure between the upper cervical spine and the vestibular system, has the potential to disturb an intact vestibular subsystem. Patients with CNP who had impaired neck mechanoreceptor inputs would be unable to utilize internal vestibular orienting information to interpret inaccurate information from the somatosensory and visual subsystem[40]. According to the "Sensory mismatch" theory, the sensation of dizziness and unsteadiness arise because of a conflict between the converging input from the different sensory subsystems and the expected sensory patterns[41]. Previous literature was hypothesized that the vestibular and the somatosensory subsystems may compensate for the balance disturbances by increasing the muscle stiffness in the joint and muscle[42], as seen by hyperactivity in the muscle in some patients with CNP[43]. Cervical induced dizziness is characterized by subjective complaints of unsteadiness, insecurity and lightheadedness[44]. Some patients informed that the feeling of dizziness is more like "spinning in the head" rather than spinning of the patient or the surroundings, as in typical vertigo of vestibular origin.

4.Postural control problem in elderly with CNP

The postural control system is important during daily functional activities. It gives people the possibility to prevent falling or unstable situation in standing or sitting posture. According to the system of postural control by Shumway-Cook[45], the postural system consists of musculoskeletal components (as joint range of motion and muscle properties) and neural components (as internal representations, adaptive mechanisms, sensory strategies, individual sensory system, and neuromuscular synergies). Sensory integration is the most important component for spatial orientation because it is used heavily in locomotion and postural stability[46-48]. There are 3 major sensory system for postural control including vestibular, visual and proprioception. Previous study found that when only one type of sensory input was mismatched, most of elderly were still able to maintain their balance[49]. This finding supports the ability to shift to an alternate sensory system as long as the sensory input are available in the elders[49, 50]. Thus, if one sensory input is impaired or absent, the central nervous system is then shifted to rely on the remaining sensory inputs. The vestibular apparatus provides information about the position and movements of the head for linear and angular acceleration related to gravity. The vestibulo-ocular and vestibulospinal reflexes function to maintain the alignment of the trunk and limb extremities[51]. The vestibular system starts to degenerate when age increases, as can be seen from reduction of sensory cells within the vestibular system found in persons over 70 years[52]. Similar to the vestibular function, vision is reducing with normal aging. Elders have significantly higher incidence of common eye diseases[53]. Furthermore, elder people with diabetes and hypertension also have the additional burden of associated retinopathies. After the age of 50, vision starts to deteriorate, with progressive decline in many visual processes, such as visual acuity[54, 55], contrast sensitivity[56, 57] glare sensitivity, dark adaptation, accommodation and depth perception[58]. Previous study found significant deterioration in the sensitivity of elder to low frequency spatial information[59]. It is obvious that visual signals are used to create the spatial map of the environment in terms of their location, speed and direction of movement. Thus, the loss of edge contrast sensitivity may predispose elderly people to tripping over obstacles such as steps, footpath cracks and surface malalignments[60].

Somatosensory inputs in the cervical spine are considered to be another important component in maintaining oculomotor and postural control[61]. The cervical spine has an important role in providing the afferent input. These inputs are divided into somatosensory (local and distal), visual, and vestibular systems[62-64]. Furthermore, the cervical region provides extensive connections to the CNS, including the vestibular nuclear complex and the superior colliculus, which are the major relay centers for coordination of gaze and postural stability[38]. Cervical proprioceptors provide the CNS with information about the movement and location of the head in relation to the trunk. The facets of cervical spine, especially in the upper neck, are abundance with mechanoreceptors and the muscles of the suboccipital area have a high concentration of muscle spindles per gram of muscle, there are 16 muscle spindles per gram when compared to the first lumbrical in the thumb[7, 65-67].

The cervical muscles, especially the suboccipital muscles, relay information to and receive information from the CNS. There are specific connections between the cervical receptors and the visual and vestibular apparatus and the autonomic nervous system[68-72]. The cervical proprioceptors are involved in the cervico-collic reflex, the cervico-occular reflex and tonic neck reflex, which provide information about the movement and position of the head in space[7]. This implies that cervical proprioceptive information is important for the function of cervical movement and postural control. Previous studies reported the importance of the cervical central and reflex connections via artificial disturbances to the cervical afferents in asymptomatic individual. For example, altered postural sway have been reported following cervical muscle vibration[73-75], experimental pain[76, 77], and neck muscle fatigue[30, 78]. Thus, It is the complexity of collaboration in cervical sensory inputs for correct interpretations of signal from vestibular and visual organs. Incorrect information from any of these sensory inputs will cause a sensory mismatch between abnormal information from disturbed cervical spine and normal information from the vestibular and visual system, resulting in disturbance of the postural control system.

5. Assessment of gait and postural control impairment in elderly with CNP

Static standing: CTSIB (foam and dome)

In the field of elders with CNP study, Modified Clinical Test of Sensory Interaction in Balance (CTSIB-M)[9, 12] was commonly used for examining sensory orientation. The CTSIB-M was developed to differentiate between visual, vestibular, and somatosensory inputs in order to design a treatment program for neurological patients having balance deficit[62] and has been found to have good test-retest reliability for older populations[79]. CTSIB-M has been used together with computerized posturography to evaluate the difference of standing balance between healthy elders and elders with CNP. In addition to standing still on firm surface versus foam surface with eyes open or blindfolded conditions, comfortable stance and narrow stance is added to challenge postural control[9]. Previous study showed results between healthy elders and elders with CNP measured by CTSIB-M assessment. There was a tendency for higher level of both total energy and RMS amplitude sway in the elders with CNP group than healthy elderly. The significant differences of both total energy were in the AP direction during comfortable stance in the condition of eye closed on a firm surface. For the RMS amplitude, the neck pain group demonstrated significant RMS difference in the AP direction in the test of eye opened on the foam surface. Furthermore, Significant differences were also seen in both total energy and RMS in the ML direction during narrow stance with eye opened in the firm surface.

Dynamic: TUG

Fall among community-dwelling elders most often occurs during walking. Turning is associated with falling incidences and injuries. Fall during turning was about eight times more frequent than straight walking in elderly people confines to small homes[80]. This could be due to the fact that turning involves more interlimb coordination and more coupling between posture and gait. Turning is considered to be the modifications of locomotor patterns which require frontal lobe cognitive function and executive function that plays role in postural transitions[81, 82]. For the elderly, turning while walking is a challenging task, as it involves deceleration of forward motion, head-neck rotation, body rotation, and stepping out toward a new direction[83]. Staggering during turning, increased turning time, and the number of step to complete turning are the prominent characteristics of recurrent fallers[84]. In this situation, CNP may restrict the component of head-trunk coordination, leading to difficulty in maintaining dynamic balance during turning and completion of the turning task in elderly with CNP.

The TUG is a combination mobility test that a patient stands from chair, walks a distance of 3 meters, including a 180° turn around, and then walking back and sits in a same chair. Thus, this test contains the features that are important for activities of daily living. Recent studies reported that objective measures of turning mobility are more sensitive than gait speed or other clinical measures of mobility to detect impaired balance and mobility in patients with mobility disorders[85, 86]. TUG has been used in several populations, including elders with CNP which showed worse scores on TUG than healthy controls, confirming that balance deficits did exist[12]. However, the total TUG score lacks specific information on which components of the TUG task that impaired. Therefore, it was still unclear on which task that was impaired during TUG test in elders with CNP.

6. Wearable sensor to assess postural control during gait

Wearable Inertial Sensor

A recent technology is the wearable inertial sensor (WIS) for studying human movement. Wearable inertial sensor are developed as an instrument to monitor in clinic and at home the movement pattern in patient with motor disorders[87]. It provides a portable use for researcher and clinicians to assess movement and balance in clinical setting. It can record three-dimensional motion using three or more types of inertial sensors such as accelerometers that measure linear acceleration, gyroscopes that measure angular velocity and magnetometers that measure heading with the Earth's magnetic field. Wearable inertial sensors consist of linear accelerometers and/or angular velocity sensors (gyroscopes) that can measure leg, arm and torso motions, while people perform clinical balance tasks or doing their daily activities. For example, ambulatory gait analysis system has been design using accelerometers on a hip belt or gyroscopes on the shanks. These systems can automatically calculate parameters of gait such as cadence, stride length, and stride velocity but can not generally evaluate postural stability of the trunk during gait. Postural stability during gait can be estimated from time spent in double support. Persons with poor balance spend more time with both feet on the ground and walk more slowly, resulting in longer time spent in double support[88].

APDM wearable sensors have been used as activity monitors or to determine time spent in various activities such as walking, sitting, and standing[89]. Algorithms have been developed to manipulate data objectively and quantitatively assess balance and mobility, such as: the instrumented test of postural sway (iSWAY), Step initiation (iSTEP), and The Timed Up and Go test (iTUG)[90]. The assessment of these three motor tasks can be calculated and evaluated three different systems underlying balance control: i) static posturography, ii) anticipatory postural adjustments due to step initiation and the sit- to-stand transitions, and iii) dynamic stability during turning as well as trunk and arm movement during gait[91].

iTUG is a software technology in a part of inertial measurement unit (IMU) to function as movement tracking devices that contain gyroscopes and accelerometers.

Gyroscopes measure angular velocity in *degrees/second.* and an accelerometers measure acceleration in *meters/second*^{2}. iTUG is an instrument that is commonly used for the TUG test in many populations such as Parkinson's Disease (PD), Fall Risk, Hemiplegia, Disability Levels, and Cognitive Impairment[92]. The iTUG has excellent test-retest reliability (intraclass correlation coefficients range 0.43 -0.99)[93]. To observe total body movement, several inertial sensors are place on the body. One bi-axial gyroscope on each forearm, one uni-axial gyroscope on each shank, one uni-axial gyroscope on each thigh, and one bi-axial gyroscope and tri-axial accelerometer on the sternum. The iTUG is divided into four sections: sit-to-stand, straight walking, 180° turn, and turn-to-sit[17, 92, 93]. Each section is automatically detected in the sensor signal and has a set of parameters computed for each body part involved. For example, *During straight walk*, gait parameters were investigated: Upper body: Peak arm swing velocity (deg/sec) detected by 2 axes of forearm gyroscope, Arm swing range of motion (deg) is range of motion of forearm in pitch axis of the body during arm swing, and Arm swing asymmetry (lv%) is difference in peak arm swing velocity. Lower body: Temporal gait parameters including Cadence (step/min), Gait cycle time (s), Double-support (%). Spatial gait parameters including stride velocity (%height/s) and Stride length (%height), and Stride time (%). Trunk: Peak trunk rotation velocity is peak angular velocity of the trunk rotation in Yaw axis (deg). The Postural transition parameter investigated: Turning phase has parameters as duration, trunk peak angular velocity, average step time, maximum step time, average step time, last step time before turn, and number of steps. Sit-to-stand : Peak and Average sit-to-stand velocity is average trunk angular velocity during sit-to-stand in pitch axis (dec/sec)[93]

The previous study using iTUG demonstrated that the PD group had slower arm swing ($p < 0.01$), walk with slow cadence ($p = 0.01$), and rotate their trunks more slowly during walk ($p < 0.05$). Turning phase was also slower than control group ($p < 0.01$). There was no significant difference between PD and control group in stride velocity, stride length, double support time, variable of stride time or stride length, peak turning velocity or sit-to-stand parameters[17]. These results confirmed that the use of wearable sensors with iTUG software is sensitive to detect movement and balance impairment in persons with balance problem.

CHAPTER 3
METHODOLOGY

Study design and setting

This cross-sectional study was to identify the component of Timed Up and Go test that was impaired in elderly with chronic neck pain (CNP) as compared to those elderly without neck pain. Elderly with CNP was recruited from the Police general hospital, Bangkok, Thailand. Healthy elderly was recruited from community in Prasert-Samakkee area, Nonthaburi, Thailand. Data collection was conducted the Rehabilitation unit of Police general hospital.

Participants

There were 2 groups of participants in this study: elderly with chronic neck pain and elderly without neck pain. The definition of chronic neck pain was the pain perceived at any area in the posterior region of the cervical spine, from the superior nuchal line to the first thoracic spinous process, with or without radiating pain to scapular region, shoulder and upper limb, for the duration of 3 months or more[2, 18]. The inclusion criteria for participants with chronic neck pain were:

1.aged more than 60 years old,

2.diagnosed with non-specific chronic neck pain ($\geq$ 3 months) with average intensity,

3.$\geq$ 30 mm on the 100 mm Visual Analog Scale (VAS) in the last week [94],

4.had neck pain with or without radiating pain from neck to scapular region, shoulder, and upper limb,

5.able to follow command and able to walk independently for 6 m without using a walking aid.

Elderly without chronic neck pain were defined as those who had no neck pain in the last year and they were included in the study if they were able to follow command and walk independently for 6 m without using a walking aid. They were also age and gender-matched to the elderly with CNP.

Participants were excluded from the study if they

1.had dizziness or vertigo from vestibular pathology or brain disorder,

2.had neurological conditions such as stroke or Parkinson's disease [95-98]; systemic condition such as cancer, peripheral neuropathy in the leg, etc.[96, 97, 99, 100];

3.had history of traumatic injury in head and neck area[95];

4.had history of orthopedic surgery or fracture (within the last six months[96, 101, 102];

5.had acute musculoskeletal injury or inflammatory joint disease/arthritis that required active treatment[97, 103, 104]; and

6.unable to understand the instruction.

This study was approved from the Ethic Committee of The Srinakharinwirot University and all procedures was conducted according to the Declaration of Helsinki. Each subject gave their informed consent prior to participate in the study.

Sample size calculation

Sample size was calculated based on data from previous study done by Quek J. et al (2014) that demonstrated total TUG time was significantly longer in elderly with CNP during TUG task, as compared to healthy elderly [12]. By assuming the power of 0.80, alpha level of 0.05, the effect size of 0.95 was calculated from mean ± standard deviation (SD) of the total time of Timed Up-and-Go test (CNP=8.74 ± 1.5 and Control= 7.70 ± 1.1 seconds) which had the smallest effect size than the other variables. This gave rise to the total sample size of thirty persons; 15 persons in each group (CON, CNP).

Data collection

After signing the informed consent, demographic data, baseline of Cervico-thoracic posture by photography and questionnaires were collected by researcher 1. The clinical demographic data was included age, gender, weight, height, history of falls in the previous 12 months, medication intake and co-morbidities which were collected via interviewing of each participant. Participants were also screened for their lower extremity strength by using some items of the Balance Evaluation System Test (BESTest); item 3 (ankle strength), item 4 (hip strength), item 5 (sit on floor and stand up) and item 9 (sit to stand)(105). Pain intensity was measured by a blank 100-mm VAS, where 0 mm corresponded to "no pain at all" and 100 mm referred to "worst imaginable pain". The neck disability index (NDI) Thai-version was used to assess the degree of self-reported neck pain and disability(106). The Activity-specific Balance Confidence scale (ABC scale) was used to assess balance confidence in participants(107). The ABC scale consists of 16 questions involving daily activities that a person could perform without losing balance or unsteady on an 11-point scale (0-100%) where the maximum score represented high balance confidence. Self-perceived handicap asscociated with dizziness was screened with the Dizziness Handicap Inventory (DHI). This scale was developed to evaluate the effect of dizziness on multiple dimensions of functional activity. It consisted of 25 items divided into three subscales including physical, functional, and emotional. The DHI shows excellent test-retest reliability with maximum score of 100 indicates disability[108]. The questionnaire will take 30 minutes to fill all questions including subjective and objective examinations.

The assessment of Timed Up and Go (TUG) was performed in the same quiet laboratory setting by researcher 2 who was blinded from patient's group and demographic data. Participants were asked to perform each test once after practicing the test. The instrumented Timed Up and Go (iTUG) from APDM Mobility Lab system (APDM, Inc., Portland, USA), a set of portable inertial sensors and solfware were used to define the components of TUG. The iTUG was a reliable and valid tool to measure TUG performance in several groups of participants such as persons with neurological disorders and elderly fallers[93, 109]. This system had exellent test-retest reliability (intraclass correlation coefficients (ICC) ranged from 0.43 -0.99)[93]. Six portable 3-dimensional inertial sensors attached to the sternum, 5th lumbar spin, both side of wrists and shanks (Figure 2). A sensor consisted of gyroscope and accelerometer were used to capture angular velocity and acceleration at the sampling rate of 200 Hz(110). Each participant started by sitting on the chair with six-inertial sensors attached to their body(110). Two portable inertial sensors were placed at the anterior shank both sides at 4 cm above the ankle joints. Two portable inertial sensors were placed on the dorsum of each wrist. One sensor was attached to the chest on the sternum at 2 cm below the sternum notch. The last sensor was placed on the posterior trunk at the level of L5, near the body center of mass of each participant. Before assessment, researcher 2 demonstated the TUG and let the participants practiced TUG until they became familiar with the task. After that, their performance was recorded. At the “Go” command, the participants stood without using their hands to support on the chair and walked bare foot at their comfortable pace. The total duration of TUG was calculated starting from when participants moved their back away from backseat of the chair until they sat down and their back touched the chair again. Researcher 1 walked beside participants during TUG test for safety precaution.

Data analysis

The components of TUG, including sit-to-stand, walking, turning (180°), walking back and turn-to-sit were classified by trunk velocity and acceleration using APDM iTUG software(85). The iTUG software used signal of the gyroscope on the trunk to record degree of trunk movement. Peak angular velocity of trunk movement was used to represent postural transition during each component of TUG by special pattern in each signal axis. The first peak on the pitch axis (an axis lying on horizontal) corresponded to sit-to-stand phase (a). The first peak in the Yaw axis (an axis lying the same as gravity line) corresponded to the 180° turn (turning component) and the second peak corresponded to the turn-to-sit transition (b) as shown in Figure 3(17). The qualitative data of peak trunk angular velocity was calculated by iTUG software from sternum accelerometer that was related to the degrees of the trunk movement per time (degrees/sec). Each highest peak of trunk movement in each component of TUG was recorded by trunk accelerometer and used for data analysis. The primary outcomes were duration of total TUG and each TUG component as well as peak angular velocity of trunk movement during each component (walking, turning, and sit-to-stand) which were calculated by APDM iTUG software[93].

Figure 2 Wearable inertial sensors placement on the body

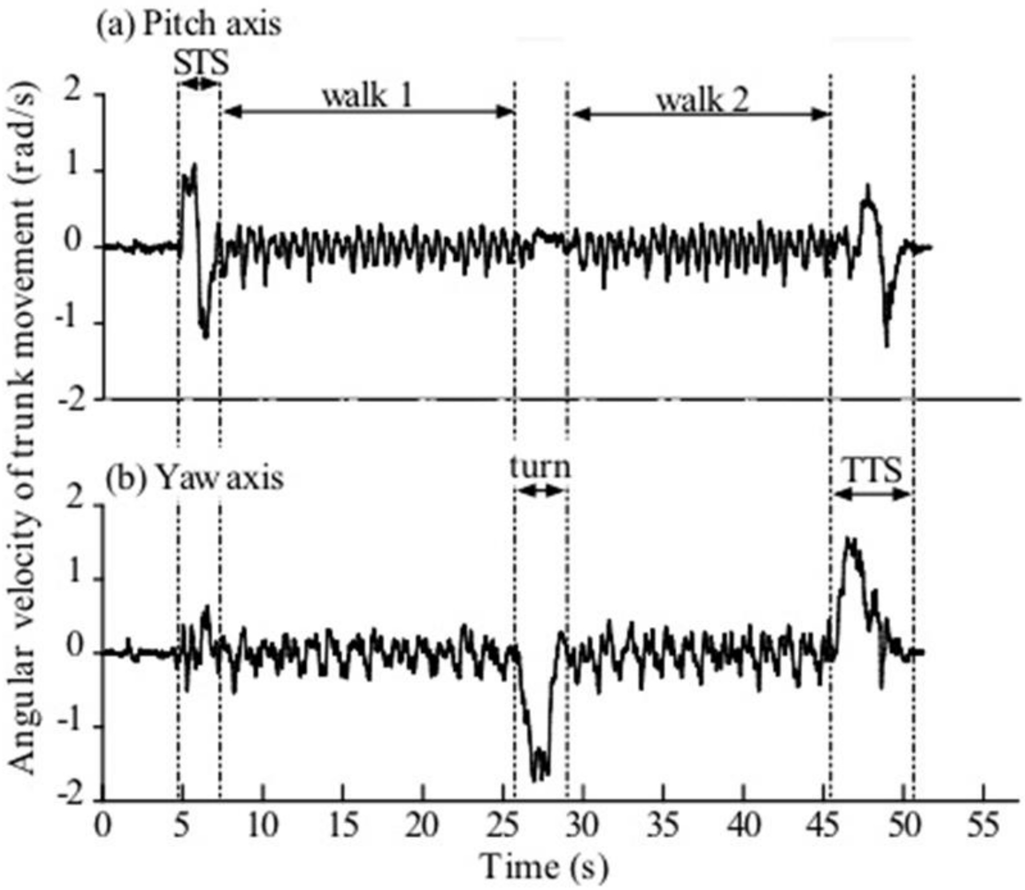

Figure 3 Raw signal derived from inertial sensor.

Source: Chaikeeree N, Chinsongkram B, Saengsirisuwan V, Boonsinsukh R. Effect of cognitive task on components of 7 meter timed up-and-go test in persons with stroke. SCIENCEASIA. 2018;44(4):247-56.

To investigate the objective of the study, The primary outcome variables were summarized in *table 1*

TABLE 1 THE VARIABLE OF INTEREST

Primary outcome variables			
Time variables	Unit	Peak trunk angular velocity variables	Unit
STS duration	second	STS	degrees/sec
Walk duration	second	Walk	degrees/sec
Turn duration	second	Turn	degrees/sec
TTS duration	second	TTS	degrees/sec
Total duration	second		

STS=sit-to-stand, TTS=turn-to-sit

Statistical analysis

Descriptive statistics was used to describe the participant's demographic data. An independent *t*-test was used for comparing age, BMI, and all questionnaire between the elderly with CNP and healthy elderly participants. To identify the component of Timed Up and Go test that were impaired in elderly with chronic neck pain as compared to those without neck pain, two-way ANOVA was used to examine the total time TUG, duration and peak angular velocity of trunk movement on each component of TUG between elderly with CNP and healthy elderly. The post-hoc analysis was using Bonferroni. As level of disability may influence the balance and motor performance in elderly with CNP, additional statistic test was conducted to sub-group analysis based on NDI score between healthy control and CNP elderly with mild disability (NDI score $\leq$ 10) and CNP elderly with moderate disability (NDI score > 10) using non-parametric statistic; independent sample Mann-Whitney U test for the total time TUG and each component of TUG and independent Kruskal-Wallis for identifying peak angular velocity of trunk movement between 3 subgroups. Statistical significance was set at $p < 0.05$.

CHAPTER 4
RESULTS

This cross-sectional study was conducted in 30 older persons with and without chronic neck pain (CNP): 15 healthy control (CON) and 15 CNP elderly. All participants gave informed consent to participate and understood the procedure of data collection. Their characteristics are shown in Table 2 which compares the demographic data and clinical scores between healthy elderly and elderly with CNP. There were no differences in general characteristics such as age, gender, BMI and general lower extremity muscle strength between the healthy elderly and elderly with CNP. However, the elderly with CNP showed significantly higher score of NDI, DHI, VAS ($p < 0.001$) and longer duration of neck pain ($p < 0.001$) than the healthy control. The ABC scale was not significantly different between elderly with CNP and healthy control group ($p = 0.951$), indicating no difference in fear of fall between 2 groups.

TABLE 2 DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF PARTICIPANTS

	Controls (n=15)	CNP (n=15)	*p*-value
Age (yrs, mean ± SD)	64.57 ± 4.03	64.00 ± 4.05	0.678
Gender (female, n (%))	11 (73.33)	13 (86.67)	-
BMI (kg/m2, mean ± SD)	24.85 ± 3.43	24.17 ± 4.17	0.951
BESTest item 3 (0-3, score)	2.53 ± 0.52	2.53 ± 0.52	1
BESTest item 4 (0-3, score)	2.40 ± 0.99	2.47 ± 0.74	0.836
BESTest item 5 (0-3, score)	3	3	-
BESTest item 9 (0-3, score)	3	3	-
NDI (0-100, mean ± SD)	0	13.60 ± 6.98	0.001*
ABC scale (%)	93.63 ± 7.3	89.29 ± 11.05	0.132
DHI (points, mean ± SD)	0	1.93 ± 5.16	0.001*
VAS (0-10, mean ± SD)	0	4.33 ± 1.35	0.001*
Duration of neck pain (months, mean ± SD)		14.87 ± 14.31	0.001*
Side of neck pain (side, n (%))			
Right side	-	2 (13.33)	-
Left side	-	3 (20.00)	-
Both sides		10 (66.67)	-
Comorbidities (condition, n (%))			
Lumbar spine or lower limb pain (VAS < 3/10)	2 (5.13)	1 (6.67)	-
Dizziness	1 (2.56)	4 (26.67)	-
Head or neck injury	-	-	-

CON=healthy elderly, CNP= chronic neck pain, BMI= body mass index, BESTest= Balance Evaluation System test, NDI= neck disability index, ABC= the activities specific confidence balance scale, DHI= dizziness handicap inventory, VAS= visual analog scale, *$p < 0.05$ between CON and CNP

Table 3 shows total TUG duration and durations of each TUG components between elderly with CNP and healthy controls. There was no difference in total TUG duration between healthy elderly and elderly with CNP. Similarly, no significant differences were found in duration of each TUG components between 2 groups.

TABLE 3 DURATION OF TUG AND EACH TUG COMPONENT IN HEALTHY ELDERLY AND ELDERLY WITH CNP

	CON (n=15)	CNP (n = 15)	Mean difference	95% confidence interval of difference		*p*-value
	Mean±SD	Mean±SD		Lower	Upper	
STS(sec)	1.39±0.46	1.64±0.54	-0.25	-0.59	0.09	0.15
Walk(sec)	3.97±0.91	3.62±0.63	0.35	-0.20	0.91	0.21
Turn(sec)	1.53±0.38	1.77±0.45	-0.24	-0.52	0.05	0.10
TTS(sec)	2.78±0.44	3.04±0.72	-0.27	-0.70	0.17	0.21
TUG duration (sec)	9.66±1.26	10.06±1.49	-0.40	-1.34	0.53	0.39

CON=healthy elderly, CNP=chronic neck pain, STS=sit-to-stand, TTS=turn-to-sit

Further subgroup analysis based on the extent of disability in the persons with CNP was shown in Table 4. Elderly with CNP was classified into 2 groups according to the NDI score as mild disability (NDI score $\leq$ 10) and moderate disability (NDI score > 10) groups. CNP elderly with mild disability showed significantly longer total TUG duration and longer durations of STS and TTS components than healthy elderly. Longer TUG durations indicated impairment of postural control during activities of TUG in CNP elderly with mild disability. However, no difference was found between healthy elderly and CNP elderly with moderate disability on duration of TUG total and TUG components (Table 3).

TABLE 4 DURATION OF TUG AND EACH TUG COMPONENT IN HEALTHY ELDERLY AND CNP ELDERLY WITH MILD AND MODERATE DISABILITY

	CON (n=15)	CNP with mild disability (n = 7)		CNP with moderate disability (n = 8)	
	Mean±SD	Mean±SD	*p*-value	Mean±SD	*p*-value
STS(sec)	1.39±0.46	1.85±0.37	0.01*	1.45±0.62	0.94
Walk(sec)	3.97±0.91	3.84±0.71	0.96	3.43±0.53	0.11
Turn(sec)	1.53±0.38	1.66±0.46	0.72	1.86±0.44	0.08
TTS(sec)	2.78±0.44	3.53±0.55	0.01*	2.62±0.58	0.40
TUG duration(sec)	9.66±1.26	10.88±0.97	0.01*	9.36±1.54	0.52

CON=healthy elderly, CNP=chronic neck pain, STS=sit-to-stand, TTS=turn-to-sit, *$p < 0.05$ difference between CON and CNP with mild disability

We further analyzed the trunk angular velocity during TUG components to identify the movement strategy used during those TUG components between healthy controls and CNP elderly with mild and moderate disability. Although there were no statistical differences in peak trunk angular velocity between each group, it can be seen from Table 5 that peak trunk angular velocity of TUG components in CNP elderly with moderate disability tended to be larger than other groups during almost all TUG components, such as walk, turn and TTS components of TUG. When the durations of TUG were not significant different, larger peak trunk angular velocity could suggest the problem in the control of trunk stability in CNP elderly with moderate disability. In contrast, CNP elderly with mild disability tended to have smaller peak trunk angular velocity during TUG components of

STS and TTS than healthy elderly. These findings corresponded to the significant longer duration of TUG components shown in Table 3.

TABLE 5 PEAK TRUNK ANGULAR VELOCITY OF TUG COMPONENTS BETWEEN SUB-GROUP ELDERLY WITH CNP AND CONTROL

	CON (n = 15)		CNP with mild disability (n = 7)		CNP with moderate disability (n = 8)		*p*-value
	Mean	SD	Mean	SD	Mean	SD	
STS (degrees/sec)	72.67	25.27	63.29	13.63	66.92	31.04	0.63
Walk (degrees/sec)	35.68	13.29	33.69	5.55	38.11	6.67	0.45
Turn (degrees/sec)	119.36	28.65	116.66	22.07	122.9	20.27	0.65
TTS (degrees/sec)	150.42	34.89	135.51	27.55	167.66	40.52	0.35

CON=healthy elderly, CNP=chronic neck pain, STS=sit-to-stand, TTS=turn-to-sit

CHAPTER 5
SUMMARY DISCUSSION AND SUGGESTION.

This study focused on the mobility and balance impairment in elderly with chronic neck pain (CNP) by identifying specific activity during the test of Timed Up and Go (TUG) that older persons with CNP demonstrated their marked impairment. Results showed that elderly with CNP did have more pronounced mobility and balance impairment during sit-to-stand (STS) and turn-to-sit (TTS) component of TUG, as seen by the significantly longer duration of those TUG components, especially in the elderly with mild disability.

Previous literatures reported gait and balance impairment in elderly with chronic neck pain [9, 11, 12]. One study reported that elderly with CNP showed decrease in gait speed while performing straight walk with head movement than older persons without neck pain[11]. Another study supported that older with CNP had impairment of dynamic balance as well as low walking performance as represented by increasing duration of walk when performed walking with head movement[9]. Furthermore, Quek and colleagues in 2014 demonstrated that the total duration of TUG can be used to indicated balance impairment in elderly with CNP[12]. They found that elderly with CNP took longer time to complete the TUG test than the elderly without CNP.

In this study, however, we did not find significant difference of total TUG duration between healthy elderly and elderly with CNP. Different findings may be due to differences in characteristics of participants in our and previous studies. The participants with CNP in previous study were older (average age 70.3±4 years) than those in this study (average age 64.00 ± 4.05 years). Studies showed that balance impairments were more evident in those elderly with increasing age [12]. Additionally, NDI score of CNP participants in previous study were higher (average score 23.6±10.2) than those in this study (13.60±6.98). Lower NDI scores in this study suggest that young elderly had less amount of neck disability which could lead to less balance impairment when compared to the previous study. Nevertheless, our results still showed that young elderly with CNP did have balance impairment during TUG test, but they compensated to the impairment in different ways. Therefore, when analyzing the performances of young elderly with CNP together as a whole, the results did not show significant balance problems. As a result, this study performed subgroup analysis to unravel balance impairments in young elderly with CNP.

The neck disability index (NDI) was selected in this study to classify elderly with CNP into 2 groups for further analysis. The NDI was developed to assess functional activities that are related to the neck movement[106]. The NDI scoring is divided into five levels of disability where the minimum score of zero means no disability in those functions and maximum score of four means severe disability to perform those functions due to limited neck function. The NDI consisted of ten items to evaluate the level of neck pain, headache, arm function related to neck movement (such as lifting and driving), sustained neck posture (such as reading), routine work and recreation time. Our CNP elderly with mild disability had neck pain in low intensity (VAS = 3) and showed very little limited functional activity of neck (NDI score ≤ 10 points). In contrast, the elderly CNP with moderate disability (NDI score > 10 points) were presented with disability of functions related to the neck during almost all activities in daily livings. The items that most of our elderly CNP with moderate disability reported with high scores were lifting, driving, reading, working and recreation time. Our results showed that elderly with CNP in the mild and moderate disability categories compensated for their balance impairments differently. The CNP elderly with mild disability decreased speed of performance during TUG test, resulting in longer duration of TUG, whereas those with moderate disability tried to maintain the speed of TUG performance which reflected in larger peak trunk angular velocity.

By classifying participants with CNP into 2 sub-groups, our study also demonstrated that not all balance impairment in elderly with CNP can be evaluated by using the total duration of TUG but the sign of balance impairment in CNP group can also be revealed by other outcome variables. In this study, older persons with moderate disability showed larger peak angular trunk velocity during all components of TUG which led to larger trunk acceleration as an indicator of higher trunk sway during TUG performance, when the TUG durations were not significantly different. These findings indicated poor balance control in CNP elderly with moderate disability. In contrast, impaired balance control in CNP elderly with mild disability can be seen on different outcome variables. CNP elderly with mild disability demonstrated longer total TUG duration while maintaining relatively lower peak angular trunk velocity during corresponding TUG components (STS and TTS). Longer TUG duration was an indicator for impaired dynamic postural control and mobility as mentioned previously.

The explanation of 2 different findings in CNP with mild and moderate disability could be due to different compensatory strategy which was resulted from the tradeoff between speed (accuracy) of trunk control vs speed of movement, such that CNP with moderate disability prioritized their trunk control over the speed of movement. The tradeoff between trunk (or balance) control and speed of movement was also seen in patients with stroke when performing arm lifting such that they slowed down their arm movement velocity in order to maintain standing balance[111]. Another example from previous study about trunk sway in older adult fallers showed that they reduced pitch angular velocity with deceasing gait speed to reduce trunk sway during get up and go test[112].

Timed Up and Go (TUG) test is the popular clinical scale used to assess impairment of mobility or dynamic balance in several populations[9]. However, this test contains several sub-activities which may be impaired differently among groups of people. In this study, older persons with CNP who had mild disability showed marked impairments in the “sit-to-stand (STS)” and “turn-to-sit (TTS)” components but not in the “walk” component of TUG. Since all participants were received full scores in the BESTest items for lower extremity muscle strength, decreased lower extremity muscle strength may not be the reason for longer duration during STS and TTS components of TUG.

STS and TTS components are the postural transition components where a person changes from one to another body posture, thus, they involve larger movement of the head and neck in several planes of movement, as compared to the movement of the head and neck during straight walking. During STS and TTS, precise inputs from the neck, trunk and body positions were required to create accurate postural orientation for movements.

Previous study demonstrated that some elderly with CNP showed deficits in eyes movement control and perception of verticality[8]. Moreover, the systematic changes of cervical sensory inputs from cervical joints which were impaired in persons with CNP as a result of reduced joint position sense (JPS) and weakness of neck flexors and extensors led to deficits in repositioning the head to neutral position[113]. The explanation that STS and TTS components triggered larger movements of the neck and head could be the possible explanation to the marked impairment seen during the STS and TTS components of TUG.

The study has some limitations. Participants in this study were young elderly who were active in the community with less fear of fall. Findings in our study could not be generalized to other groups of elderly persons. In addition, this study selected the NDI score to classify elderly with CNP into 2 groups. Further studies are required to explore whether the use of NDI score is the most appropriate method to categorize elderly with CNP when assessing their balance impairment. Moreover, movement of the head and neck were not examined in this study as the main outcomes were time and trunk acceleration. The evaluation of neck and head movement during functional performance was important in assessing performance of elderly with CNP and hence needs to be carried out in the future study.

Results from this study could benefit the clinicians in planning the assessment for elderly with CNP. The clinicians should be aware that elderly with CNP not only have the neck problem, but they also have dynamic balance impairment to some extents, especially when performing the activities that require larger neck movement in multiple planes, such as during STS and TTS activities. To assess dynamic balance impairment in elderly with CNP, this study suggested the measurement of both TUG duration and trunk velocity because elderly with CNP may use different compensation strategy to safely complete their movement and activity. To implement this suggestion in clinical practice, it would be worthwhile to conduct a study to examine whether a mobile phone would be sensitive enough to measure trunk velocity during TUG test. In addition, findings from this study should bring the safety awareness to the clinicians that the elderly with chronic neck pain had balance impairment and may be prone to falls. Therefore, safety precaution should be taken into account during the treatment training for elderly with CNP such as the sit to stand training in multi-plane of head-trunk movement.

CONCLUSION

This study can summarize that older person with CNP demonstrated the impairment in dynamic balance as measured by the Timed Up and Go test. The “sit-to-stand” (STS) and “turn-to-sit” (TTS) components of Timed Up and Go test were impaired in elderly with chronic neck pain who had mild disability (as classified by NDI scores of <10). Those impairment can be reflected by longer duration of STS and TTS components. In contrast, elderly with chronic neck pain who had moderate disability (as classified by NDI scores of >10) had a tendency to create larger peak angular trunk velocity during walk, turn and TTS components.

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Appendix

Appendix A

Visual Analog Scale (VAS)

Visual Analog Scale (VAS)

No pain Most pain

Appendix B

Neck Disability Index (NDI)

Neck Disability Index

Office Use Only
Name ______________________________
Date ______________________________

This questionnaire has been designed to give us information as to how your neck pain has affected your ability to manage in everyday life. Please answer every section and **mark in each section only the one box that applies to you**. We realise you may consider that two or more statements in any one section relate to you, but please just mark the box that most closely describes your problem.

Section 1: Pain Intensity

☐ I have no pain at the moment
☐ The pain is very mild at the moment
☐ The pain is moderate at the moment
☐ The pain is fairly severe at the moment
☐ The pain is very severe at the moment
☐ The pain is the worst imaginable at the moment

Section 2: Personal Care (Washing, Dressing, etc.)

☐ I can look after myself normally without causing extra pain
☐ I can look after myself normally but it causes extra pain
☐ It is painful to look after myself and I am slow and careful
☐ I need some help but can manage most of my personal care
☐ I need help every day in most aspects of self care
☐ I do not get dressed, I wash with difficulty and stay in bed

Section 3: Lifting

☐ I can lift heavy weights without extra pain
☐ I can lift heavy weights but it gives extra pain
☐ Pain prevents me lifting heavy weights off the floor, but I can manage if they are conveniently placed, for example on a table
☐ Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned
☐ I can only lift very light weights
☐ I cannot lift or carry anything

Section 4: Reading

☐ I can read as much as I want to with no pain in my neck
☐ I can read as much as I want to with slight pain in my neck
☐ I can read as much as I want with moderate pain in my neck
☐ I can't read as much as I want because of moderate pain in my neck
☐ I can hardly read at all because of severe pain in my neck
☐ I cannot read at all

Section 5: Headaches

☐ I have no headaches at all
☐ I have slight headaches, which come infrequently
☐ I have moderate headaches, which come infrequently
☐ I have moderate headaches, which come frequently
☐ I have severe headaches, which come frequently
☐ I have headaches almost all the time

Section 6: Concentration

☐ I can concentrate fully when I want to with no difficulty
☐ I can concentrate fully when I want to with slight difficulty
☐ I have a fair degree of difficulty in concentrating when I want to
☐ I have a lot of difficulty in concentrating when I want to
☐ I have a great deal of difficulty in concentrating when I want to
☐ I cannot concentrate at all

Section 7: Work

☐ I can do as much work as I want to
☐ I can only do my usual work, but no more
☐ I can do most of my usual work, but no more
☐ I cannot do my usual work
☐ I can hardly do any work at all
☐ I can't do any work at all

Section 8: Driving

☐ I can drive my car without any neck pain
☐ I can drive my car as long as I want with slight pain in my neck
☐ I can drive my car as long as I want with moderate pain in my neck
☐ I can't drive my car as long as I want because of moderate pain in my neck
☐ I can hardly drive at all because of severe pain in my neck
☐ I can't drive my car at all

Section 9: Sleeping

☐ I have no trouble sleeping
☐ My sleep is slightly disturbed (less than 1 hr sleepless)
☐ My sleep is mildly disturbed (1-2 hrs sleepless)
☐ My sleep is moderately disturbed (2-3 hrs sleepless)
☐ My sleep is greatly disturbed (3-5 hrs sleepless)
☐ My sleep is completely disturbed (5-7 hrs sleepless)

Section 10: Recreation

☐ I am able to engage in all my recreation activities with no neck pain at all
☐ I am able to engage in all my recreation activities, with some pain in my neck
☐ I am able to engage in most, but not all of my usual recreation activities because of pain in my neck
☐ I am able to engage in a few of my usual recreation activities because of pain in my neck
☐ I can hardly do any recreation activities because of pain in my neck
☐ I can't do any recreation activities at all

Score: ___/50 Transform to percentage score x 100 = %points

Scoring: For each section the total possible score is 5: if the first statement is marked the section score = 0, if the last statement is marked it = 5. If all ten sections are completed the score is calculated as follows: Example: 16 (total scored)
50 (total possible score) x 100 = 32%

If one section is missed or not applicable the score is calculated: 16 (total scored)
45 (total possible score) x 100 = 35.5%

Minimum Detectable Change (90% confidence): 5 points or 10 %points

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NDI developed by: Vernon, H. & Mior, S. (1991). The Neck Disability Index: A study of reliability and validity. Journal of Manipulative and Physiological Therapeutics. 14, 409-415

Appendix C

The Activity specific Balance Confidence scale (ABC)

Stanford HEALTH CARE

Department of Rehabilitation Services
The Activities-specific Balance Confidence (ABC) Scale*

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10 20 30 40 50 60 70 80 90 100%
no confidence completely confident

"How confident are you that you will not lose your balance or become unsteady when you…

1. …walk around the house? ____%
2. …walk up or down stairs? ____%
3. …bend over and pick up a slipper from the front of a closet floor ____%
4. …reach for a small can off a shelf at eye level? ____%
5. …stand on your tiptoes and reach for something above your head? ____%
6. …stand on a chair and reach for something? ____%
7. …sweep the floor? ____%
8. …walk outside the house to a car parked in the driveway? ____%
9. …get into or out of a car? ____%
10. …walk across a parking lot to the mall? ____%
11. …walk up or down a ramp? ____%
12. …walk in a crowded mall where people rapidly walk past you? ____%
13. …are bumped into by people as you walk through the mall?____%
14. … step onto or off an escalator while you are holding onto a railing? ____%
15. … step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? ____%
16. …walk outside on icy sidewalks? ____%

*Powell, LE & Myers AM. The Activities-specific Balance Confidence (ABC) Scale. *J Gerontol Med Sci* 1995; 50(1): M28-34

Appendix D

Dizziness Handicap Inventory (DHI)

Instructions: The purpose of this scale is to identify difficulties that you may be experiencing because of your dizziness. Please check "always", <u>or</u> "no" <u>or</u> "sometimes" to each question. Answer each question only as it pertains to your dizziness problem.

	Questions	Always	Sometimes	No
P1	Does looking up increase your problem?	☐	☐	☐
E2	Because of your problem, do you feel frustrated?	☐	☐	☐
F3	Because of your problem, do you restrict your travel for business or pleasure?	☐	☐	☐
P4	Does walking down the aisle of a supermarket increase your problem?	☐	☐	☐
F5	Because of your problem, do you have difficulty getting into or out of bed?	☐	☐	☐
F6	Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to movies, dancing or to parties?	☐	☐	☐
F7	Because of your problem, do you have difficulty reading?	☐	☐	☐
F8	Does performing more ambitious activities like sports, dancing, and household chores, such as sweeping or putting dishes away; increase your problem?	☐	☐	☐
E9	Because of your problem, are you afraid to leave your home without having someone accompany you?	☐	☐	☐
E10	Because of your problem, have you been embarrassed in front of others?	☐	☐	☐
P11	Do quick movements of your head increase your problem?	☐	☐	☐
F12	Because of your problem, do you avoid heights?	☐	☐	☐
P13	Does turning over in bed increase your problem?	☐	☐	☐
F14	Because of your problem, is it difficult for you to do strenuous housework or yard work?	☐	☐	☐
E15	Because of your problem, are you afraid people may think that you are intoxicated?	☐	☐	☐
F16	Because of your problem, is it difficult for you to go for a walk by yourself?	☐	☐	☐
P17	Does walking down a sidewalk increase your problem?	☐	☐	☐
E18	Because of your problem, is it difficult for you to concentrate?	☐	☐	☐
F19	Because of your problem, is it difficult for you to walk around your house in the dark?	☐	☐	☐
E20	Because of your problem, are you afraid to stay home alone?	☐	☐	☐
E21	Because of your problem, do you feel handicapped?	☐	☐	☐
E22	Has your problem placed stress on your relationship with members of your family or friends?	☐	☐	☐
E23	Because of your problem, are you depressed?	☐	☐	☐
F24	Does your problem interfere with your job or household responsibilities?	☐	☐	☐
P25	Does bending over increase your problem?	☐	☐	☐

Appendix E

Ethical approve

MF 10 1 version 2.0
วันที่ 18 ต.ค. 61

เอกสารชี้แจงผู้เข้าร่วมการวิจัย

(Participant Information Sheet)

ในเอกสารนี้อาจมีข้อความที่ท่านอ่านแล้วยังไม่เข้าใจ โปรดสอบถามหัวหน้าโครงการวิจัยหรือผู้แทนให้ช่วยอธิบายจนกว่าจะเข้าใจดี ท่านอาจจะขอเอกสารนี้กลับไปอ่านที่บ้านเพื่อปรึกษา หารือกับญาติพี่น้อง เพื่อนสนิท แพทย์ประจำตัวของท่าน หรือแพทย์ท่านอื่น เพื่อช่วยในการตัดสินใจเข้าร่วมการวิจัย

ชื่อโครงการวิจัย การระบุความบกพร่องด้านการทรงตัวในผู้สูงอายุที่มีปัญหาปวดคอเรื้อรัง

ชื่อหัวหน้าโครงการวิจัย นางสาว ธันยา หมัดสะและ

สถานที่วิจัย โรงพยาบาลตำรวจ และคลินิกกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ ประสานมิตร

สถานที่ทำงานและหมายเลขโทรศัพท์ของหัวหน้าโครงการวิจัยที่ต่อได้ทั้งในและนอกเวลาราชการ

67/102 หมู่ที่ 3, ถนนติวานนท์, ต.บางตลาด, อ.ปากเกร็ด, จ.นนทบุรี 11120 โทร. 089-927-5497

ผู้สนับสนุนทุนวิจัย โครงการปริญญาเอกกาญจนาภิเษก (คปก.) สำนักงานกองทุนสนับสนุนการวิจัย

ระยะเวลาในการวิจัย 2 ปี (โดยผู้เข้าร่วมวิจัยแต่ละคนจะเข้าร่วมโครงการวิจัยเพียง 1 ครั้งใช้เวลา 2 ชั่วโมงโดยประมาณ)

โครงการวิจัยนี้ทำขึ้นเพื่อ

1). เพื่อระบุความบกพร่องในการทรงตัวของผู้สูงอายุที่มีปัญหาปวดคอเรื้อรังตามองค์ประกอบการทรงตัวด้านต่างๆ เทียบกับผู้สูงอายุที่ไม่มีอาการปวดคอ
2). เพื่อทดสอบความสามารถในการจำแนกผู้สูงอายุที่มีปัญหาปวดคอเรื้อรังที่มีและไม่มีปัญหาด้านการทรงตัวของเครื่องมือทดสอบการทรงตัวที่นิยมใช้ในทางคลินิก

ประโยชน์ที่คาดว่าจะได้รับจากการวิจัย

1). ท่านจะได้รับทราบข้อมูลเกี่ยวกับความสามารถ และ/หรือ ความบกพร่องด้านการทรงตัวในแต่ละด้านของตนเอง รวมไปถึงได้รับความรู้และคำแนะนำเบื้องต้นในการปฏิบัติตัว เพื่อหลีกเลี่ยงปัจจัยเสี่ยงที่ทำให้เกิดการล้ม ตามความสามารถด้านการทรงตัวของแต่ละบุคคล
2). ระบุเครื่องมือทดสอบการทรงตัวในทางคลินิกที่สามารถจำแนกผู้สูงอายุที่มีปัญหาปวดคอเรื้อรังที่มีและไม่มีปัญหาด้านการทรงตัว

ท่านได้รับเชิญให้เข้าร่วมการวิจัยนี้เพราะ

1). ท่านเป็นผู้ที่มีอายุ 60 ปีขึ้นไป สามารถเดินได้โดยไม่ใช้เครื่องช่วย และไม่มีอาการปวดคอในระยะเวลา 2 ปีที่ผ่านมา
2). ท่านเป็นผู้ที่มีอายุ 60 ปีขึ้นไป สามารถเดินได้โดยไม่ใช้เครื่องช่วย มีอาการปวดคอ มากกว่าหรือเท่ากับ 30/100 มม. เมื่อทดสอบโดยมาตรวัดด้วยสายตาในช่วงสัปดาห์ที่ผ่านมา และมีอาการอย่างน้อย 3 เดือน

จะมีผู้เข้าร่วมการวิจัยนี้ทั้งสิ้นประมาณ 84 คน โดยแบ่งออกเป็นกลุ่มที่มีอาการปวดคอเรื้อรังเพศชายและหญิงจำนวน 56 คน และกลุ่มที่ไม่มีอาการปวดคอเรื้อรังเพศชายและหญิงจำนวน 28 คน

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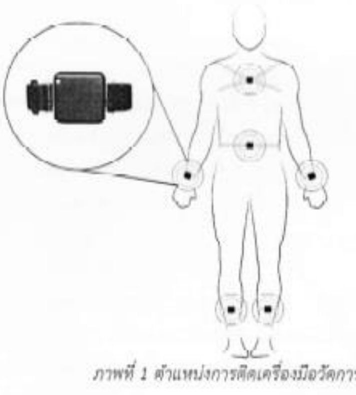
หากท่านตัดสินใจเข้าร่วมการวิจัยแล้ว จะมีขั้นตอนการวิจัยดังต่อไปนี้คือ

1. หลังจากเซ็นใบยินยอมเข้าร่วมวิจัย ท่านจะต้องกรอกประวัติส่วนตัว และทำแบบประเมินดังต่อไปนี้
   - ประวัติส่วนตัวประกอบด้วย อายุ, เพศ, ดัชนีมวลกาย, ประวัติการล้มในช่วง 12 เดือนที่ผ่านมา, ยาที่รับประทานเป็นประจำ และโรคประจำตัว หรือโรคร่วม
   - แบบประเมินวัดระดับความปวดคอ ความสามารถของการเคลื่อนไหวคอ วัดผลกระทบของอาการเวียนศีรษะต่อการทำกิจกรรม และวัดความมั่นใจในการทรงตัวขณะปฏิบัติกิจกรรมในชีวิตประจำวัน
2. ท่านจะได้รับการทดสอบการทรงตัวด้วยเครื่องมือและแบบทดสอบการทรงตัวในคลินิก โดยจะใช้ระยะเวลาในการทดสอบ 2 ชั่วโมงโดยประมาณ
3. ก่อนทำการทดสอบท่านจะต้องถอดรองเท้าและถุงเท้า จากนั้นสวมใส่เครื่องมือวัดการทรงตัวทั้งหมด 6 ชิ้น ซึ่งมีลักษณะคล้ายนาฬิกาข้อมือขนาดเล็กน้ำหนักเบา บริเวณกึ่งกลางอก, ระดับกระดูกสันหลังส่วนเอวชิ้นที่ 5, ข้อมือและข้อเท้า ทั้ง 2 ข้าง ดังแสดงในภาพที่ 1 เพื่อเป็นการเก็บข้อมูลการแกว่งของจุดศูนย์กลางมวล ขณะทำการทดสอบการทรงตัวด้วยท่าทดสอบต่างๆ



ภาพที่ 1 ตำแหน่งการติดเครื่องมือวัดการทรงตัว

4. ท่านจะถูกทดสอบการทรงตัวด้วยเครื่องมือ และแบบทดสอบการทรงตัวในทางคลินิกทั้ง 4 ชนิด ดังต่อไปนี้
   4.1. Balance Evaluation Systems Test (BESTest) เป็นการทดสอบการทรงตัวตามองค์ประกอบการทรงตัวทั้งหมด 6 องค์ประกอบ โดยทำการทดสอบในท่านั่ง ยืน และเดิน รวมทั้งหมด 27 ท่า ซึ่งจะทำการทดสอบท่าละ 1 ครั้ง ยกเว้นท่าทดสอบที่ต้องใช้การจับเวลาจะทำการทดสอบท่าละ 3 ครั้ง

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4.2. Modified Clinical Test of Sensory Interaction in Balance (CTSIB-M) เป็นการทดสอบการทรงตัวขณะยืนนิ่งๆบนพื้นราบและพื้นนิ่ม โดยจะให้ท่านยืนห่างจากกำแพง 1.5 เมตร เอามือพาดไว้ที่หน้าอกในลักษณะกากบาท ในแต่ละท่าทดสอบให้ท่านยืนให้นิ่งที่สุดเป็นระยะเวลา 30 วินาที ในแต่ละลักษณะพื้นผิวจะประกอบด้วย 4 ท่าทดสอบ ได้แก่ ยืนกางขาเท่าความกว้างไหล่ร่วมกับการจ้องไปที่จุดบนกำแพง, ยืนกางขาเท่าความกว้างไหล่ร่วมกับหลับตา, ยืนเท้าชิดร่วมกับการจ้องไปที่จุดบนกำแพง, ยืนเท้าชิดร่วมกับหลับตา โดยจะทำการทดสอบท่าละ 3 ครั้ง

4.3. Dynamic Gait Index (DGI) เป็นการทดสอบการทรงตัวขณะเดินด้วยลักษณะการเดินในรูปแบบต่างๆ ดังต่อไปนี้; การเดินบนพื้นราบ, การเดินแบบเปลี่ยนความเร็ว, การเดินร่วมกับการหันศีรษะซ้าย-ขวา, การเดินร่วมกับการก้ม-เงยศีรษะ, การหมุนตัว, การเดินข้ามสิ่งกีดขวาง, เดินอ้อมสิ่งกีดขวาง, และการขึ้น-ลงบันได โดยจะทำการทดสอบการเดินรูปแบบละ 1 ครั้ง

4.4. Timed-UP and GO test (TUG) เป็นการทดสอบการทรงตัวที่มีลักษณะใกล้เคียงกับการทำกิจวัตรประจำวัน โดยการทดสอบจะให้ท่านลุกขึ้นยืนจากเก้าอี้ เดินเป็นระยะทางสั้นๆ 3 เมตร หมุนตัวกลับ และเดินย้อนกลับไปนั่งที่เก้าอี้เดิม โดยทำการทดสอบทั้งหมด 3 ครั้ง

ท่าทดสอบใดที่ซ้ำจะทำการทดสอบร่วมกัน ดังนั้นจะประกอบด้วยการทดสอบทั้งหมด 34 ท่า หลังทำการทดสอบแต่ละท่า ท่านจะได้พักเป็นระยะเวลา 1 นาที ซึ่งในการทดสอบจะใช้เวลาทั้งสิ้น 2 ชั่วโมงโดยประมาณ เพื่อป้องกันอาการล้าที่อาจเกิดขึ้น ซึ่งระหว่างทำการทดสอบจะมีการบันทึกภาพเคลื่อนไหวเพื่อนำไปใช้ในการประเมินผล และจะมีผู้ช่วยวิจัยอยู่ข้างท่านตลอดการทดสอบเพื่อป้องกันการล้ม หากระหว่างทำการทดสอบท่านพบอาการไม่พึงประสงค์ หรือความผิดปกติใดๆ สามารถแจ้งผู้วิจัยได้ทันที

ความเสี่ยงที่อาจจะเกิดขึ้นเมื่อเข้าร่วมการวิจัย

1) การล้มขณะทำการทดสอบ
2) อาการเวียนศีรษะ หรืออาการปวดศีรษะที่อาจเพิ่มขึ้นระหว่างทำการทดสอบ
3) อาการล้า หรือปวดตามกล้ามเนื้อระหว่างทำการทดสอบ

หากท่านไม่เข้าร่วมในโครงการวิจัยนี้ ท่านก็จะได้รับการตรวจเพื่อการวินิจฉัยและรักษาโรคของท่านตามวิธีการที่เป็นมาตรฐานคือ การตรวจวินิจฉัยและรักษาทางกายภาพบำบัด

ท่านจะได้รับการช่วยเหลือหรือดูแลรักษาการบาดเจ็บ/เจ็บป่วยอันเนื่องมาจากการวิจัยตามมาตรฐานทางการแพทย์ โดยผู้รับผิดชอบค่าใช้จ่ายในการรักษาคือ นางสาว ธันยา หมัดสะและ

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ประโยชน์ที่คิดว่าจะได้รับจากการวิจัย

1) ประโยชน์โดยตรงต่อผู้เข้าร่วมวิจัย
   - ผู้เข้าร่วมวิจัยทราบถึงความสามารถ และ/หรือ ความบกพร่อง ด้านการทรงตัวในแต่ละด้านของตนเอง
   - ผู้เข้าร่วมวิจัยจะได้รับความรู้และคำแนะนำเบื้องต้นในการปฏิบัติตัว เพื่อหลีกเลี่ยงปัจจัยเสี่ยงที่ทำให้เกิดการล้ม ตามความสามารถด้านการทรงตัวของแต่ละบุคคล
2) ประโยชน์ต่อส่วนรวม
   - ทราบแนวทางการตรวจสอบการทรงตัวในแต่ละด้านของผู้สูงอายุ และผู้สูงอายุที่มีปัญหาปวดคอเรื้อรัง ทั้งทางห้องปฏิบัติการและทางคลินิก
   - ค้นพบเครื่องมือที่มีความไวต่อการตรวจสอบความบกพร่องด้านการทรงตัวในผู้สูงอายุที่มีปัญหาปวดคอเรื้อรัง ผู้วิจัย และผู้ร่วมวิจัยสามารถนำเครื่องมือดังกล่าวไปประยุกต์ใช้ในทางคลินิก เพื่อตรวจสอบความบกพร่องในการทรงตัวแต่ละด้าน และเป็นแนวทางในการวางแผนการรักษาปัญหาด้านการทรงตัวในผู้สูงอายุที่มีปัญหาปวดคอเรื้อรังต่อไป
   - ได้ข้อมูลอ้างอิงสำหรับการพัฒนางานวิจัยชิ้นต่อไปในอนาคต

ค่าตอบแทนที่ผู้เข้าร่วมการวิจัยจะได้รับ 200 บาท

ค่าใช้จ่ายที่ผู้เข้าร่วมการวิจัยจะต้องรับผิดชอบเอง ไม่มี

หากมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ทราบโดยรวดเร็วและไม่ปิดบัง

ข้อมูลส่วนตัวของผู้เข้าร่วมการวิจัย จะถูกเก็บรักษาไว้โดยไม่เปิดเผยต่อสาธารณะเป็นราย บุคคล แต่จะรายงานผลการวิจัยเป็นข้อมูลส่วนรวมโดยไม่สามารถระบุข้อมูลรายบุคคลได้ ข้อมูลของผู้เข้าร่วมการวิจัยเป็นรายบุคคล อาจมีคณะบุคคลบางกลุ่มเข้ามาตรวจสอบได้ เช่น ผู้ให้ทุนวิจัย สถาบัน หรือองค์กรของรัฐที่มีหน้าที่ตรวจสอบ รวมถึงคณะกรรมการจริยธรรมการวิจัยในคนมีหน้าที่ตรวจสอบได้

ผู้เข้าร่วมการวิจัยมีสิทธิ์ถอนตัวออกจากโครงการวิจัยเมื่อใดก็ได้ โดยไม่ต้องแจ้งให้ทราบล่วงหน้า และการไม่เข้าร่วมการวิจัยหรือถอนตัวออกจากโครงการวิจัยนี้ จะไม่มีผลกระทบต่อการบริการและการรักษาที่สมควรจะได้รับตามมาตรฐานแต่ประการใด

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วันที่ 26 เมษ 2562 ถึง 25 เม.ย. 2563

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หากท่านได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารชี้แจงนี้ท่านสามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนทราบได้ที่ สำนักงานคณะกรรมการจริยธรรมการวิจัยในมนุษย์ สถาบันยุทธศาสตร์ทางปัญญาและวิจัย อาคารศาสตราจารย์ ดร.สาโรช บัวศรี ชั้น 20 โทร (02) 649-5000 ต่อ 11019 โทรสาร: (02) 259-1822

ลงชื่อ..ผู้เข้าร่วมโครงการวิจัย
(..)
วันที่..

คณะกรรมการจริยธรรมในมนุษย์
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วันที่ 26 เมย 2562 ถึง 25 เมย 2563

VITA

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