ISASE-MAICS 2018

Expectation about contribution on comfortable nursing care from Affective Science and Engineering

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Abstract: We investigated the comfort in nursing care. First, we examined the use of “Vein Display” to observe variations in individuals’ subcutaneous blood flow. We found the venipuncture site selection was significantly improved with “Vein Display”, but did not evaluate the difficulty of students to perform venipuncture as there are currently no scales to reflect their affective fluctuations. Second, we verified the comfortability of MRI with limited body movement. We measured the affective and physical distress of patients in response to body positioning using various devices. Next, we aim to measure the physical ability and perception of the elderly with a high risk of sarcopenia to cope with daily activities. Here we will determine parameters used to predict the risk of sarcopenia and identify factors which worsen sarcopenia. We intend to use the tools available from Affective Science to measure the detectable emotional change.

Keywords: comfort, nursing care, affect

1. INTRODUCTION

We have been challenging education and researches on comfortable nursing care both for patients and for nurses including students. On this opportunity, we want to show you what topics we have tried, difficulties found there and what we are aiming next for comfortable nursing care. Something we expect your contribution from Affective Science and Engineering will be also presented here.

2. Utilization device

2.1 The use of “Vein Display” to observe the positioning of individual subcutaneous blood

The 1st use of Affective Science and Engineering at our nursing program in improving nursing care took place when teaching our nursing students how to accurately select venipuncture sites. Venipuncture is often painful for patients. And, some of the known complications from venipuncture include nerve injury, hemorrhage, infection, vasovagal reaction, and so forth.

It is not easy for novice students to learn such an invasive skill like venipuncture at the training room in the school. A vein visualization display system, “Vein Display”, had been developed to observe individual subcutaneous blood running by near infrared light. We used “Vein Display” for students’ education of the safe and proper selection of venipuncture sites in the forearm (Figure1).

The protocol of the series of the trials was set as a part of scenario to get a suitable route for drip infusion by a needle with wings at the forearm.

We evaluated whether the sites selected by the students were consistent with safe and appropriate venipuncture, as defined by the 3-point-based scale on the following 4 adverse criteria: 1) meandering site of the vein, 2) branching site of the vein, 3) near the common site of cutaneous nerve, and 4) less than 4cm from the cubital crease or the most distal crease of the wrist. In order to maximize butterfly needle safety even during joint motion, the following 3 levels were evaluated: “yes” meant the site selected represented a clear risk and was scored as 0, “ambiguous” meant the site selected represented a potential risk and was scored as 1, and “no” meant free from any risk and was scored as 2. The total possible score ranged from 8 (highest) to 0 (zero), except in the case of...
“extravascular” site selection (defined as site selection more than 2mm away from the target vein), which was not scored, regardless of any other criteria (Table1).

We found that venipuncture site selection time was significantly improved with the “Vein Display”, particularly in the case of “difficulty to see” subcutaneous veins (1). But at that time, we could not evaluate how difficult the nurse-role students felt during the trial, because of no scale to reflect their affective fluctuation. Just we expect a tool on emotional change while students are doing not so easy tasks.

### Table 1 vein selection score to keep a butterfly needle safely at the forearm

<table>
<thead>
<tr>
<th>item</th>
<th>score</th>
<th>yes</th>
<th>ambiguous</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>meandering site of the vein</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>branching site of the vein</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>near the common site of cutaneous nerve</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>less than 4cm from the cubital crease or the most distal crease of the wrist</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>extravascular : site selection of more than 2mm from blood vessels on the forearm</td>
<td>not scored</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2 Whether people can stay still comfortable in the MRI without movement of the focused body parts or not?

To avoid any nerve injury on venipuncture is mandatory. Variation of cutaneous nerve running causes sometimes complication on venipuncture. Some patients insist that they are suffering from causalgic pain caused by venocentesis. Now we may be able to detect some of large cutaneous nerves by electro-physiological methods like nerve conduction studies. It also causes another discomfort due to electric stimulation. And the method is different from imaging. Magnetic resonance images (MRI) itself has no pain except for forced staying in very narrow space without movement. MRI may be able to let us accumulate precise data on alive human cutaneous nerves. A dangerous zone map may be shown from the data. Once we had a good experience to have felt effectiveness of visualizing tool on superficial veins, then we wanted to visualize cutaneous nerves at the forearm by MRI. However, it was very difficult for any type of MRI sequences to visualize small peripheral nerves like a cutaneous nerve (2). We tried to make an educational navigation system to avoid the high risk area of nerve injury at venipuncture with the partial support from the national Grants-in-aid for Scientific Research “Challenging Exploratory Research (2015-2019)”, depending on the published variation of cutaneous nerves at the forearm (3,4,5). During waiting for development of new MRI sequences to show fine nerves, a topic rose: whether people can stay still comfortable in the MRI without movement of focused body parts or not?

The reason: first of all, such nerves are too fine to be delineated. The second, it is not easy to keep the object site at the center of the gantry.

To take fine images of MRI, people include healthy persons are supposed to be supine or slightly lateral decubitus position and to keep the examining part of body in the center of the gantry for 20 minutes or longer without movement in the narrow space. This positioning can create distress for people include health persons. No article was found that focused on measurement about affective and physical distress on patients as a result of the body positioning requirement in MRI, and body motion in the limited space of MRI.

Then, we made a simulated model MRI out of wood and acrylic boards, precisely tracing the actual Philips INGENIA 3.0T Omega HP. No movement of the object is necessary for fine MRI images. So, we want to measure the total amount of the movement by the 3 axis acceleration sensors and a small video camera and participants feeling. (Figure2, 3).

**Figure 2 Simulated model MRI out of wood and acrylic boards**
Participants: Eighteen adult students (20-40 years of age, mean 25.3 ± 6.3 years, comprising 8 men and 10 women) were participated with the written consent among applicants after a call for paid volunteers from the school of nursing and the faculty of industry, Mie University’s IRB approved this study. (No.3090 13, January, 2017, Faculty of Medicine, Mie University).

Methods: Each subject’s physical data was collected beforehand on height, weight, and body-mass index (BMI). The forearm motion was recorded by the 3 axis acceleration sensors on the forearm and the chest wall (just above the sternal body), both ① during 15 minutes on supine without any restriction before entering the model and ② during 20 minutes on keeping the subject’s dominant forearm as center and motionless as possible in the model gantry. The small camera installed inside the acrylic transparent board was used as a supplemental tool to check their motion after the trial. The autonomic nervous reaction was simultaneously monitored as to heart rate variability and LF/HF (the ratio of low frequency / high frequency) by the MemCalc/Bonaly Light (GMS Co., Ltd. Tokyo, Japan 2015) (Figure4).

The subjective pain of areas of the body and mental & physical fatigue were collected by using the questionnaire with visual analogue scales (VAS). VAS 0 means “free” and 100 means “extreme”. To test the significance of the differences, we used a non-parametric Mann-Whitney test for comparison of coefficient of variation between the forearm and sternum, and distress on hold state of dorsal position by BMI, and Wilcoxon signed-rank test for comparison of the heart rate variability analysis on LF/HF between before and during the gantry. For the analysis, SPSS Ver.20.0 was used and the significance level was set at <5%.

Results: The participants showed very little motion of their dominant forearm, keeping with suitable positioning for 20 minutes in the simulated gantry. The value of XYZ (Accx, Accy, Accz : acceleration, Gyrox, Gyroy, Gyroz: angular velocity) is used to calculate and detect the motions. There was no significant difference of coefficient of variation between the forearm and sternum. (Figure3, Table2). However, one case of Gyroz was large variations.

Table 2 Coefficient of Variation (average value)

<table>
<thead>
<tr>
<th>mounting region</th>
<th>Accx</th>
<th>Accy</th>
<th>Accz</th>
<th>Gyrox</th>
<th>Gyroy</th>
<th>Gyroz</th>
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</thead>
<tbody>
<tr>
<td>forearm</td>
<td>0.09</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.82</td>
<td>-0.74</td>
<td>-1.46</td>
</tr>
<tr>
<td>sternum</td>
<td>0.10</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.32</td>
<td>-0.24</td>
<td>-0.73</td>
</tr>
</tbody>
</table>

Mann-Whitney Test

The heart rate variability analysis on LF/HF was measured between before and during the gantry. Both of them the hold state (15-20min.) was significantly lower than the relaxed state (10-15min.) (Figure5, 6).
How was their pain or fatigue? The subjects with not more than BMI 18.5 scored the higher VAS values of fatigue and pain at staying in the gantry than the participants with more than BMI 18.5. The subjects with not more than BMI 18.5 showed pain in their finger tips on the dominant side, around their both side hips or uni-lateral hip, and unstable sense on their dominant (right) leg (Table 3).

Table 3 Comparison of distress on hold state of dorsal position by BMI

<table>
<thead>
<tr>
<th>BMI</th>
<th>under 18.5 (N=9)</th>
<th>over 18.5 (N=13)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>fatigue</td>
<td>32.5±17.6</td>
<td>18.7±18.9</td>
<td>0.046*</td>
</tr>
<tr>
<td>pain</td>
<td>10.1±12.6</td>
<td>1.5±2.3</td>
<td>0.041*</td>
</tr>
<tr>
<td></td>
<td>19.4±24.7</td>
<td>21.3±31.1</td>
<td>0.037*</td>
</tr>
<tr>
<td></td>
<td>22.2±23.3</td>
<td>5.3±12.5</td>
<td>0.008**</td>
</tr>
<tr>
<td>unstable</td>
<td>18.9±24.8</td>
<td>5.9±12.0</td>
<td>0.033*</td>
</tr>
<tr>
<td></td>
<td>19.0±26.3</td>
<td>2.2±4.4</td>
<td>0.02*</td>
</tr>
</tbody>
</table>

*P<0.05 **P<0.01
Mann-Whitney Test

3. To measure sense and the evaluation of the comfortableness for elderly of high risk of sarcopenia

Then, waiting for the next chance to delineate a fine cutaneous nerve, we have headed to the next topic on predicting and preventing of sarcopenia. Sarcopenia stems from the word “sarco” which means muscle and the word “-penia” which means reduction. Sarcopenia itself does not cause pain, unless fall or fracture occurs. But once elder people got such a fall or fracture, not only does sarcopenia create physical and emotional discomfort and pain for older adults, it is known to shorten their life expectancy. Japan’s current “aging” society is forecasted to become even more “aging” with projected 31.8% of its population to be “older adults” in 2030. Of the older adults in 2013, over 45% of them are estimated to be single elder women’s households. (7). Female’s longevity means the increasing risk of sarcopenia and osteoporosis. One in 4 to 5 healthy elderlies in community was reported having sarcopenia in Japan (8). Decrease of muscle bulk in legs was reported even in the early stage of aging (9). Fracture, fall, and joint disorders are said to be the main reasons that people utilize the long-term care insurance in Japan (10,11). People with less movement tend to become more osteoporosis and sarcopenia as astronauts lost their bone density and muscle bulks under the state of zero-gravity. Three percent of muscle bulk is estimated to be lost a day in plaster fixation.

Therefore, we want to detect the effective parameters to predict the risk of and to find worsening factors of sarcopenia. Now we are thinking that it is natural and smooth for people to be checked in the activity of daily life: to acquire the data such as acceleration of the standing-up movement from the stool seat, the frequency of posture changes indoors, level of physical activities indoors and outdoors and so forth. Utilization of the technology of IoT seemed to be the most efficient tool for the elderly for its small size. Elderly tends to move a few times per hours. So collecting long time span would be
good for the analysis. (12,13). The level of physical activity and measurements of physical strength of elderly are influenced by seasonal changes in physical condition (14). It may be well-known that hypertension control or parkinsonism reflects seasonal environments. In addition to this, the physical activity of elderly is greatly influenced by the degree of pain and fatigue. Therefore, it is important to capture the feeling or emotional change detectable by any objective tool in addition to the physical data (amount of muscle mass, grip, 10 m walking speed etc.), behavioral data (activity strength, walking distance, acceleration of posture change etc.) and environmental data (temperature, humidity, weather etc.). We would like to get the viewpoints from Affective Science such as the measuring of detectable emotional change using available tool.

REFERENCES


