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A Proposal for Manual Handling in the Health Care Sector Using Kinaesthetics Techniques

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ABSTRACT

The proper mobilisation of patients affects not only the health of the caregiver but also the patient himself, since it is a critical condition for preventing treatment failure and avoiding strain injuries from pressure and wrong placement. Professional experience, using standardised handling techniques, can be modified using kinaesthetics techniques. The kinaesthetic is a self-perception discipline, based on proprioception, that is, the capacity to feel and perceive the posture of the body in space, its movements and muscle contractions, also without visual input. Moreover kinaesthetics could contribute significantly to reduce biomechanical load and to improve healthcare outcomes. By using an optoelectronic system (SMART-DX 6000 System, BTS, Milan, Italy) and 6 spherical reflective markers placed at selected landmarks (c7, bilaterally scapular acromion, sacrum, bilaterally anterior superior iliac spine (Davis, 1991)), the trunk kinematics of a worker was recorded during several patient handling tasks (lateral decubitus, sitted placement, lateral shift, side displacement, downward displacement) with (KIN) and without (NOKIN) kinaesthetic. Then, the ranges of motion (RoM) of the trunk in the three planes of space were calculated. Muscular activity coactivity was also recorded through surface electromyography from the following muscle bilaterally: Erector Spinae, Rectus Abdominis, Rectus Femoris, Biceps Femoris, Anterior Tibialis and Gastrocnemius Medialis. The most relevant kinematic results are in the reduced trunk flexion in all the analyzed tasks when using kinaesthetics. Otherwise kinematics results showed increased values of RoM for trunk lateral bending in all tasks but sitted placement. About sEMG results showed a decreased co-activation of the trunk muscles in lateral decubitus, sitted placement and side placement. Co-activazion of the legs showed decreased values for lateral shift, side placement and downward displacement. These are preliminar results that should be confirmed with a larger sample of experienced workers.

Keywords: Patient handling, Ergonomic, Biomechanics, Biomechanical overload

INTRODUCTION

Patient handling in the health care sector is a work-related task that, even using advanced equipment, still is overloading and cannot be eliminated. The daily practice could include patient handling with both 'major' (e.g., active and passive mechanical lifts) (Draicchio, 2016) and 'minor' (e.g., slip sheets) aids. Although with these lifting aids, the worker may operate under disadvantageous work conditions. These conditions imply an increased risk of biomechanical overload injuries of the workers' spine involving limitations in patient handling. Patients handling affects not only the health of the caregivers but also the patient himself since it is a critical condition for preventing treatment failure and avoiding strain injuries from pressure and wrong deployment as recommended by Quick Reference Guide EPUAP (https://www.epuap.org/pu-guidelines/).

It could also perform standardized patient handling tasks using kinaesthetics techniques (Freiberg, 2016).

Kinaesthetics is a self-perception science, i.e., being able to feel and recognize the body's position in space, its movements, and the contraction of its muscles, regardless of visual input (Hatch, 2003). The kinaesthetics applied in patient care during positioning and handling imply respect for the patient's functional anatomy and the health and safety of the caregiver performing the handling. Kinaesthetics presupposes that patients are moved with spiral rather than parallel movements as these require less effort (Hatch, 2003). Kinaesthetics theory says that the human body is mass (bones) and space (muscles) (Hatch, 2003), and, when a caregiver touches and moves these masses, it should be easier to manipulate a patient (Hatch, 2003). Kinaesthetics bases his theoretical framework on behavioral cybernetics principles (Hatch, 2003).

A recent review (Freiberg, 2016) shows that it remains unclear whether kinaesthetics can influence the reduction of musculoskeletal disorders in patient handling. In this review, the author noted that the papers are from Europe, mainly from German-speaking countries. Indeed, the European Kinaesthetics Association includes national organizations from Germany, Switzerland, Austria, and the North of Italy [EKA, 2008] and is widely used in Germany [Heyn, 2012]. This scoping review concludes that the benefits of kinaesthetics are only assumed. Kinaesthetics seem to decrease the perceived exertion and musculoskeletal pain of persons who handle patients. However, most included studies are of poor methodological quality, overestimating these positive effects. Thus, it is difficult to make concrete recommendations about the effectiveness of kinaesthetics for patient handling. The review concludes that further high-quality intervention studies will be needed to clarify this question.

Another paper claims it is hard to standardize a care method as individual as kinaesthetics [Haasenritter, 2009]. It is not just a simple transfer and lifting technique (Enke, 2009) but a complex intervention [Behncke, 2014].

Our study aims to objectively assess the efficacy of kinaesthetics techniques to reduce the biomechanical load of caregivers through wearable devices (Ranavolo, 2018).

MATERIALS AND METHODS

By using an optoelectronic system (SMART-DX 6000 System, BTS, Milan, taly) and six spherical reflective markers placed at selected landmarks (c7, sacrum, bilaterally scapular acromion, and anterior superior iliac spine (Davis, 1991)), we calculated the trunk kinematic, expressed as Range of Motion (RoM), in the three planes of space. RoM is a parameter that provides the displacement in degrees (°) of the whole analyzed joint movement in each of the three planes of the body.

We also recorded surface electromyography (sEMG) from the following muscles bilaterally: Erector Spinae (ES), Rectus Abdominis (ABD), Rectus Femoris (RFEM), Biceps Femoris (BFEM), Anterior Tibialis (TIB) and Gastrocnemius Medialis (GAS). We placed sEMG probes according to the Atlas of Muscles Innervation Zones (Barbero et al., 2012).

Kinematic and sEMG data were integrated and synchronized.

To estimate the co-activation of the torso and legs muscles during patient handling, we applied the time-varying multi-muscle co-activation function (TMCf) (Ranavolo et al., 2015). The co-activation index (Ranavolo, 2015) is a parameter that provides the percentage of simultaneous activation during each task of the antagonist muscles of the trunk and legs. Muscles' increased co-activation can be disadvantageous for the joints (Granata, 2001). We calculated the maximum (TMCfMax) value of co-activation synthetic indices within the cycles.

We recorded one experienced worker during various simulated patient handling tasks (patient weight 70 Kg) with (KIN) and without (NOKIN) kinaesthetics. The sub-tasks were: 1) lateral decubitus, 2) seated placement, 3) lateral shift, 4) side displacement, and 5) downward displacement. For each task, the worker performed three acquisitions.

Figures 1 and 2 show frames of the lateral decubitus task (NOKIN Fig. 1; KIN Fig. 2). Figures 3 and 4 show some frames of the seated placement task (NOKIN Fig. 3; KIN Fig. 4).

Figure 1 and 2: The images show some frames of the task of lateral decubitus without kinaesthetics (Fig. 1 left) and with kinaesthetics (Fig. 2 right).

Figure 3 and 4: The images show some frames of the task of seated placement without kinaesthetics (Fig. 3 left) and with kinaesthetics (Fig. 4 right).

RESULTS

Kinematic

Table 1 shows mean (± SD) RoM values of the trunk flexion, torsion, and lateral bending KIN and NOKIN for the five investigated tasks. No RoM data for the lower limbs are given in the table, as no notable changes in lower limb kinematics occurred with both techniques.

As regards the trunk, the most remarkable result is in the constant reduction of trunk flexion RoM in all the tasks analyzed (Tab. 1) whit KIN. Data also indicates a contextual increase in trunk lateral bending with KIN for all sub-tasks but seated placement. Concerning the trunk torsion, there is a relevant reduction in the seated placement task whit KIN (92.5° Vs. 180.1°).

Table 1. The table shows trunk kinematics results in the three planes of the spaces with kinaesthetics (KIN) and without kinaesthetics (NOKIN) for the five investigated tasks.

Task	RoM trunk (°)	KIN	NOKIN
Lateral decubitus	Flexion	38.9±6.2	46.5±1.0
	Torsion	79.9±2.3	71.3±7.2
	Lateral bending	52.2±5.9	45.5±9.3
Seated placement	Flexion	46.8±3.9	58.6±1.0
	Torsion	92.5±0.8	180.1±0.9
	Lateral bending	45.3±2.7	56.4±0.5
Lateral shift	Flexion	38.2±2.7	49.8±7.8
	Torsion	96.7±8.7	86.8±19.2
	Lateral bending	50.0±2.6	31.7±2.0
Side displacement	Flexion	32.6±1.6	40.2±2.8
	Torsion	81.8±7.3	79.5±5.7
	Lateral bending	42.4±5.2	26.1±0.2
Downward displacement	Flexion	28.1±0.3	52.3±10.8
	Torsion	86.8±8.3	100.1±3.7
	Lateral bending	37.7±2.1	29.9±5.6

Table 2. The table shows trunk kinematics results in the three planes of the space with kinaesthetics (KIN) and without kinaesthetics (NOKIN) for the five investigated tasks.

Task	Max co-activation	KIN	NOKIN
Lateral decubitus	Trunk	12.45±0.96	14.68±3.93
	Legs	10.76±0.54	4.69±0.44
Seated placement	Trunk	10.31±0.53	13.83±0.20
	Legs	6.48±0.48	6.23±1.08
Lateral shift	Trunk	14.16±4.05	11.96±0.01
	Legs	4.55±0.39	4.89±0.01
Side displacement	Trunk	10.64±0.01	12.83±0.27
	Legs	5.20±0.01	6.41±0.04
Downward displacement	Trunk	18.04±3.95	15.45±0.01
	Legs	3.85±0.33	4.86±0.01

Surface Electromyography

The reported parameter is maximum muscle co-activation of the torso and legs, resulting from the following muscles: ES and ABD for the torso, and RFEM, BFEM, TIB, and GAS for the legs (Tab. 2). The most relevant result is in the side displacement task that showed a reduction of the max co-activation for both trunk and legs. In lateral decubitus and seated placement, data shows a reduced co-activation for the trunk muscles and a simultaneous increase of the legs' muscles' co-activation; by contrast, in lateral shift and downward displacement tasks, there is an increase in trunk muscle co-activation but a reduction in leg muscle co-activation.

CONCLUSION

Although caregivers use similar techniques when handling patients, each worker uses different motor strategies due to their experience, their anthropometry, the patients' anthropometry, and the available equipment. Comparative data presentation is, therefore, not easy, because the investigated sub-tasks can hardly be standardized even in a lab simulation scenario.

Concerning the kinematics, whereas we found lower trunk flexion RoM in all the tasks analyzed with kinaesthetics, we also noted an increase of the RoM in lateral bending.

In terms of surface electromyography, the task showing a co-activation reduction for both muscle districts using kinaesthetics is the side placement task. Beneficial findings include the lateral decubitus and seated placement sub-tasks, which showed a co-activation decrease in the trunk muscles.

Results suggest that kinaesthetics, in the investigated tasks, could lead to positive outcomes to reduce the risk of biomechanical overload in healthcare workers.

However, we could have underestimated the positive results for two reasons:

1) the weight handled (70 kg) is lower, on average, as compared to hospitalized patients (80–95 kg);

2) the subject acquired, being well experienced regarding kinaesthetics, may have unconsciously used some principles of kinaesthetics also while using conventional handling techniques.

In conclusion, this preliminary data, even optimistic, remains contrasting and needs corroboration on a larger sample.

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