

Movement Analysis of Transfer Assistance Using a Slide Board

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Abstract. In this study, the transfer process from wheelchair to bed was focused and investigation by comparing expert and non-expert. The 3D motion analysis system was used during transfer process in order to obtain the motion characteristic. The whole transfer was separated into 3 processes to make process analysis. The expert can transfer care-receiver smoothly with a comfortable condition. Using hand support Shoulder bones and hold care-receiver lean forward was considered a current method to adjust care-receiver's position. And the current using method of slide board was also found according to process analysis.

Keywords: Movement analysis · Transfer · Slide board · Process analysis · Expert and non-expert

1 Introduction

Japan has become a super-aged society. In recent years, the importance and demand of care workers are expected to increase. On the other hand, care workers tend to suffer from musculoskeletal disorders such as back pain or cervico-omo-brachial disorder. The Ministry of Health, Labor and Welfare is promoting the measures to prevent these health impairments and the use of slide boards. A slide board is a tool to use when a caregiver transfer a care-receiver from a bed to a wheelchair or a vehicle. Using a slide board, it is not necessary to lift up a care-receiver at the time of transfer assistance. It therefore, reduces the work load of caregivers, which eventually prevent the occurrence of back pains.

However, in order to use a slide board perfectly, practice and time is required. In this study, we focus on transfer assistance work by using a slide board, especially when

transferring a care-receiver from a wheelchair to a bed, and then analyze the movements of expert and non-expert to clarify the differences between them.

In order to measure the movement of subjects, 6 MAC3D System cameras were installed (MAC3D System; motion analysis Co. Ltd.). We attached markers on subjects to analyze the movements and obtained the following results.

The whole data was separated into 6 steps and 3 processes. The caregivers' motion was clarified and comparing according to each process. The key points of transfer from wheelchair to bed by using slide board were found by comparing expert and non-expert. Using hand support Shoulder bones and hold care-receiver lean forward was considered in process-1. Insert slide board into space under bottom with a slight angle with bed was considered the basic condition of slide board using method.

2 Experiment

2.1 Participants and Instruments

In this study, two caregivers who had experienced were employed and called expert and non-expert. A man was selected as care-receiver who requiring care.

The caregivers were required transfer care-receiver from wheelchair to bed by using slide board as shown in following (Fig. 1).



Fig. 1. Slide board

2.2 Motion Analysis

The three-dimensional motion capture system was used for evaluating the motion during the whole transfer process as shown in Fig. 2. (MAC3D System; motion analysis Co. Ltd.) The infrared reflection markers were affixed at the bodies of expert, non-expert and care-receiver. As shown in Fig. 3, 20, 33, 6 points was pasted on the bodies of expert, non-expert and care-receiver in order to analyze motion. And six cameras captured the position of each marker in the three dimensional coordinate system with 100 Hz sampling rate. All markers position data were synchronized and entered into a computer.



Fig. 2. Experiment setting

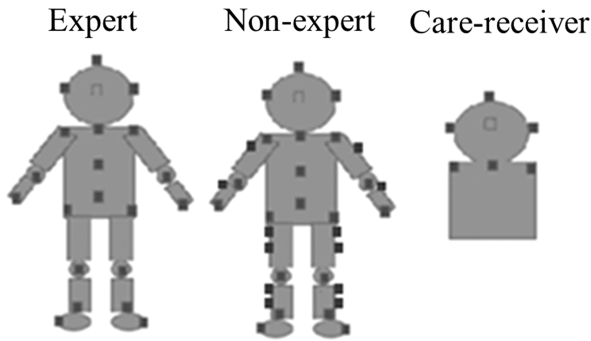


Fig. 3. The Location of infrared reflection markers for expert, non-expert and beginner.

2.3 Working Sequence and Process Analysis

The whole transfer working Sequence was separated into six steps as shown in following:

1. The caregiver stop wheelchair and press wheelchair' brakes before adjust the position of care-receiver's feet and position.
2. Adjust the posture and position of the care-receiver so that obtain a suitable.
3. Put the slide board between the care-receiver's bottom and bed. One side of slide board was inserted into space between bottom and a wheelchair, the other side was put on the bed.
4. The caregiver's right hand was held on care-receiver's back in order to carry care-receiver closing to caregiver's chest. The caregiver's left hand push care-receiver sliding on the board to the bed.
5. Take off the board
6. Adjust care-receiver's position

The first three steps were focused on in this study. And the expert’s working time of first three steps was summarized on Table 1.

Table 1. The working time of first three steps (Second)

No.	Process	Expert	Non-expert
1	Adjust care-receiver’s position until a suitable location	21	33
2	Put the slide board between the care-receiver’s bottom and bed.	11	5
3	Push care-receiver sliding on slide board from wheelchair to the bed	15	21

3 Result and Discussion

The main motion of first three steps for expert and non-expert were illustrated on Fig. 4. As shown in process-1, the expert’s hand holding the care-receiver’s back, which hand was hugged at the top of the care-receiver’s back. However, non-expert’s hand was held on the chest of care-receiver. In case of process-2, Experts putted the slide board under care-receiver’s bottom had an angle with a wheelchair. The non-expert putted the slide board perpendicular to the wheelchair as shown in Fig. 4. Furthermore, expert was taken crouching posture during process-3. Non-expert was taken standing posture.

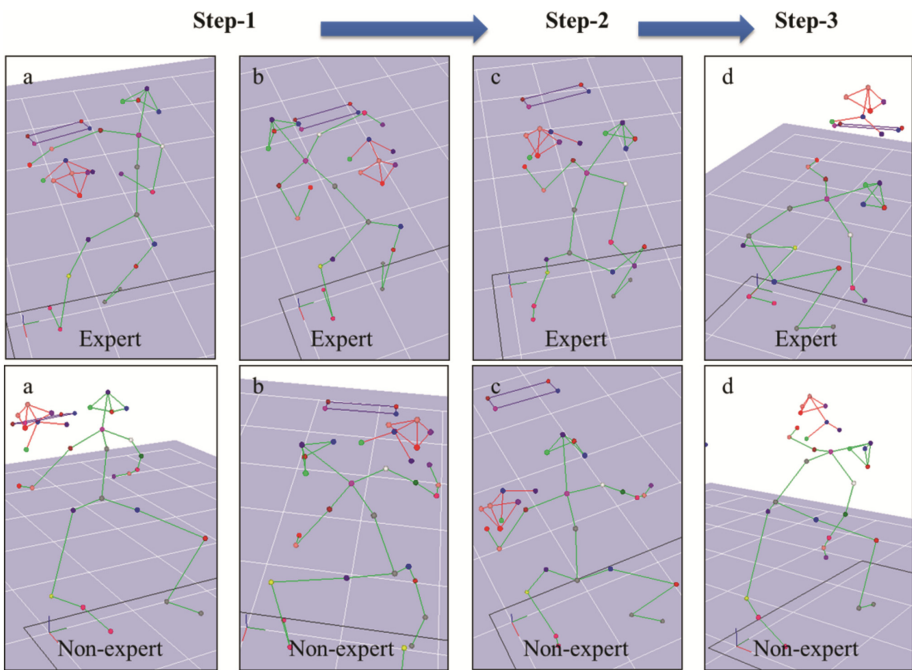


Fig. 4. The main motion of first three steps

Figure 5 was shown the body adjustment by expert and non-expert. As shown in Fig. 5, Experts used one hand support care-receiver’s shoulder blade, used other hand pulled care-receiver’s body tilted down on him. However, care-receiver’s upper body was significantly down to one side during process-1 of non-expert, especially the head.

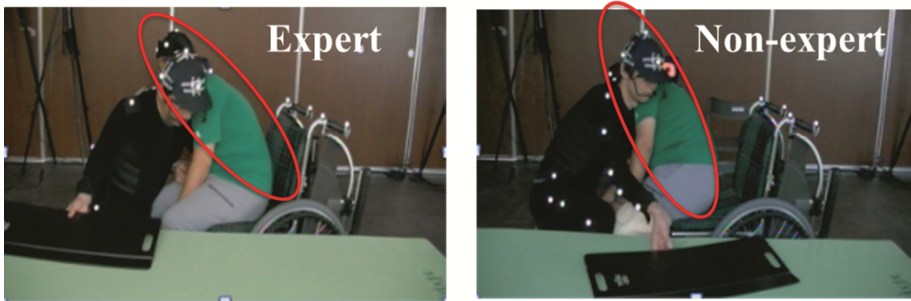


Fig. 5. Body adjustment by expert and non-expert during process-1

The Fig. 6 was the Schematic diagram of distance between care-receiver’s shoulder and wheelchair during process-1. The distance change was calculated according to the 3D motion analysis data as shown in Fig. 7. It was can consider that both expert and non-expert was understanding that need lean forward care-receiver’s upper body. Comparing with expert, non-expert had to take more often to lean forward care-receiver’s upper body.

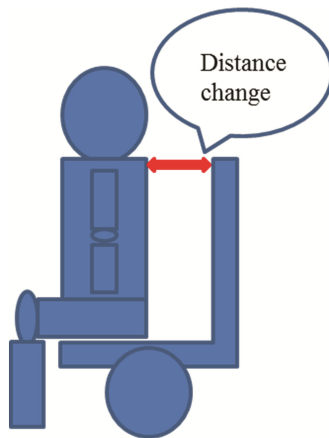


Fig. 6. Schematic diagram of distance between care-receiver’s shoulder and wheelchair

The position of care-receiver’s left and right shoulder during transfer by expert and non-expert was illustrated in Fig. 8 (Process-1). It is can found that there was a large height difference between left and right shoulder in Z direction when non-expert adjusting care-receiver’s position. Comparing with non-expert, it was shown slight

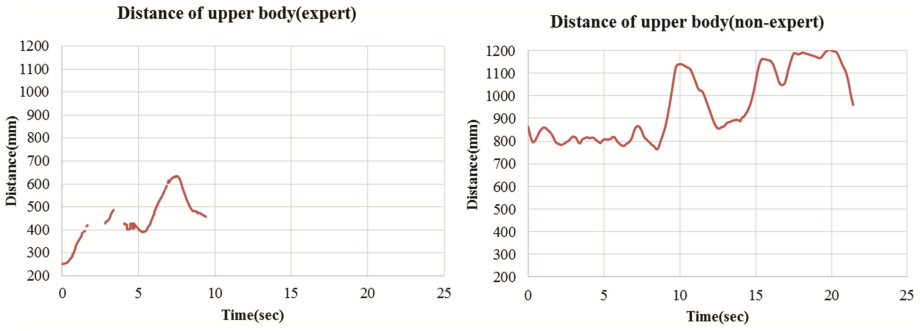


Fig. 7. The Distance change between care-receiver’s shoulder and wheelchair for expert and non-expert.

height difference in Z direction, because expert did not raise care-receiver’s bottom during adjusting process.

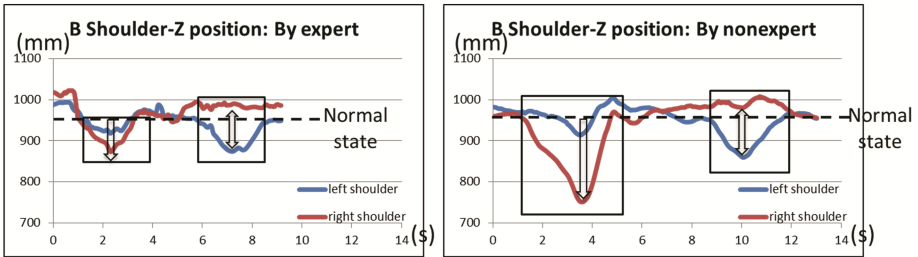


Fig. 8. The care-receiver’s shoulder position in Z direction during transfer by expert and non-expert.

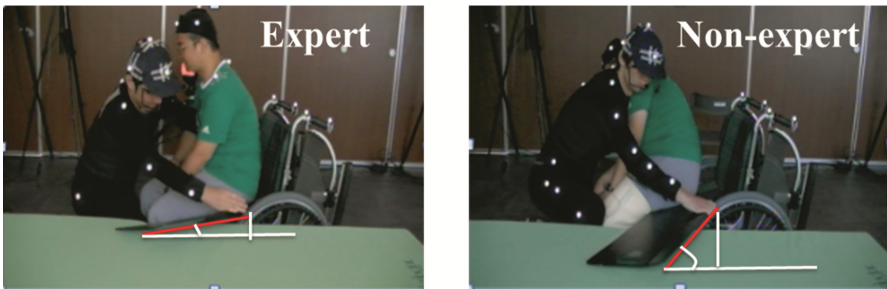


Fig. 9. The slide board insert method of expert and non-expert

As mentioned above, expert and non-expert used the slide board with different methods as shown in Fig. 9 Expert insert slide board had a small angel with bed. Non-expert shown a large angle between slide board and bed when insert board. During this process, expert held care-receiver’s body slightly and obtain a space under whole bottom so that easy insert slide board.

The expert and non-expert’s left waist joint and left knee angle during the first three processes were shown in Fig. 10, which the first, second, third process were marked by blue, red and green color. As shown in left waist joint angle of process-2, expert can keep the posture because standing work. The non-expert didn’t have large angle change, because he working bent waist down. In case of left knee angle, expert shown large change of left knee angle use left angle many time during process-2, which was considered that stable move care-receiver.

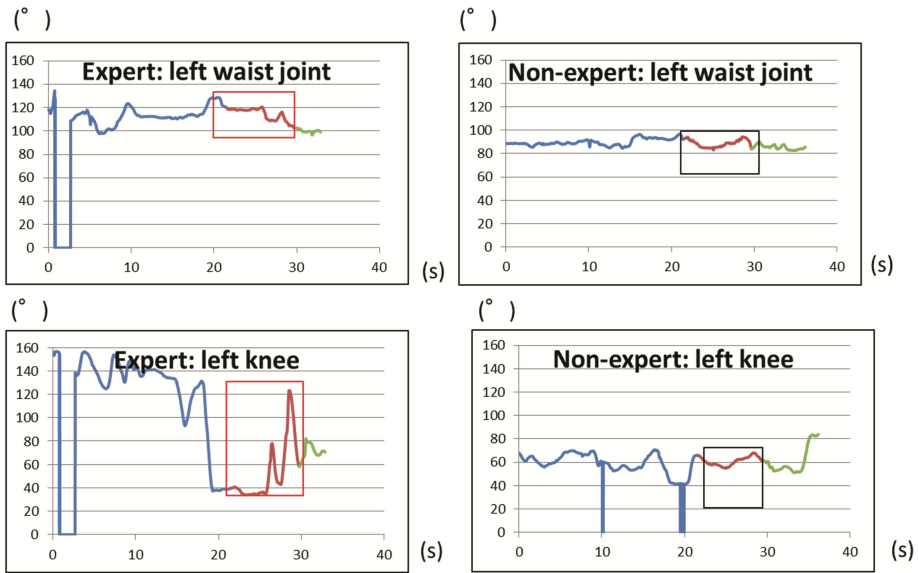


Fig. 10. The left waist joint and left knee angle of expert and non-expert

The position, velocity and acceleration data of care-receiver’s head on Z direction was calculated and summarized on Fig. 11, which expert’s data was shown on upper side, and non-expert’s data was shown on down side. And the process-1, process-2 and process-3 were marked by blue, red and green color.

The head of care-receiver was shown strenuous vibration up and down when non-expert inserted the slide board into space between bottom and bed during process-2. Non-expert’s motion was given care-receiver feeling unstable. It was considered that the care-receiver’s head and shoulders were presented small moving range with slight from side to side during expert’s process-2.

The Transfer process from wheelchair to bed by expert and non-expert was illustrated in Fig. 12 (Process-3). During the transfer process, expert’s hand was hold on care-receiver alar and support his shoulder blade in order to provide a comfortable feeling. Expert can master the transfer technique with current using method of slide board. The non-expert didn’t catch the slide board using skill so that have to lift care-receiver and put down again.

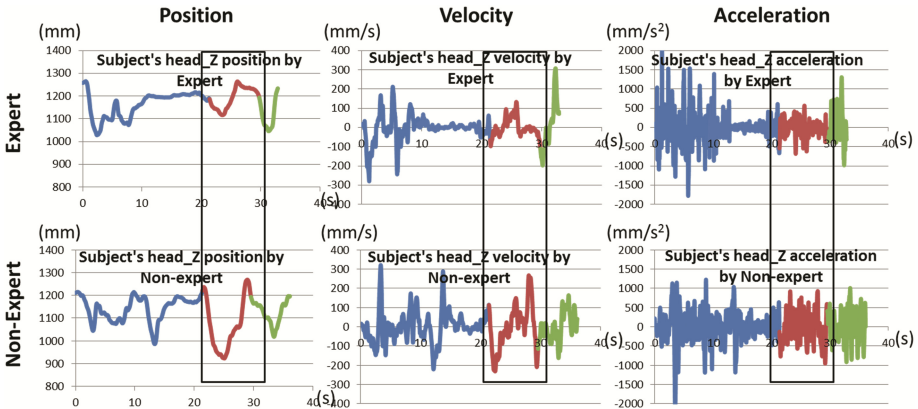


Fig. 11. The position, velocity and acceleration of care-receiver’s head on Z direction (Colour fig online)

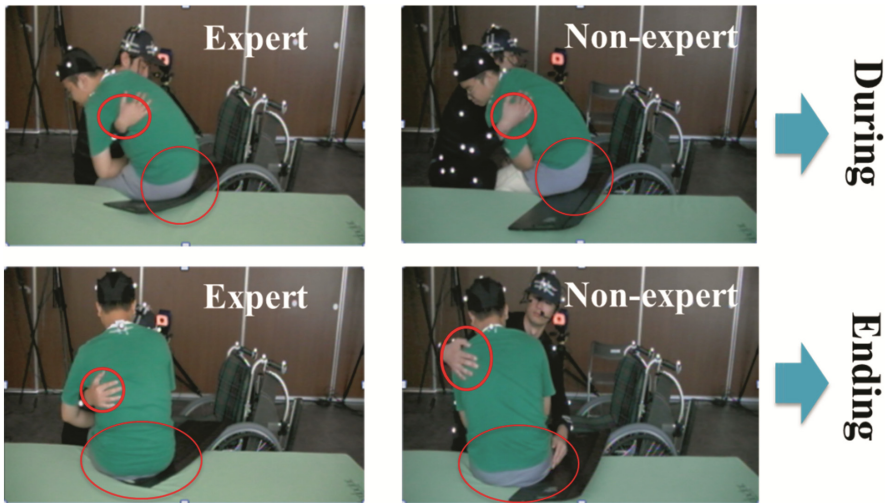


Fig. 12. Transfer process from wheelchair to bed by expert and non-expert

The care-receiver’s neck and shoulder position change was shown in Fig. 13 during process-3. As shown in Fig. 13, the working time of process-3 by expert was shorter than non-expert. Care-receiver’s neck was displayed a smooth move up and down. The care-receiver’s neck was presented a dramatic move up and down during transferring by non-expert, which was same with above mentioned. The shoulder position change had a similar moving characteristic with neck position.

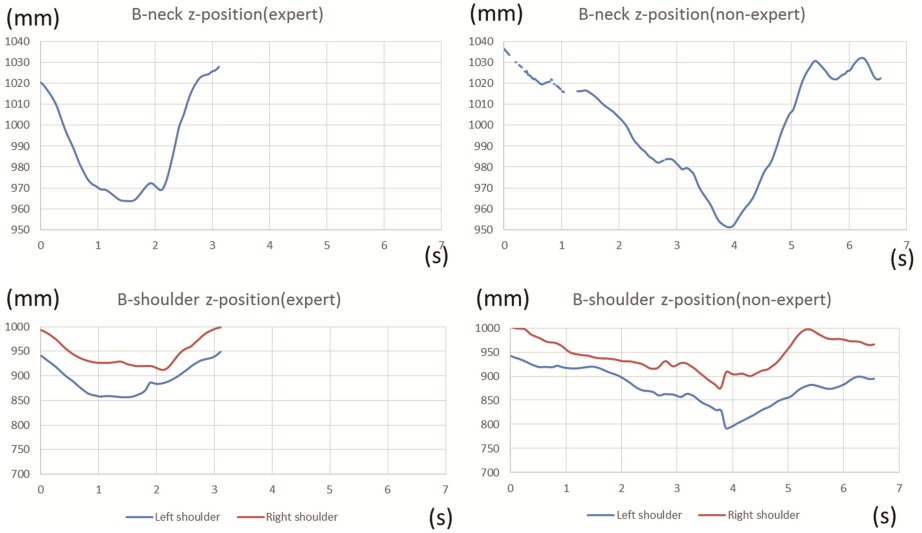


Fig. 13. The care-receiver’s neck and shoulder position in Z direction during process-3

4 Conclusions

In a word, the conclusions were summarized as following:

In the case of expert, when adjusting the posture of care-receiver, the expert had the upper-half body of the care-receiver leaned forward slightly and moved him to the right and left in order to move the weight to one leg. While being careful not to lean the care-receiver diagonally forward too much, the expert repeated this movement. Then, the expert secures a wheelchair with his foot to keep the balance of the care-receiver.

The expert had the care-receiver leaned diagonally forward and moved the weight of the care-receiver to one leg. Then, he inserted the slide board between the base of thighs and the ischial bone on the bed side. After securing one end of the slide board on the bed firmly, he adjusted the angle between the slide board and the bed narrower to make the transfer easily.

Then the expert put his arm under the arm of the care-receiver on the bed side to support around his shoulder blade. The expert put his opposite arm around the care-receiver’s waist, and had him leaned toward the bed. He transferred him to the bed by pushing the care-receiver’s waist to make him slide on the board without lifting. When transferring a care-receiver using a slide board, the angle of the caregiver’s back arch changed slightly, and it can be considered to reduce physical burdens of the caregiver. Moreover, a slide board enables the transfer stable, and it helps to minimize uneasiness of care-receivers during transferring.

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