Musculoskeletal aspects in patient handling

Methods and intervention

PhD thesis

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Summary in Danish

Muskuloskeletale aspekter i relation til patient håndtering – metoder og intervention

Blandt plejepersonalet er muskuloskeletale problemer velkendt og arbejdet indenfor sundhedsvæsenet er generelt vurderet som værende fysisk krævende. Specielt er patient håndteringsopgaver anset for at være hoved bidragsyder til muskuloskeletale problemer. Afhandlingens formål er derfor at evaluere om introduktion af forflytningsteknik alene eller i kombination med konditionstræning kan reducere muskuloskeletale klager hos plejepersonalet ansat på et hospital. Forskellige forflytningsteknikmetoder er hyppigt blevet anvendt for at reducere arbejdsbelastningerne og dermed de muskuloskeletale klager blandt plejepersonalet. Dog har der ikke været fokus på at evaluere, hvorvidt disse forflytningsteknikmetoder bliver anvendt i hverdagen. Det første delstudies formål var derfor at udvikle en gyldig og pålidelig observationsmetode. Pålideligheden var observationsmetoden var tilfredsstillende og metoden var i stand til at finde forskel på en selvvalgt teknik og en indlært forflytningsteknik. At gennemføre et interventionsstudie på en arbejdsplads medfører en risiko for tilstedeværelse af forstyrrende "confounders". Ændringer i patient klientellet, behandlingsmetoder eller mangel på personale kan være en confounder. Dagbøgerne (studie II) var udviklet for at imødekomme behovet for at have et pålideligt instrument til at registrere daglige belastninger på arbejde. Generelt var pålideligheden af dagbøgerne tilfredsstillende og de kunne fra dag til dag registrere ændringer med hensyn muskuloskeletale klager. Derudover kunne dagbøgerne identificere forskellige fysiske og psykosociale faktorer der var relateret til muskuloskeletale klager. Til trods for at de to instrumenter overordnet viste sig at være pålidelige, er det nødvendigt med yderligere undersøgelser for de punkter/opgaver der blev vurderet ikke at have en tilfredsstillende pålidelighed. Interventionsstudiet (studie III) bestod af 11 afdelinger klynge randomiseret til enten intervention (6 afdelinger) eller kontrol (5 afdelinger). I alt blev 337 mulige plejepersonaler inviteret til at deltage og 175 accepterede at deltage. Der var ligelig repræsentation af alle 11 afdelinger blandt deltagerne. De 100 plejepersonaler i interventionsgruppen blev individuelt randomiseret til enten forflytningsteknik eller forflytningsteknik og konditionstræning. Resultaterne viste, ved 12 måneders opfølgning,

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ingen forskel mellem intervention og kontrol gruppen med hensyn til lænderygbesvær, omfanget af smerter, fysisk funktionsformåen og sygefravær. Blev studiets intenderet design fuldt, viste resultaterne at interventionsgruppen opnåede en forbedring med hensyn deres viden om forflytningsteknik i forhold til kontrolgruppen. Mellem de to interventionsgrupper forbedrede forflytningsteknik/konditionstrænings gruppen sig markant med hensyn den fysiske funktionsformåen. Til trods for at studiet havde et stort bortfald og selvom det væsentlige objektive mål mangler (observationsdata er endnu ikke gjort op) bør det nøje overvejes, hvorvidt det hensigtsmæssigt at indføre forflytningsteknik. Yderligere eller andre metoder/koncepter syntes nødvendige, hvis formålet er at nedbringe lænderygbesvær og sygefravær.

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Abstract

Musculoskeletal disorder is well known among nurses and the work within the health care sector is considered to be physical demanding. Thus patient handling tasks are considered a main contributor to musculoskeletal disorder. The aim of this thesis was to evaluate whether introducing transfer technique alone or in combination with physical fitness training would reduce musculoskeletal complaints among hospital nurses. Transfer technique or similar methods are the most common methods taught for reducing the load on nurses and thereby the musculoskeletal complaints. Little attention has been to evaluate the use of the technique in the daily working situations. Study one was therefore to develop a valid and reliable observation instrument for this purpose. The reliability was found to be satisfactory for most of the items and the observation instrument was able to detect a difference between a self chosen and recommended technique. Performing an intervention study at worksite implies the risk of interfering confounders. Changes of the type of patients, treatment regimes or lack of staff could be such confounders. The logbook in study two was developed to meet the need for a reliable instrument to register the workload on a daily basis. Overall the reproducibility was found to be satisfactory and the logbook able to detect changes in musculoskeletal complaints on a daily basis. In addition different types of physical and psychosocial factors were found to be associated with musculoskeletal complaints. Although the two developed instruments showed an overall satisfactory reliability, further evaluation of the items not satisfactory is required.

The intervention study (study three) comprised of 11 wards cluster randomized to either intervention (6 wards) or control (5 wards). In all 337 eligible nurses was invited to participate whereas 175 equally representing the 11 wards accepted to participate. The 100 nurses in the intervention cluster were individually randomized to either transfer technique alone or transfer technique with additional physical fitness training. The results showed no differences between the intervention and control according to self reported low back pain, pain level, disability or sick leave at the 12 months follow up. Adhering to the protocol the intervention group improved their knowledge of transfer technique when compared to the control group. Between the two intervention groups the transfer technique/physical training

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group improved their disability significantly. However, the study had a high withdrawal rate and although the substantial objective measures of implementation is missing (the observation data is not evaluated) thorough consideration has to be taken before introducing transfer technique to hospital nurses. For the purpose of reducing low back pain and sick leave additional or other concepts seem to be needed.

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Abbreviations

ANOVA	Analysis of Variance
CI	Confidence Interval
DINO	Direct nurse observation instrument
EMG	Electromyography
ICC	Intraclass Correlation Coefficient
ITT	Intention-to-treat
KP	Knee Pain
LBP	Low Back Pain
MSC	Musculoskeletal complaints
MSD	Musculoskeletal Disorders
MVC	Maximal voluntary contraction
NIOSH	National Institute for Occupational Safety and Health
NSP	Neck/Shoulder Pain
OR	Odds Ratio
OWAS	Ovako Working posture Analysis System
REBA	Rapid Entire Body Assessment
RPE	perceived exertion
TT	Transfer Technique
TTPT	Transfer Technique/Physical fitness Training

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Definitions

Musculoskeletal disorder (MSD)

The term MSD is used and defined as musculoskeletal pain, -complaints, -discomfort, -aches and -problems.

Patient handling task

Patient handling tasks are defined as all activities where the nurse assists the patient. It comprises of both patient transfer tasks and patient care tasks. A transfer task is when the nurse assists the patient in moving from one position to another e.g. moving towards the head of the bed. A care task is when the nurse assists the patient in doing daily activities (e.g. getting dressed) or necessary professional tasks for the well being of the patient (e.g. wound-care).

Nurses

The term nurse is used and includes reg. nurse, auxiliary nurse, nursing assistants, nursing aides etc.

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1. Introduction

Musculoskeletal disorders (MSD) constitute a major problem in many industrial countries and the costs for the society are enormous in use of the health care system and loss of production [123],[136], besides the individual costs in loss of "good years of life" [27]. The dominator within MSD is low back pain (LBP) with a life-time prevalence of 60-85% [63],[42] but also neck/shoulder pain (NSP) is estimated to have a high lifetime prevalence of 67-71% [61],[108].

In order to identify causations to LBP, research has for the last decades been intensive both within clinical medicine and epidemiology. In the clinical field several classification models (symptom-based) have been developed for the 80% of LBP diagnosed as "non-specific LBP" [21],[18] and within epidemiology several risk factors related to the working life/environment have been identified for the 30-40% of MSD occurrences estimated to be related to work [136]. However, the predominating risk-factor found to be associated with LBP, is previous episodes of LBP [79]. This indicates that LBP is highly periodic and not single cause related.

1.2 Conceptual models/framework

Several conceptual models of MSD in relation to work have been presented [8], [137],[136],[131],[1]. Basically the models focus on describing the causal relationship between risk factors at workplace (external exposure) and musculoskeletal health.

The models try to address and simplify the complex multifactorial nature of the development and recurrence of MSD in relation to work. Thus [136] elaborate on the model of external exposure – dose – capacity – response [8] by emphasizing the importance of the capacity as a modifying factor and add the company and community elements to the external level (fig 1).

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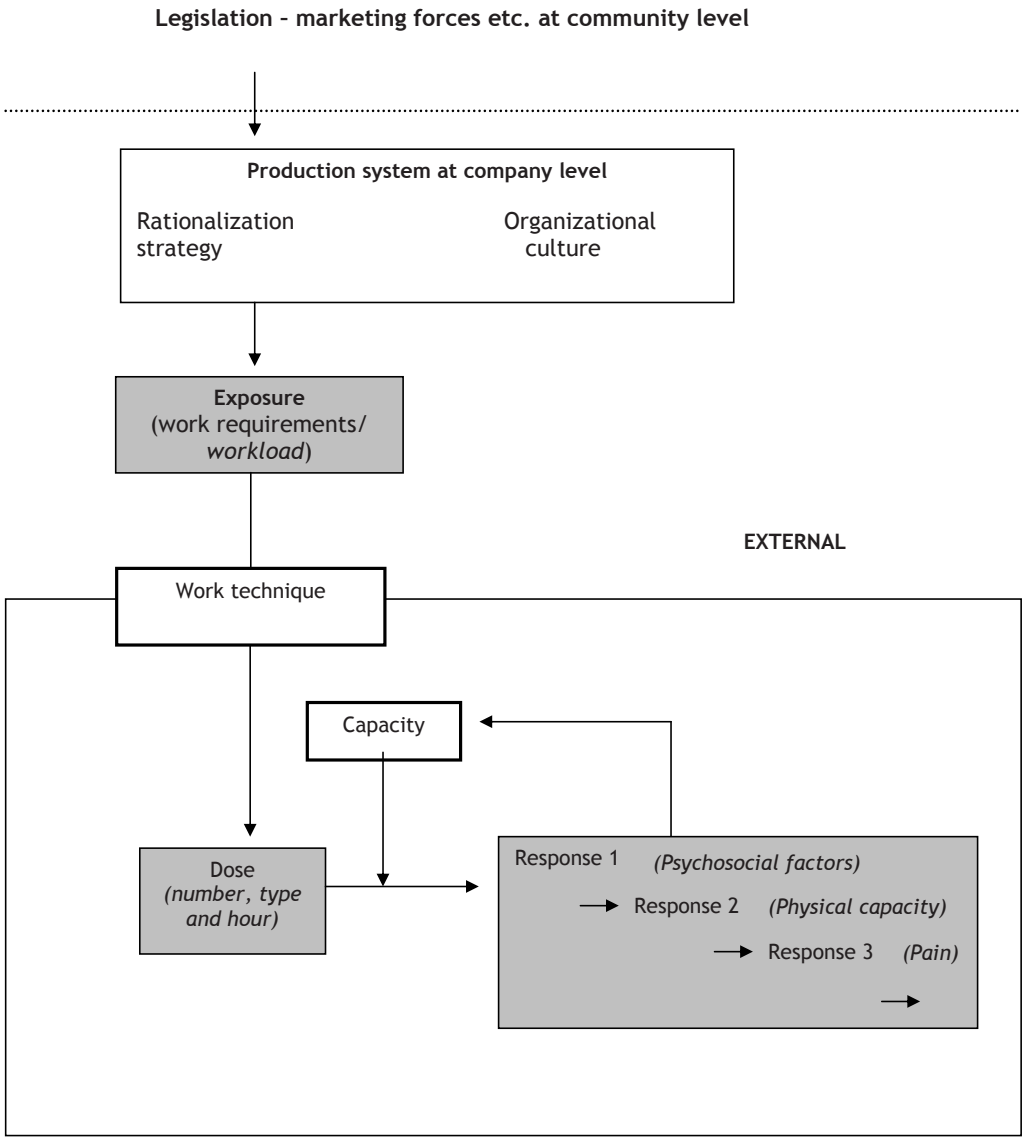

Figure 1.The dose-response model proposed by Armstrong, 1993 and Westgaard 1997. To the model, as suggested by Johnson (thesis 2005), work technique is added because work technique according to Kjellberg, 1998 can act as a modifier to the mechanical exposure. On the basis of this concept the elements of this thesis is applied. The elements in the boxes with thick lines are the focus of the intervention study. The elements in the shaded boxes are elements monitored by use of logbooks, physical test or questionnaire.

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Although the models focus on the physical mechanical load, they are valuable tools for structuring the highly complex interaction of variables (physical as well as psychological/psychosocial) into assessing possible risk factors. Several reviews have presented substantial epidemiological evidence for the purported causal relationship between physical work place risk factors and development of MSD [74],[22],[77],[85]. However, to achieve more knowledge about the complexity and relationship between environmental factors, health and quality of life Hagberg (2001)[1] stressed the need for broadening the view of exposure assessment, for interdisciplinary research and intervention.

1.3 MSD in nurses

Nurses is a profession in high risk of musculoskeletal disorder [5],[7],[19],[94],[118],[120],[119],[133],[142],[143],[128],[7],[88],[22],[36] and the most common musculoskeletal disorder, low back pain (LBP) has a higher 12-month prevalence when compared with the general working population [58],[64],[96],[107],[63]. Thus the 12-month prevalence of reported LBP among nurses ranges from 44% to 80% [5],[120],[7],[115],[119],[11],[133],[128],[15],[19]. However, a high prevalence of neck, shoulder and knee pain among nurses has also been reported. The 12-month prevalence of neck/shoulder pain (NSP) ranges from 29% to 60 % [7],[5],[120],[119],[128],[15] and knee pain (KP) ranges from 16 % to 20% [120],[119],[22],[79]. MSD has also been reported among nursing students thus a 12-month prevalence of 59% for LBP, 58% for NSP and 25% for KP have been shown [119],[41].

1.4 Risk factors

Although the development of MSD is complex and multifactorial and the cause relationship is not fully understood, several studies have associated risk factors in nursing with musculoskeletal complaints. They can be divided into physical, psychosocial/psychological work factors and individual factors [17].

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1.4.1 Physical factors

The physical factors in relation to MSD cover areas such as static components (work postures), dynamic components (work technique) and work tasks. As for the general population awkward postures, pushing/pulling, twisting/bending/stooping and frequently lifting heavy burdens have been found to be related to LBP and NSP among nurses [5,32,31,69,142,15,116,62,86]. In addition the nurse/patient ratio and increased working hours have been found to be associated with MSD [80,36]. Recently a study has indicated possible forthcoming MSD's by finding an association between the use of lifts/hoists when handling patients and knee and wrist pain [97].

Patient handling tasks

Patient handling tasks comprising both patient transfer and care tasks have been found to be the far most common physical factor associated with MSD in nurses [33,35,77,111,116,143,99,97]. Especially transfer tasks in bed [37] and assisting patients in and out of bed have the highest injury rate [104]. Biomechanical measurements evaluating different work technique when performing transfer tasks [92,24,113,140] have thus found that for example "assisting from lying in bed to sitting at the edge of the of the bed" and "reposition in chair" by far exceeded the limit 3400N (limit purposed by the National Institute for Occupational Safety and Health, NIOSH). However, when using a recommended transfer technique Schibye (2003) [113] showed that the load on the lumbar spine decreased to limits beyond the acceptable limit of 3400N. In addition particular attention should be made to the compression/deviation of patient handling tasks during the working shift [10] and to the accumulative load of the nurses doing repetitive transfer and care tasks during a shift or a working week. This is of special interest as the working shifts tend to be longer and working on scheduled days off is not uncommon due to an increasing lack of staff [127,84,32].

1.4.2 Psychosocial factors

In spite the absence of consensus definitions within the area some psychosocial factors are frequently reported related to MSD among nurses. Perceived stress [48,116] low job satisfaction [133,143,118] and lack/low social support [36,37,143,142,19]. Two qualitative studies [51,46] have looked

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into how nurses would define stress and job satisfaction. Stress was identified related to failure to meet the patient's needs; self-expectations, physical workload and inexperienced colleagues. Job satisfaction was identified related to lack of social support from supervisors, reward and control over work. In addition Gelsema (2006)[46] found that work and time pressure and physical demands were strongly related to emotional exertion. High physical demands have also been found related to MSD by Alexopoulos (2003)[5] and Trinkoff (2003)[126].

1.4.3 Individual factors

Previous episodes of LBP and NSP seem to be a strong predictor for new episodes of MSD among nurses [41],[78],[116],[118]. In addition low physical fitness [102],[11], more years working in nursing [19], gender [36],[104], obesity [35], [86] and perceived poor or moderate general health [5],[86] have been associated with musculoskeletal problems, disease related absence and injuries among nurses.

In several studies the above mentioned risk factors appear in combination [19],[86],[36],[37],[118],[126].

Despite intensive research both within clinical medicine and epidemiology the complexity of the causations to MSD are still unanswered. Several risk factors have been identified among nurses but still we know very little about their interaction and the dose response in a daily working situation.

1.5 Methods for assessing risk factors,

There is a general conception that the methods for assessing exposure to risk factors can be classified into three categories of data collection; self-reports, observations and direct measurements [70],[17],[131],[23]. Self-reports can be used to collect data on physical, psychosocial and individual data by use of questionnaires, logbooks or interviews. Generally the data are written and the methods are easy to use, applicable to a wide range of working situations and to a large sample size (with the exception of interview). The disadvantages are that they are less precise as they rely on the people's perception and memory of the question asked (systematic errors and recall-bias) - thus less costly but more unreliable. Observations can be either direct or video-based and have proven useful for assessing workload. The direct

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observation has to be simple for the measurement of either static components (postures) or of less complex repetitive work, whereas the video-based observations enable the measurement of the dynamic components (work technique). The video-based observations range from simple field observation with one camera to very advantage with e.g. two or three cameras for biomechanical modelling in laboratory settings. The observation methods are more reliable but also more costly as the equipment is more expensive, the time to analyze extensive and require often highly trained observers/operators. Direct measurements can provide very accurate data, yet although direct measurement systems such as Lumbar Motion Monitor, EMG, goniometry and pedometers are available for field studies they are highly costly in terms of equipment and skilled technical staff and not often used for large sample sizes. Furthermore, devices attached to the subject may result in discomfort or change of work pattern/behaviour. Direct measurements are used for physical data, such as movements and physical capacity but could also be used as a proxy variable for psychosocial factor (heart rate and stress).

1.5.1 Instruments for assessing workload among nurses

As handling patients is a major risk factor, valid and reliable methods for assessing the work technique used when assisting in transfer and care situations are required. Patient transfer technique or compliance with recommended methods has been evaluated by use of all three abovementioned categories; questionnaires [78] or subjective ratings [105],[113], observational methods [31],[39],[53],[71],[66],[121] or checklists based on specific transfer techniques [3],[28],[40] and direct biomechanical measurements [24],[93],[113]. In addition several studies have used both self-reports and biomechanical methods [45],[44],[113]. As the focus of a recommended transfer technique is to teach and train the nurses to use it during daily routines, an observation method easy applicable in clinical settings seemed the most useful. Several observation instruments are available and have been used for the evaluation of nurses' work technique. OWAS (Ovako Working posture Analysis System) is an observation instrument for working postures in the industry but have also been used among nurses [29],[31],[53], REBA (Rapid Entire Body Assessment) is a risk assessment tool in the health care sector [56], PATE is an video-based observation

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instrument for the assessment of health care workers' work technique and safety [71] and recently a direct nurse observation instrument (DINO) was introduced [66]. This is a further development of PATE and has in addition; focus on the safety and feelings of the patient. The drawbacks for some of the above mentioned observation instruments are though that the validity and reliability have not been tested (PATE and DINO are an exception [71],[66]. Additionally most of them focused on the static component (postures) considering that a transfer situation highly consists of dynamic movements over a very short period of time. In conclusion, when this study started there was a need for an observation instrument, which in detail could describe the elements of a modern transfer technique. It had to be fairly easy to fill in and applicable in clinical setting.

Besides to observe the transfer technique used an instrument for the registration of level, frequency and duration of the exposure (transfer and care tasks) was needed [139],[131]. As a transfer task only takes seconds to perform a registration of the frequency of the different tasks and the hour (instead of the duration) were considered as valuable information. The instrument should be easy to fill in, inexpensive and applicable in clinical settings, therefore a direct measurement and thus registering the level of exposure was not an option. A logbook would fulfil the purpose of a simple inexpensive instrument useful for information about the exposure over a period of time. Logbooks are self-reports and considered to be imprecise and unreliable [82],[23], [131]. However, some studies have found self-reports useful for crude registrations, thus Wiktorin (1993),[138] suggests that manual loads exceeding 5 kg. in high risk occupations can be acceptable and Viikari-Juntura (1996) [132]indicates that logbooks may be more reliable when compared to questionnaires. This is probably related to that logbook registrations are on a daily basis which reduces possibility of recall bias. Within the area of the nurse profession we found three studies using logbooks – Rogers (2004) [112](registration of skipping breaks/no meal association with making errors), Gonge (2001) [48](registration of psychosocial factors and onset of LBP) and Knibbe (1999) [72] (registration of lifting activities within patient care). On the basis of Gonge (2001) [48] and Knibbe (1999)[72] a logbook for this study was developed.

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1.5.2 Instruments for assessing physical fitness training among nurses

Low physical fitness has been found to be associated with MSD among nurses [102],[11] and for the assessment of physical fitness and capacity a high number of valid and reliable of instruments (especially direct measurements) are available. Thus physical fitness/capacity has among nurses been evaluated by questionnaires [76] and by direct measurements [94],[68],[47],[114]. Studies assessing direct measurements have focused on the aerobic capacity [68],[47],[114] and the strength and endurance of the trunk muscles [68],[94],[60]. For assessing muscle strength isokinetic is commonly used and to evaluate muscle endurance the isometric test of Biering-Sørensen is used [12]. Regarding the aerobic capacity the most used method is the Aastrand bicycle test and for range of motion inclinometer or well established clinical tests for this purposed have been used.

Instruments for detailed description of the technique used when transferring patients and to register the workload and MSD on a daily basis do not exist. However regarding physical fitness reliable direct measurements are available.

1.6 Training programs in recommended patient transfer methods

Several methods and concepts of performing patient transfers are available worldwide but within the Scandinavian countries three methods have commonly been used; the Dürewall concept, the Stockholm training concept [78] and "The knowledge of transfer and movement assistance" developed by Per Halvor Lunde (1997)[87]. In spite of the different names and they origin are based on different theories/pedagogical models all the methods have many parts in common. Basically they are all funded on the general principle of work technique for the purpose of reducing the physical load (mechanical load). The principles include the use of short levers, keeping the back in vertical position, keeping the load on the joints as low as possible, adjust working height, and reduce the vertical lifting [67],[76],[135]. When changing from work technique to patient transfer technique the patient perspective is added – the cooperation and functional capability of the patient are becoming important elements and so

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to assist the patient in accordance to the natural human movement patterns is essential [87],[135],[98].

The implementation of and practical training in patient transfer technique varies in many ways. The training of nurses can vary from training trainers who train the rest of the staff [34],[98] or on the job training [38] to a class based education in the theoretical principles and practical skills [67],[38]. In addition the hours of training shows a great variety ranging from 1 hour [89] to 8 days [4] and the pedagogical methods range from a problem-solving approach [67],[34] approach to a more teacher dictated method of what is correct/incorrect technique [38],[106].

1.6.1 Evaluation of the transfer technique training programmes

Overall the transfer technique intervention studies at worksite are focused on either the individual level alone or at the individual level in combination with the organizational level. During our intervention-period studies have shown that intervention focus on transfer technique alone has little or no effect in reducing musculoskeletal symptoms or injuries [52],[67],[106],[65] although increased knowledge of transfer technique or performance of technique were registered [67],[106]. However when transfer technique in addition or alone have focused on the skills of handling the mechanical devices the results show a decrease in musculoskeletal symptoms or injuries [83],[89],[105],[34],[20] although Smedley did not find this [116]. Some of these studies have in addition with the transfer devices skills involved the organizational level in making a no lifting policy, which seems to add to the beneficial effect of reducing musculoskeletal symptoms and injuries among the nursing staff [34],[20],[43],[100]. This is in line with two recent reviews of Hignett (2003)[55] and Bos (2006)[16] who found multidisciplinary interventions more likely to be successful and effective.

1.7 Physical training among nurses

In general several reviews have found beneficial effect of worksite physical training/exercises at worksite to musculoskeletal disorders [109],[90],[129]. Among nursing staff exercise training has been evaluated alone [50],[94], [59],[103],[114] or as part of a multidisciplinary intervention [78],[4]. The exercise training has especially focused on the trunk muscles or/and aerobic capacity [103]. The

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muscle training has in some studies focused/consisted of endurance exercises [50],[59] in others strength training [114],[4],[103] or these two in combinations [94],[50]. The training methods varied highly according to frequency, duration and intensity from a home training logbook registration of more than 20 min of training to intense supervised progressive one hour training sessions for at duration of a maximum of 15 weeks with training at least twice a week. Four out of the seven studies showed a decrease in musculoskeletal pain and disability – for the three showing no effect, one was affected by a large number of drop-outs [114] and two had hardly any description of the exercise program [78] or had a voluntary exercise program [59].

Transfer technique inventions have shown little effect in reducing MSD if not focussed on patient handling devices skills whereas for physical training interventions at worksite the results are inconclusive. The combination of these two initiatives has not been evaluated.

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2. Aims

2.1 Overall aim

The overall aim of the thesis was to introduce transfer technique and physical fitness training to hospital nurses for the benefit of reducing LBP and sick leave. The intervention study was designed as a cluster randomized controlled trial.

Specific aims

- To develop an observation instrument for the description and assessment of transfer technique and to evaluate the validity and reliability (study I).
- To develop a logbook for the description of workload during the intervention period, to evaluate the inter-observer reliability and to evaluate the associations between reported workload and musculoskeletal complaints (MSC) (study II).
- To evaluate the effect of transfer technique alone or in combination with physical fitness training in reducing LBP among nurses when compared to nurses following their usual routines (study III).

2.2 Hypotheses

We hypothesized that MSD (especially LBP) was common among hospital nurses. That introducing transfer technique (including transferring aids) in combination with physical fitness training would improve the patient handling skills and physical capacity in return to a reduction of LBP and/or its consequences. We expected it to be more effective than introducing transfer technique alone and definitely more effective when compared by a group following their usual routines. We expected that a detailed observation instrument would be able and needed to evaluate the transfer technique used before and after introducing an intervention program. We expected that a logbook would be able and needed for detailed registration of the workload (patient handling) to evaluate possible changes in workload at the wards during and after the intervention period.

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3. Subjects and methods

Overall design

A randomized controlled intervention study (study III) on transfer technique was initiated on the background of transfer technique being widely introduced to health care workers hardly without any form of evaluation - at the most questions about the usability of the technique have been asked. Adding the physical fitness training was initiated on the background of a study [134], master thesis) indicating that supervised physical fitness training was superior to supervised endurance training and voluntary home-training in reducing low back disability among health care workers experienced LBP. Study I (observation instrument for transfer technique) and study II (logbook for physical workload) were method studies necessary for carrying out study III.

3.1 Subjects

An overview of the subjects is given in table 1

Table 1 Overview of basic characteristics of the subjects in studies I-III

	Development of instruments			Intervention	
	Study I (reliability/validity)	Study II (reproducibility)	Study II	Study III	*Study III (logbook)*
Numbers	21	22	148	175	*184**
Gender, numbers female/male	_	20	136/12	160	*169/15*
Age, years mean/SD	40 (range 21-59)	29.8/5.6 (range 26-44)	33.3/8.4 (range 21-60)	33.8/8.7 (range 24-60)	*33.3/8.0 (range 21-60)*
Height, cm mean/SD	_	168.8/7.3 (range 160-181)	169.5/7.6 (range 155-187)	169.3/8.7 (range 153-190)	*168.7/7.5 (range 155-187)*
Weight, kg mean/SD	_	66.0/5.9 (range 56-78)	67.6/10.7 (range 48-105)	66.2/11.4 (range 45-120)	*67.1/10.2 (range 48-105)*
Patient handling years, mean/SD	14 (range 1-37)	5.9/5.3 (range 1-20)	8.7/9.0 (range 0-45)	8.9/9.0 (range 0-45)	*8.6/9.0 (range 0-45)*

*= in all 36 nurses filled in the logbooks more than once

3.1.1 Subjects for the development of instruments

The 21 subjects performing the transfer tasks in study I were all health care workers with a mean age of 40 (range 21-59 years). They had a mean of 14 years of job experience (range 1-37 years) and performed on a daily basis a mean of 9 patient handling tasks (range 2-30 per

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day). In study II the 22 nurses (17 registered nurses and 5 nursing aides) participating for the inter-rater-reliability of the task registration sheet (physical workload) had a mean age of 30 (range 26-44 years) and a mean of 6 years of job experience within patient handling (range 1-20 years).

3.1.2 Subjects for the intervention

In Study III 175 nurses (139 registered nurses, 36 nursing aides) participated in the intervention project. They had a mean age of 34 years (range 24-60 years) and had been working with patient handling for a mean of 9 years (range 0-45 years). For filling in logbooks during the intervention study 148 nurses participated. They had a mean age of 35 (range 21-60 years) and had a mean of 9 years of job experience with patient handling (range 0-45 years).

The participating nurses were from a sample of 337 eligible representing 11 hospital wards (surgery 4, internal medicine 3, geriatric 2, acute medical care 1 and geronto-psychiatric 1) cluster randomized to either intervention (6 wards) or control (5 wards). The nurses at the six intervention wards (surgery=2, internal medicine=2, geriatric=1 and geronto psychiatry=1) were individually randomized to either transfer technique alone or in combination with physical fitness training. The control wards were instructed to follow their usual routine. In all 156 nurses equally distributed between the two cluster groups were excluded according to our criteria (not permanent staff, on leave/retirement or in job-change and pregnancy) and 158 declined to participate (refused to fill in questionnaire, attend the physical tests or to be individual randomized).

3. 2 Ethical approval

All subjects were given written and oral information about the studies and gave their consent to participate. In study III the hospital directors, the head nurses at the wards and the local ward nurses were given written and oral information and gave their consent. For the videotaped transfer situations only persons who were given their permission were videotaped. The study was notified to The Danish Data Protection Agency (2001-41-0966) and the ethical

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committee for the region (KF 01-022/99). The latter assessed that no further approval was needed for the study.

3.3 Data collection methods

An overview of the data collection methods is given in table 2

Table 2 Overview of data collection methods in studies I-III

	Study I	Study II	Study III
Video recordings	X		(X)
Logbook		X	X
Questionnaire			X
Subjective ratings (psychosocial factors)		X	X
Subjective ratings (MSC)		X	X
Subjective ratings (RPE)			X
Physical capacity (Vo2max)			X
Isometric muscle strength (MVC)			X

3.3.1 Observation instrument (study I)

Video-recordings

For the development of the observation instrument and testing the reliability and validity, 149 prerecorded videotaped transfer situations were used. The video-recorded transfer situations represented the five most commonly used transfer situations 1) moving towards the head of the bed, 2) from lying in bed to sitting at the edge of the bed and 3) vice versa, 4) from sitting at the edge of the bed to sitting in a chair and 5) vice versa. For the development and reliability test the 70 transfer situations were recorded with one camera mainly capturing a sagittal view of the whole body of the nurse and took place at a hospital or at a home care center with a simulated patient. The case story of the simulated patient was an elderly person, with reduced muscle strength in the left upper and lower limps, subject to abdominal surgery causing weakness of the abdominal muscles. For the validity the 79 transfer situations were recorded in a laboratory setting (5 cameras) and with a real patient (stroke with a hemiplegia). The camera with the sagittal view was chosen for the validity testing.
The prerecorded videos in studio/laboratory settings were not an optimal choice for the reliability and validity testing. Consequently a high number of underlying questions were not

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evaluated and for some of the video taped transfer situations questions were categorized "not seen" mainly due to clothes or objects hidden the body angles or movements. For the validity the main obstacle was no sound on the videos for which reason an important question, the verbal stimulation of the patient to cooperate in forthcoming transfer were not part of the validity testing. Furthermore the use of a simulating patient acting in the reliability videos resulted in the category "yes" was never used for the question "transfer done without a the sudden loss of balance".

Development of the instrument

An expert group, consisting of four physiotherapists, specialist in teaching patient transfer technique and two researchers studied the scientific literature and agreed on the important elements of transfer technique. Observation items were selected according to these options: scientifically documented to be associated with low back pain (lack of space, use of transfer aids, adjusting bed-height), fulfill the principle of transfer technique (center of gravity, center of rotation, reduction or increase of friction, use of the patient's functional capabilities) and describe the entire transfer situation for the above mentioned five most common transfer tasks. Furthermore, five observation instruments developed by Alavosius & Sulzer-Azaroff (1985)[3], Engels et al. (1997)[28], Feldstein et al. (1990)[40], Kjellberg et al. (2000)[71], and St. Vincent et al. (1989)[121] for the purpose of patient transfer evaluation were used as a reference.

Before reaching the final version the four experts tested the reproducibility of each item on videotaped transfer situations and adjustments were made when consensus agreement could not be reached (less than three out of the four experts agreed upon the same answer for a given transfer situation). Common adjustments were: the division of items by adding underlying questions, the rephrasing of items, the creation of more stringent definitions or adding further answer categories, e.g. not seen/heard and not applicable. The definitions were written into a guide developed for description of each item in the instrument. The final observation instrument describing the entire transfer situation consisted of a preparation phase (9 items with 27 questions) and a performance phase (14 items with 20 questions),

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table 3. The performance phase was further divided into two operations, defined as a subdivision of the transfer in order to accomplish a task.

Quantification

For an overall assessment of the technique in the transfer situation, the score from all 23 items (in total 47 questions) were added into a total score. Each question was included with a score from 1-10 according to its importance for a recommended transfer technique, table 3. The score was given to the successful completion of the technique (yes) and 0 was given to the unsuccessful completion (no). No scores were given for answers in the categories "not applicable" "not seen/not heard" or questions not supposed to be answered. They were omitted from the final calculation. The maximum total weighted score, when only using one operation to fulfill the transfer situation, e.g. moving towards the head of the bed, was 54 points for the preparation phase and 71 for the performance phase. When using two operations, as often will be recommended for the tasks 2-5, the maximum total weighted score for the preparation phase was 60 points as item eight and nine was possible to evaluate in both operations and 142 points for the performance phase as all the items could be evaluated in both operations.

Reliability and validity

For testing of the inter- and intra-observer reliability the four trained observers (the expert physiotherapists) separately evaluated 20 videotaped transfer situations (randomly ordered representing each of the 5 tasks four times). They were allowed to replay the situations in both normal speed and slow motion. Two weeks later this procedure was repeated. Thus the intra-observer reliability was evaluated once and the inter-observer reliability twice.
For the validity study, 9 items (1 item from the preparation phase and 8 items from the performance phase) from the observation instrument were tested on 79 video-recorded transfer situations comprising a set of patient handling tasks performed with a self-chosen (35 situations) and a recommended transfer technique (44 situations), table 3. The video recordings were used to assess the mechanical load on the low back by calculation of the

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maximal lumbar compression forces, using the two different transfer techniques [113]. They represented task 1 (two versions of recommended transfer technique), task 2 and task 3 plus the first operation of task 4 (from sitting at the edge of the bed to standing). With the calculated compression forces as the golden standard, the criterion validity of each situation was evaluated by comparing the total score of the weighted items with the corresponding calculated compression values.

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Table 3 The observation instrument, answering categories and weighted score

Question	Categories	Score
Preparation phase		
1. inform the patient	Yes/no	6
2a. should the handler create space	Yes/no	
2b.if yes, was it possible to create space	Yes/no	
2c.if yes, did the handler create space	Yes/no	5
3a. were other objects besides bed involved in the transfer	Yes/no	
3b. if yes, were the objects adjusted to the transfer	Yes/no	3
3c.was the brakes locked	Yes/no	1
3d.should arm/footrests be removed	Yes/no	
3e.if yes, was it possible to remove arm/footrests	Yes/no	
3f. if yes, were they removed	Yes/no	1
4a. was friction reducing transfer aids used	Yes/no	
4b. if yes, was or had it been placed according to the transfer	Yes/no	4
4c. if yes, was it placed by use of…….the patient	Supporting/lifting	4
5a. was friction increasing transfer aids used	Yes/no	
5b. if yes, was or had it been placed according to the transfer	Yes/no	4
5c. if yes, was it placed by use of…….the patient	Supporting/lifting	4
6a. was other kinds of transfer aids used	Yes/no	
6b. if yes, was or had it been placed according to the transfer	Yes/no	4
6c. if yes, was it placed by use of…….the patient	Supporting/lifting	4
6d. did it need further adjustments	Yes/no	
6e. if yes, was it adjusted	Yes/no	2
7a. was the transfer divided into operations	Yes/no	
7b. was this the optimal choice	Yes/no	6
●8a. was the bed-height adjusted	Yes/no	
●8b. was it optimal adjusted	Yes/no	3
9a. was the bed further adjusted	Yes/no	
9b. was it optimal adjusted	Yes/no	3
Performance phase		
10a. did the handler use a starting signal	Yes/no	
10b. if yes, was the verbal stimulation of the patient due to natural movement pattern	Yes/no	4
10c. if yes, did the handler allow the patient time enough to cooperate	Yes/no	4
11a. was an assistant used	Yes/no	
11b. if yes, was it clear who had the command	Yes/no	2
11c. was it optimal to use an assistant	Yes/no	2
●12a. was the direction of effort	Push-pull/ both/ lifting	10/6
●12b. if lifting was the distance from the handler's back to the centre of gravity of the patient the shortest possible	Yes/no	2
●13. was the quality of movement	Smooth/jerky	5
●14. was the transfer without a sudden loss of balance	Yes/no	6
●15. was the transfer done without any back flexion/extension of the handler's back	Yes/no	5
●16a. the maximal degree of back flexion during the transfer (beginning/middle/end)	0°/>10° -45° />45°	5/0
●16b. was the back non curved back in flexed position	Yes/no	2
●17. was the back without lateral flexion or rotation	Yes/no	5
●18. was the feet in gait position and in the direction of movement	Yes/no	3
●19. was the leg movement done by weight transfer	Yes/no	3
20. did the handler avoid having the patient's hands/arms around her neck/shoulder	Yes/no	5
21. was the friction reduced as planned	Yes/no	3
22. was the friction increased as planned	Yes/no	3
23. was the patient's physical/functional ability used optimal	Yes/no	4

The weighted score were given to the positive answer (the answer first listed). When more than two answering categories (12a, 16a) the weighted score of both the first and the second in the row is shown.●= questions in the validity study that were compared with the compression forces. The bold questions were evaluated in the reliability study (the remaining was omitted because the response rate was less than 50%)

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3.3.2 The logbook (study II)

Development

For the development of the logbook the scientific literature was studied by a group of experts (two ergonomic physiotherapists, one medical doctor within industrial medicine and one researcher). In addition a researcher was consulted, who previous had used logbook for the registration of LBP and workload in the health care sector. Besides to register known musculoskeletal disorders the logbook items were selected according to the scientifically documented associated with MSD. Furthermore two logbook instruments developed by Knibbe and Friele (1999)[72] and Gonge (2001)[48] were used as a reference.

Before reaching the final version a group of nurses representing different hospital wards tested the logbook and adjustments were made especially on wordings and layout, but also care and transfer tasks were added. The final logbook consisted of questions about the perceived level of pain for the low back, neck/shoulder and knee region and questions about psychosocial factors such as, perceived level of stress, time pressure and conscience of the quality of today's work. Further the shift, the general workday (overtime) and work tasks (mostly administrative or patient-related work tasks) were registered. In addition the logbook consisted of a separate (to bring along) task registration-sheet for continuously during the working day to register all transfer and care tasks performed by types, number and hour.

Reproducibility of the task registration sheet

For testing the inter-rater-reliability five observers (four ergonomic physiotherapists and one medical doctor within industrial medicine) followed 22 nurses during one working day (each nurse was observed by one of the five observers). The observer and the nurse separately filled in the task-registration instrument by types, numbers and the hour and the inter-rater-reliability was evaluated by comparing the two separate registrations. The observers were trained and tested the instrument for approximately 3x2 hours by doing field registrations in pairs. The nurses were the day before the reproducibility test introduced to the task-registration sheet and followed 2-3 hours by one of the observers doing their daily work.

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During this training the nurses and observer were separately doing their registration and after each task were done comparison were made and difficulties clarified.

The design of the reproducibility was not optimal primarily to the uneven conditions for the two persons filling in the registration sheet. The nurse both performed the tasks and filled in the registration sheet whereas the observer only registered the tasks performed. Furthermore some of the care tasks were very intimate (assisting with washing and changing incontinence pads) for which reason the observer waited outside. This may have influence the reproducibility.

3.3.3 The intervention (study III)

A cluster randomized controlled design was chosen, as the concept of the patient transfer technique educational program was to pass on knowledge and practical skills among the nurses working at the same ward. The individual randomization of the intervention group into transfer technique educational program alone or in combination with additional physical fitness training was performed to ensure that the participants within the intervention wards were randomly selected. The cluster randomization was done by use of the envelop-method stratified for medical specialities (six intervention wards and 5 control wards). The individual randomization was done by use of a computer program "Minimize" [125] stratified for ward, age and profession.

Transfer technique education program

The education-concept [98] consists of experts educate key-persons from the field. The key persons pass on the knowledge and practical skills to their colleagues taken into consideration the context and culture of the wards. The key-persons received a four-day-program including two consecutive days of being introduce to the concept of transfer technique and to practice basic skills [87] and two follow-up days with intervals of 6 weeks for the key-persons to have mutual discussions and to address problems with e.g. specific transfer situations after having introduce and practice the transfer technique to their colleagues at the wards. The four-day

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educational program was held at the hospital during working hours and by a physiotherapist, highly experienced within teaching transfer technique.

During the six weeks period of introducing the transfer technique to the colleagues at the wards the teacher was available and could be used to assist the key-persons with the process. This offer was used only a few times and only in "on-job-training" situations.

Patient transfer technique

"The knowledge of transfer and movement assistance" developed by Per Halvor Lunde (1997)[87] was the transfer technique taught. Besides using the law of physics, the technique focus on the natural movement pattern and if necessary supported by use of transfer aids when assisting the patient to use their functional capability in moving from one place to another. The pedagogic principle for passing on knowledge is based on a problem-solving concept, so focus is to practice a lot of different transfer situations based on the theoretical knowledge.

Physical fitness training

The eight-week program consisted of aerobic fitness and strength training for one hour twice a week. The training took place at the hospital, partly within working-hours (approx. 50%) and was held four times in the afternoon and twice in the morning, for the participants to attend irrespectively of the work shift. The fitness training was formed as circuit training between different exercises (e.g. run on a treadmill, cycling, skipping). The strength training was group instruction with focus on the trunk and gluteal muscles. A training session consisted of 5 minutes warm up, 5 x 6 minutes of aerobic circuit training (circuit every 1 minute), 4x 5 minutes of strength training in between the aerobic session's and 5 minutes of cool down. Polar S810, Polar Electro, monitored heart rate and a level of 70-90% of the participant's $V0_2max$ was considered sufficient for increasing the aerobic fitness. To promote participation one missed training session was substituted by an extra week (2 sessions). If the 16 sessions of consecutive training was not completed within a four-month period the participant was considered as a dropout.

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Four of the training possibilities were held in the afternoon. This was not an optimal choice as the participating nurses often had difficulties leaving the wards in the afternoon due to lack of staff or unexpected situations. The scattered attendance entailed that 18% of the participants did not complete the training twice a week within the four month period.

Outcome measures

Perceived LBP, the pain level, disability and sick leave due to LBP were considered as primary outcome as well as knowledge of transfer technique. All self-reported by means of questionnaire (including changes of daily routines) at baseline (0 month) and at follow-up (12 months). The change of daily routines due to LBP and physical tests were considered as secondary outcome. The physical tests included; the aerobic capacity (VO_2max) estimated by use of a sub maximal bicycle test described by Aastrand and Rhyming (1954)[2] the perceived exertion (RPE) by use of Borg Scale [14] supplemented the bicycle test. The maximal isometric strength (MVC) of the back and abdominal muscles was measured by use of the method described by Asmussen (1959)[101]. The physical tests were performed at baseline, 6 month (end of the intervention program) and at 12 month.

Questionnaire

In addition the questionnaire concerned individual factors, experience in patient handling, physical activity habits (National Institute of Public Health, National Institute of Occupational Health), general health (SF-36 – Bjorner JB, 1998) [13]and psycho-social factors (COPSOQ – Kristensen TS, 2005)[73].

The questions concerning musculoskeletal pain and LBP were by use of a modified version of the Nordic Questionnaire [75]. For the disability of LBP a modified version of Manniche Rating Scale was used (four questions concerning disability in daily transfer situations were added)[91]. For the knowledge of transfer technique four questions were constructed and five possible answers to each question rated the degree of knowledge (appendix).

All the LBP questions, the individual factors and years of experience in patient handling were chosen on the basis of a consensus meeting between researchers within work environment

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and occupational health. The structure of the questionnaire was ours, which may have influenced their way of answering. Although the response rate was satisfactory (73%), some had difficulties with the method “if no, go to question..” they either skipped too much or answered all questions anyway.

Logbooks

On the basis of the logbook registrations (study II) from the participating wards changes in the work situation and workload were estimated. The logbooks were filled in at baseline; end of intervention and at follow-up.

Additionally before and after the intervention program we video-recorded transfer situations at the wards (data not reported in this thesis).

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3.4 Statistical analyses

An overview of statistical analyses used in the different studies is shown in table 4

Table 4 Overview of the variables and statistical analyses

Study	Dependent variables	Measurement scales	Statistical analyses	Parametric/non-parametric
Study I	Observation items	Nominal and ordinal	Overall agreement,	-
			Kappa coefficient	Non parametric
	Weighted score	Ordinal	Spearman's Rho,	Non parametric
			Wilcoxon signed rank test	Non parametric
Study II	Task items	Ordinal	Overall agreement	-
			Intraclass correlation	Parametric
	Tasks	Dichotomous	Logistic regression	-
	Subjective ratings			
Study III	Subjective ratings	Ordinal	Linear regression	-
		Dichotomous	Fishers exact test	Non parametric
	Objective ratings	Ratio	Linear regression	
	Withdrawal	Ratio	ANOVA	Parametric
		Dichotomous	Chi2	Non parametric
	Subjective ratings	Ordinal	Mann Whitney U test	Non parametric
	Tasks			

For the reliability of the observation instrument the overall (consensus) agreement was calculated and the Kappa coefficient performed for each item. An overall agreement of at least 0.80 and a Kappa value of at least 0.61 were considered to be satisfactory [6]. For the validity, by means of the weighted scores and the calculated compression values, the Wilcoxon signed rank test was used to evaluate the differences between the self-chosen and recommended technique and Spearman's Rho correlation was used to test the association between the total weighted score and the compression values. P-values <0.05 were considered as a significant level.

For the logbooks the reproducibility of the task registration sheet and the association between reported MSC and exposure variables (psychosocial factors and workload) were evaluated. For the reliability both the observed and the modified percentage agreement (accepting a difference of +/-1of the number of tasks registered between the observer and the nurse) were calculated and the intra class correlation (ICC) was performed. The ICC

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coefficient was computed by use the class of random raters and random targets=class 2. An ICC coefficient of at least 0.7 was considered to be satisfactory [26]. The day-to-day variation of reported MSC and the exposure variables by use of Friedman test and a p-value <= 0.05 was considered significant. Univariate and multiple logistic regressions analyses were performed to examine the association between the physical load, the psychosocial factors and each of the three types of MSC by estimating the odds ratio (OR) and 95% confidence interval (CI) for nurses who reported pain on all three days compared with those who did not reported pain on any of the three working days. The psychosocial factors (time pressure, stress and conscience of the quality of today's work) and the physical workload were dichotomized. The model was adjusted for gender, age and time-period of data collecting (pre-intervention, post-intervention, follow-up) and before pooling the data the influence of the time-period according to the exposure and outcome variables were analyzed by use of Kruskal Wallis test (significant-level at 5%).

For the intervention we examined the differences between the two cluster groups (intervention versus control) by performing linear regression for each outcome variable. The follow-up data was set as the dependent variable and the baseline data and the two clustered groups as the independent variables. This procedure was performed for both the primary outcome in the ITT-analysis and for the primary and secondary outcome in the per protocol analysis. At this cluster level the analyses were performed by use of the mean value of each participating cluster. The same procedure was used for the individual randomized data (transfer technique versus transfer technique/physical training). However the linear regression model was used only for the continuous data whereas Fishers exact test was used for the delta values of the categorical data corrected for ties. As the withdrawal rate was high, the ITT-analysis was performed only for those present at follow-up. To detect for statistical differences between the two clustered groups we performed analysis of the withdrawal by comparing the baseline characteristics of the participants in the clusters present at 12-month follow up. Mann Whitney U test was used for the continuous data and Chi^2 for the categorical data. In addition a one-way ANOVA at cluster level was performed for the continuous data to detect for differences between the participating wards (clusters).

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Level of significance was 5% and all the analyses were performed using SPSS (Statistical Package for the Social Services) version 12.0.

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4 Results

4.1 The observation instrument

The intra- and inter-observer reliability of the 29 questions developed for the description of transfer technique were mostly satisfactory, table 5. Thus 15 questions showed an overall agreement of at least 0.80 and a Kappa-value of 0.61 or higher in at least ten out of the twelve times tested. Ten questions were classified to "deserve further attention" as they were reliable 8-9 times of the 12 times and four questions were considered not reliable, as they were reliable for a maximum of 7 times evaluated. The reliable question consisted of 8 from the preparation phase and 7 from the performance phase. Of the ten questions "deserve further attention" eight were from the performance phase and for the unreliable questions one was from the preparation phase and three were from the performance phase. The questions not reliable were "further adjustments of bed", "direction of effort", "transfer done without any flexion/extension of the nurse's back". For the criterion validity ten questions from the performance phase and two questions from the preparation phase was used. The association between the weighted score and calculated compression forces was considered satisfactory (r=-0.589) and the weighted score was able to detect a significant difference between a self-chosen and a recommended transfer technique ($p<0.01$).

4.2 The logbook

The inter-observer reliability of the transfer and care tasks registered on the task registration sheet showed a satisfactory overall intra-class correlation coefficient of 0.933 (95% CI 0.845-0.972) for transfer tasks and 0.907 (95% CI 0.791-0.960) for care tasks. Three transfer tasks were below the satisfactory level of 0.7 ("from lying to sitting at the edge of the bed", "from sitting in a chair to the toilet-chair" and "from lying in the bed to sitting in a chair"). For the care tasks four tasks showed an ICC below the satisfactory level. This was "assisting with washing", assisting teeth-brushing", "medical wound-care" and "change of lined".

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Table 5 the reliability of the observation instrument

	Intra-observer reliability								Inter-observer reliability				Reliability of questions	
	Observer A		Observer B		Observer C		Observer D		1. time		2. time			
Question	Overall	Kappa	Overall	Kappa	Overall	Kappa	Overall	Kappa	Overall	Kappa	Overall	Kappa	Total	Class
Preparation phase														
1. inform the patient	X	#	X	X	X	X	X	X	X	-	X	X	10/12	A
2a. create space	X	#	X	#	X	#	X	#	X	#	X	#	#/12	
3a. other objects besides bed involved	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
4a. friction reducing transfer aids	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
5a. friction increasing transfer aids	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
6a. other kinds of transfer aids	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
7a. the transfer divided into operations	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
7b. was this the optimal choice	X	X	X	-	X	X	X	X	X	-	X	-	9/12	B
8a. the bed-height adjusted	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
8b. was it optimal adjusted	X	X	X	X	X	X	X	X	X	X	-	X	11/12	A
9a. the bed further adjusted	X	X	X	X	X	#	X	-	X	#	X	X	9/12	B
9b. was it optimal adjusted	X	x	-	X	X	X	X	#	-	-	-	-	6/12	C
Performance phase														
10a. did the nurse a starting signal	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
10b. according to natural movement pattern	X	X	X	X	X	X	X	X	X	X	X	#	11/12	A
11a. an assistant used	X	#	X	#	X	#	X	#	X	#	X	#	#/12	
12a. the direction of effort	X	X	-	-	X	X	-	-	-	X	X	X	7/12	C
12b. if lifting was the distance shortest possible	X	X	-	-	X	X	-	-	-	-	X	-	5/12	C
13. the quality of movement	X	#	X	X	X	X	X	-	X	-	X	-	8/12	B
14. a sudden loss of balance	X	#	X	#	X	#	X	#	X	#	X	#	#/12	
15. without any back flexion/extension	X	-	X	X	X	#	X	-	-	-	-	-	5/12	C
16a. max back flexion during the total transfer	X	X	-	-	X	#	X	X	X	X	X	-	8/12	B
16b. non curved back when in flexion	X	X	-	#	X	X	X	X	X	X	X	X	10/12	A
17. without any lateral flex/rotation of back	X	X	-	-	X	X	X	X	-	X	X	X	9/12	B
18. feet in gait position/ direction of movement	X	X	-	-	X	X	X	X	X	X	X	X	10/12	A
19. leg movement done by weight transfer	X	X	X	X	X	X	-	-	X	X	X	-	9/12	B
20. avoid having pt.'s arms around neck	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
21. friction reduced as planned	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
22. friction increased as planned	X	X	X	X	X	X	X	X	X	X	X	X	12/12	A
23. pt.'s functional ability used optimal	X	X	x	-	X	X	X	#	X	-	X	-	8/12	B

X=satisfactory agreement, -=agreement below the satisfactory level of Kappa < 0.61 and a percentage agreement < 80%, #=could not be calculated. A= question satisfactory, B=question needs further attention, C=question not reliable.

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Table 6 The agreement between observer and nursing personnel

	Range of tasks	Actual inter-rater reliability[a]		Modified inter-rater reliability[b]		ICC	95% CI
Transfer tasks							
From lying to sitting in bed	0-5	16/22	73 %	20/22	91 %	0.785	0.548-0.905
Moving towards the head of the bed	0-7	18/22	82 %	19/22	86 %	0.751	0.493-0.888
Turning in bed	0-10	16/22	73 %	20/22	91 %	0.889	0.755-0.952
From lying to sitting at the edge of the bed or vice versa	0-4	18/22	82 %	21/22	95 %	0.555	0.180-0.788
From lying in bed to sitting in a chair or vice versa	0-6	17/22	77 %	20/22	91 %	0.624	0.296-0.823
Reposition in chair	0-1	22/22	100 %	22/22	100 %	1.000	1.000
From sitting in a chair to the toilet or vice versa	0-1	19/22	86 %	22/22	100 %	*	
From sitting in a chair to the toilet-chair or vice versa	0-2	20/22	91 %	21/22	100 %	0.632	0.292-0.829
Overall agreement, transfer tasks		18/22	82 %	21/22	95 %	0.933	0.845-0.972
Care tasks							
Assisting with washing	0-5	15/22	68 %	21/22	95 %	0.561	0.205-0.789
Hair-wash	0-1	21/22	95 %	22/22	100 %	0.784	0.553-0.903
Assisting teeth-brushing	0-1	19/22	86 %	22/22	100 %	0.648	0.319-0.837
Assisting dressing	0-6	15/22	68 %	22/22	100 %	0.884	0.746-0.950
Assisting eating	0-2	20/22	91 %	22/22	100 %	0.837	0.651-0.929
Changing incontinence pads	0-6	17/22	77 %	22/22	100 %	0.927	0.832-0.969
Bedpans	0-1	21/22	95 %	22/22	100 %	0.784	0.553-0.903
Uridom/kateder	0						
Shaving	0						
Medical wound care	0-2	19/22	86 %	22/22	100 %	0.683	0.367-0.855
Medicine	0-6	13/22	59 %	19/22	86 %	0.882	0.736-0.949
Change of lined	0-3	15/22	68 %	20/22	91 %	0.466	0.070-0.736
Overall agreement, care tasks		17.5/22	80 %	21/22	95 %	0.907	0.791-0.960

a) The actually number of times the raters agreed upon the same task and b) the modified inter-rater reliability is the number of times the two raters agreed +/- a difference of 1.

*Cannot be computed because at least one of the variables is constant

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The daily logbook registration during three consecutive working days followed by day off showed a significant increase ($p<0.001$) for both the numbers of nurses reporting MSC and in pain level and with a decrease at the day off. The additional analyses (multiple logistic regressions) to evaluate whether patient handling tasks and psychosocial factors were associated with reported MSC showed an association between performing more than five transfer tasks per day (OR) 7.9, 95% CI 2.3-26.9 and stress (OR) 4.0 95% CI 1.0-15.4 were related to LBP and performing more than five tasks per day (OR) 5.7, 95% CI 1.5-22.2 was associated to knee pain. For the specific tasks "changing incontinence pads" (OR) 3.5, 95% CI 1.2-10.1 was associated with LBP and "moving towards the head of the bed" (OR) 51.8, 95% CI 1.6-1661.2 and "turning in bed" (OR) 11.6, 95% CI 1.4-97.9 were associated with knee pain.

4.3 The intervention

The intention-to-treat analysis performed on the primary outcome (experience LBP and pain level/sick leave within the last 12 and 3 month, disability and knowledge of transfer technique) showed no significant differences between the intervention and control group at follow up. Between the two intervention groups a significant difference in the disability score was seen at follow-up ($p=0.001$), thus the disability score was improved for the transfer technique/physical training group whereas the transfer technique had an increase in the disability score at follow up. Otherwise no significant differences are seen between the two intervention groups. However, the TTPT-group showed improvements for all the primary outcomes at follow up whereas for the TT-group the opposite was found, table 7.

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Table 7 Intention-to-treat analyses for the primary outcome. Values are number and percentage unless otherwise stated

	Individual randomized intervention groups				P -value linear regression	Cluster randomized groups				p-value linear regression
	TTPT (n=35)		TT (n=33)			Intervention 6 wards (n=86)		Control 5 wards (n=51)		
Baseline										
Knowledge transfer technique, mean (SD)	11.47	(2.50)	10.94	(3.57)		11.45	(3.08)	10.80	(3.05)	
Experienced LBP	20	57%	22	67%		57	66%	38	75%	
LBP, 12 month	17	49%	17	52%		45	52%	26	51%	
Average pain level, 12 months, mean (SD)	1.68	(2.06)	2.00	(1.95)		1.84	(1.92)	1.53	(1.59)	
Sick leave, 12 month	6	17%	4	12%		12	14%	5	10%	
LBP, 3 month	14	40%	15	45%		36	42%	27	53%	
Average pain level, 3 months, mean (SD)	1.33	(1.81)	1.73	(2.00)		1.57	(2.01)	1.53	(1.91)	
Sick leave, 3 month	2	6%	2	6%		4	5%	2	4%	
Disability score, last 14 days, mean (SD)	5.32	(3.32)	4.68	(3.47)		5.15	(4.39)	5.41	(4.98)	
Follow up										
Knowledge transfer technique, mean (SD)	13.46	(2.82)	12.94	(3.14)	NS	13.06	(3.04)	11.91	(2.66)	NS
Experienced LBP	25	71%	25	76%	NS	66	77%	42	82%	NS
LBP, 12 month	14	40%	22	67%	NS	45	52%	29	57%	NS
Average pain level, 12 month, mean (SD)	1.58	(1.67)	2.06	(1.69)	NS	2.0	(1.91)	2.0	(1.9)	NS
Sickleave, 12 month	2	6%	5	15%	NS	12	14%	5	10%	NS
LBP, 3 month	12	34%	18	55%	NS	40	47%	25	49%	NS
Average pain level, 3 month, mean (SD)	1.17	(1.49)	1.77	(1.88)	NS	1.74	(2.01)	1.63	(2.1)	NS
Sick leave, 3 month	-		3	9%	NS	7	8%	1	2%	NS
Disability score, last 14 days, mean (SD)	3.29	(2.79)	5.92	(3.93)	**0.001**	5.24	(5.34)	5.85	(4.52)	NS

Linear regression was performed for the continuous data and Fisher exact test was performed for the delta values of the categorical data, corrected for ties. Significance level 5%

As a supplement we performed a per protocol analysis for both the primary and secondary outcome (VO_2max with perceived exertion, isometric abdominal and back strength and changes of daily routines due to LBP). At cluster level the intervention group had significantly improved their knowledge of transfer technique compared to the control group (p=0.045). Between the two intervention groups a significant difference was seen for the disability score at follow up in favor of the transfer technique/physical training group (p=0.004). Otherwise no significant differences were seen between either the two cluster groups or the two intervention groups. However, for the two intervention groups the same pattern as seen for the ITT-analysis was present, the improvements within the transfer technique/physical training at follow up were more substantial than within the transfer technique group.

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During the intervention changes in workload were registered by use of a 3-working day logbook filled in at baseline; end of intervention and at 12-month follow-up. No significantly changes in the workload (transfer and care tasks) were seen at the three time periods for the intervention and control group, respectively. Between the cluster groups significant differences were seen for transfer tasks at the end of the intervention (p=0.037) and at 12-month follow up (p=0.006), table 8.

Table 8 Differences between the intervention group and control group during the study based on the logbook registrations

	Baseline (0 month)		End of intervention (6 month)		Follow up (12 month)	
	Intervention n=35	Control n=27	Intervention n=35	Control n=25	Intervention n=35	Control n=27
Shifts, numbers						
Day	15 43%	16 59%	24 69%	11 44%	23 66%	20 74%
Evening	5 14%	4 15%	2 6%	5 20%	2 6%	4 15%
Night	8 23%	7 26%	3 9%	5 20%	-	1 4%
Mixed	7 20%	-	3 9%	2 8%	10 29%	2 7%
LBP, mean (SD)	1.5/1.8	1.0/1.8	1.0/1.4	1.9/2.0	1.5/1.8	1.5/1.6
Neck, mean (SD)	1.4/2.0	1.1/2.1	0.8/1.4	1.7/2.6	1.4/2.2	1.7/2.1
Knee, mean (SD)	0.5/1.1	0.5/1.6	0.4/1.0	1.0/1.7	0.4/0.8	0.4/0.8
Time pressure mean (SD)	3.3/2.1	3.4/1.9	3.4/1.9	3.8/2.4	3.2/2.0	3.6/2.0
Stress	2.6/2.0	2.4/2.1	2.7/2.0	3.1/2.2	2.5/2.0	2.6/1.9
Conscience	2.7/2.0	2.3/1.8	2.2/1.7	2.4/1.9	1.9/1.5	2.6/1.9
Transfer tasks	6.0/8.0	4.2/3.4	3.7/4.2 *	6.2/5.2	3.8/4.3 ***	5.9/3.9
Care tasks	5.0/6.0	5.0/5.2	6.8/8.0	7.3/9.1	5.5/5.4	6.9/6.8

All values are the average values of the three working days. No significantly differences were seen within the two cluster groups during our intervention study, but between the two groups significantly differences were seen for the transfer tasks. The intervention group had less transfers at the end of intervention (p=0.037) and follow up (p=0.006) when compared to the control group, Mann Whitney-U-test.

During our study a high number of participants from the intervention (55%)/control (56%) groups dropped out. Besides for not wanted to be tested the most common reasons were; temporary due to leave/pregnancy or totally due to job-change/retirement, fig. 2. Nurses who did not complete the 8-week physical training within the 4-month training period caused an additional reduction of the patients in the TTPT-group, fig. 2. The evaluation of the baseline characteristics at cluster level for those who were present at 12-month follow up showed that the number of nurses performing at least 5 transfer tasks per day were significantly higher for the control group (p=0.001) and the representation of nurses from the medical specialties differed significantly between the two cluster groups (p=0.001).

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In addition the analysis of differences between the participating clusters (11 wards) showed a significant difference according to age ($p<0.001$) and according to years of working with patient handling ($p<0.001$). At the geriatric wards and at one of the internal medicine wards they were older and had been working more years with patient handling.

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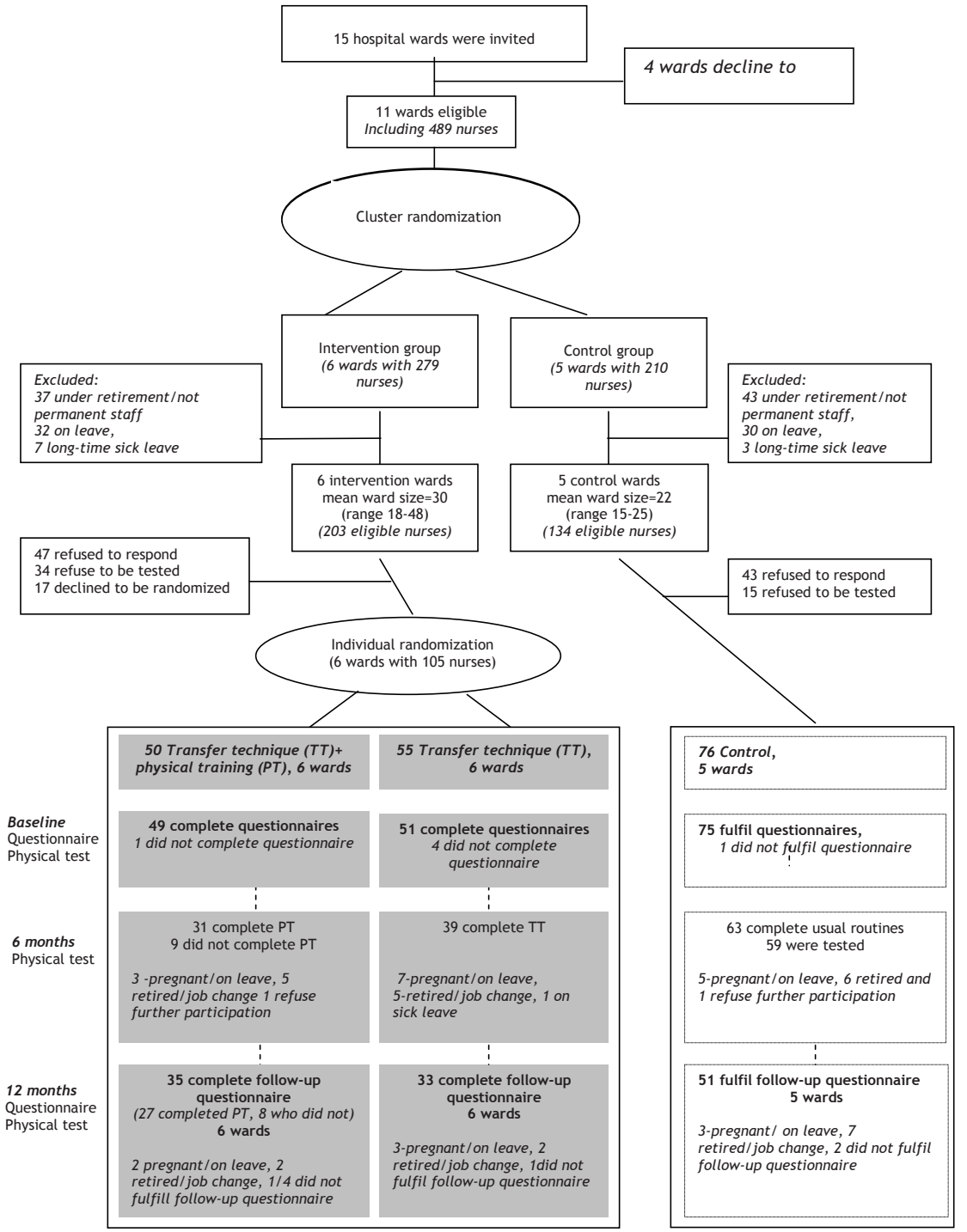

Figure 2 Flow chart of hospital-ward clusters and participants through the trial

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5. Discussion

Aiming at a reduction of LBP and consequences of LBP among hospital nurses this thesis has in a randomized controlled design investigated the effect of a transfer technique course alone or supplemented with physical training. Additionally the focus has been on the development of methods for describing and assessing the workload and transfer technique applicable in the field.

5.1 The observation instrument

The observation instrument in study I was developed for the purpose of evaluating changes in transfer technique after a training course. The instrument should meet the need for a practical tool for a detailed description of the transfer technique widely utilized in Denmark [87] and shown to reduce the biomechanical load on the low back in a laboratory setting [113]. This implied focus on the performance phase at expense of the static component, because of its less relevance and the low reliability shown by others [71],[121]. However, for the observation of dynamic work performance video recordings and subsequent analysis have been recommended [25],[81] because videos offers the opportunity of replay, slow motion and freeze function [70]. Consequently this instrument, in contrast to the direct observation instrument of Johnsson, 2004[66] is mainly for use in research where more detailed registrations are required. In addition the observation instrument separates the description from an evaluation on health and safety which differs from other methods [71],[110].

A quantification of the instrument as suggested by Kjellberg (2000) was considered useful for the evaluation of changes in the technique used before and after a training course (the intervention). Questions specific related to the principles of transfer technique and musculoskeletal load were given high weighted scores. Thus a higher maximum score for the performance phase was obtainable compared to the preparation phase. Separating the quantification from the registration makes the method flexible, gives the possibility to change and weigh the sum score differently according to the existing scientific evidence for health and safety risks.

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Reliability

The total reliability (intra and inter-observer) of the questions in the present observation instrument were mostly satisfactory. But four questions (14%) were classified as not reliable and nine questions (21%) were classified "deserve further attention". This indicates that even with the video-recordings and an informative guide, items may be difficult to address even for trained observers. Possible reasons for a low inter-observer reliability but high intra-observer reliability could be insufficient definitions in the guide or lack of consensus among the observers was not really achieved (qu. 9b, "further adjustment of the bed"). More than two response categories or movements of the back demand very distinct definitions and intensify the demands to the video recordings, which could be the explanation for question 12a+b ("direction of effort") although this was not found by others using the same question [71],[121]. The latter had only two response categories. Further the low agreement could be due to the reduced number of observations as the amount in "not to be answered"-category for qu. 12b was high. For question 15 ("without flexion/extension of nurses back") a reduced number of observations due to technical problems (could not be seen) could be part of an explanation for the low inter-observer reliability. This is similar to the results of Kjellberg (2000)[71] but not to St-Vincent (1989)[121].

Validity

The content validity was obtained through the process of reviewing the literature, development and adjustment of the instrument. The criterion validity was evaluated by comparing the weighted score with the calculated compression forces as the golden standard [49],[122]. The weighted score evaluated was found to be able to detect changes in transfer technique. This was so since a significant difference between the self-chosen and the recommended technique was found for the total weighted score as well as for the calculated compression forces. Further, a significant association between the weighted score and the compression forces was found for all the measurements showing that the score is related to the musculoskeletal load, especially in the situations where a recommended technique was used. It can, however, be questioned if compression forces can be used as a golden standard to the observation instrument, as the calculated compression forces represent only a part of

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the observation instrument while the scores were weighted according to the entire principles of transfer technique including the musculoskeletal load.

5.2 The logbooks

For the purpose of evaluating changes of physical workload at the wards during our intervention the logbook was developed. The logbook should meet the need for a practical tool to register transfer and care tasks in addition with registration of musculoskeletal pain and psychosocial factors. As the registration was on a daily basis, this implied focus on a simple but accurate registration. To minimize recall bias and ensure registration in connection with the performed tasks the registration sheet needed to be separated from the logbook and designed to fit into the uniform pocket. Irrespectively of this separation could increase the possibility of incomplete logbooks. In addition to the written guide made, the pocket-size registration sheet listing both transfer and care tasks by numbers, hour and type needed thorough information and guiding to be filled in correctly.

Reliability and validity

The total inter-rater reliability of both transfer and care tasks were above the satisfactory level of ICC > 0.70 [26]. However, three transfer and four care tasks were considered not reliable. In addition two care tasks were not registered by the observers. In general this may be due the small sample (only 22 participated for the reliability), but for the two transfer tasks one explanation could be that the tasks are closely related which may have induced misclassification. For the care tasks an explanation might be that the four not reliable tasks could be of ethical reasons. The content validity of the registration sheet and (the logbook) was secured by the development using a experienced extern consultant and having nurses from the field to test the instrument.

The logbook registration was able to detect differences in the reported MSC on a daily basis. Thus MSC increased during the three working days and decreased on the day off regardless that the first day could be any day in the row of working days indicating that at least a part of the reported MSD is related to work and is a reversible process. However a daily

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registration of MSC might heighten the awareness of the nurses, as suggested by smedley (2003) [116] or it could be merely a within-worker-variance as found by van der Beek (1994)[130]. In general the prevalence of the three day was higher than the 7-day prevalence reported by Lusted [88](using the Nordic Questionnaire) indicating either that a daily registration gives more accurate information or induces more attention and thereby an over-reporting. Further using different scales for the registration might also be an explanation for the high prevalence.
The logbook was able to detect physical and psychosocial factors related to different MSC at a general level which is in accordance with other studies [30],[37],[97],[118],[143]. Thus performing > 5 transfer tasks and stress were associated with LBP and performing >5 transfer tasks were associated with knee pain. On a detailed level the specific tasks associated with MSD were subject to some uncertainty (wide confidence intervals) probably because of the small sample size.

5.3 The intervention

In accordance with several others [31],[45],[54],[76],[116],[121],[141],[52] the overall results of our intervention program (implementing transfer technique alone or supplemented with physical fitness training) failed to show an effect on self reported LBP, pain level and sick leave at a 12 month follow-up when compared to the control group. However, at 12-month follow up the intervention group adhering to the protocol had significantly improved their knowledge of transfer technique when compared to the control group. Between the two intervention groups both the ITT and per-protocol analysis showed a significant improvement in the disability score for the TTPT group at follow up.
This could indicate that the additional physical training has some influence on the perceived disability in relation to LBP, especially as we monitored heart rate during the training sessions and an improvement of the physical fitness was detected for those who completed the physical training program. Thus physical training may have an effect on the consequences of LBP (disability score) which has also been reported by others [57],[95]. In a group of hospital workers with chronic LBP Maul (2005)[95] found that 3 month of physical exercises significantly improved the capacity, decreased LBP and disability at 12 month follow-up. One explanation could be that self-rated disability is more sensitive to changes than LBP-episodes and sick-

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leave [141] especially if considering that nurses have been found to be at work despite being sick [9] and disability have been found to be a predictor of future symptoms [117] as well as a predictor for time loss from work after an injury [124].

Adhering to the protocol a significant improvement of the knowledge of transfer technique was seen for the intervention group when compared to the control group. From an educational perspective this improvement could indicate that the knowledge of transfer technique apparently is handed over from the key-persons to the colleagues at the ward. Similar results have been found by others [100],[98]. However, whether the staff is using the knowledge of transfer technique and practices the principles when handling patients we do not know. To evaluate this we need more objective measures than self-reports, and the forthcoming analysis of the video-recorded transfer situations at the wards will give us more direct information about the implementation and use of transfer technique.

Even though the results seem promising in regards to the educational model, the enormous turnover among the hospital staff, as registered in our study, could be a difficulty in relation to the implementation. This makes it very time consuming for the key-persons and the wards to educate the new staff. On the other hand key-persons within transfer technique make it possible to develop and collect a greater variety of transfer technique knowledge in relation to the group of patients within the specific ward. However, high turnover among the nursing staff may emphasize that the basic education/training in transfer technique is to be placed at the educational institutions whereas the workplaces at an organizational level may focus mainly on developing a patient handling policy, which is simple, clear and supported by training in the use of the necessary equipment (lifts, electric beds, transfer aides etc.) as this has shown more promising results [34],[20]. This could be combined with educating local key-persons especially at wards where patient transfers are often performed.

The use of transferring aids (if necessary) is an essential part of transfer technique and one could argue that the lack of reducing LBP could be because transferring aids is not available, which would be in line with the recent positive results of the using the method “no lifting system”. To comply with this a selection of transferring aids (lifts, easy-slides etc) was purchased to the participating wards in our study and a depot was established for special lifts

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etc. However, despite the availability of transferring aids they may not be used which would be in line with Byrns (2004)[19].

Compliance

Most of the drop-outs were because of plausible reasons (leave, job-change, retirement, and long-time sick leave), nevertheless there will always be internal as well as external factors that influence the compliance. Thus the hospital is situated in Copenhagen surrounded with other hospitals with which we have a joined community; this makes a job change easy especially considering that we in Denmark are beginning to have a shortage of educated nursing staff.

The compliance to participate and to use transfer technique could be influenced by only 30% of the nursing staff performed more than 5 transfer tasks per working day in contrast to the control group where 65% performed more than 5 transfer tasks per day. According to the logbooks this difference seemed to persist throughout the study period.

The participating wards for this study were not selected according to a high rate of injuries or sick leave but were part of an overall agenda of introducing transfer technique to all the hospital wards. This may also influence the compliance to implement and use the transfer technique on daily basis. Although a high rate of LBP (approx. 55% within the last 12 month and approx. 50% within the last 3 month) the consequences of having LBP are all rated in the lower quartile of their scales/scores (sick leave at a maximum of 17%, average pain level at maximum 2 on a scale from 0-10 and average disability score of 6 out of maximum 38).

5.4 General discussion

For doing the intervention study there was a need for practical tools to asses the workload during the intervention period and to assess changes in the transfer technique used. Changes in the workload during the intervention could be a potential confounder to the possible effect of the intervention, especially as our primary outcome measurements were focus on changes in LBP including the consequences of having LBP such as sick leave and disability. For the registration of changes in the transfer technique used before and after the intervention a more objective measurement was needed, as the knowledge of transfer technique not

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necessarily reflects the use of the technique in a clinical setting. A methodological drawback in this study is the fact that the data from video recorded transfer situations are not evaluated. This had enlightened whether the lack of reducing LBP might be due to no use of the transfer technique on the daily basis. However, in the intervention study of Johnsson (2002)[67] using a direct observation instrument results showed an increase of transfer technique skills and decrease in perceived exertion but no reduction of musculoskeletal pain (LBP and NSP).

The design of the intervention needed to be cluster randomized according to wards merely because we aimed to evaluate the use of a transfer technique introduced by use of key-persons. Further a change in patient handling practice for the individual will often affect the colleagues due to the fact that the care of the patients is shared by the nurses working at the same ward and naturally exchange of knowledge in doing so (patient handling practice) is also shared. For the purpose of evaluating an additional effect of a physical training program the individual randomization at intervention wards was performed. The advantage was the comparability of the two intervention groups as external factors such as different categories of patients/specialties or local organizational structure or culture, which could be confounders were identical. The disadvantage was that the two intervention groups could not separately be compared to the control group but only in total as the randomization was performed at two different levels. The additional effect of the physical training if any could be "hidden" in the group of transfer technique alone when compared to the control group.

In general the total intervention referred to many parts of the conceptual models presented by Armstrong [8] and Westgaard [136]as seen in figure 1, but doing the intervention using a randomized controlled design revealed the importance of the production system at a company level. The level had great influence on our intervention in relation to the implementation of intervention and in relation to the fact that some specialties and wards were reorganized during our intervention. The latter might have contributed to the turnover of the nurses as registered in this study. In all it emphasized that the conceptual models should be regarded as describing a highly dynamic and adaptable system not only at an internal but also at an external level.

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6. Conlusion

- The observation instrument developed for detailed description of patient transfer technique is found to be valid, reliable and useful for the evaluation of changes in the technique before and after a training course. A quality to the present instrument is the separation of the registration from the evaluation and the focus on the performance phase. Recommendations and further improvements are: video-recordings due to the degree of details, field studies incl. further analysis for the questions classified “need further attention” and rephrasing incl. further analysis of the questions classified “not reliable”.

- The logbook developed for the registration of patient handling tasks, psychosocial factors and MSC is considered to be valid, reliable and useful for an evaluation of changes in the daily work over a period of time. A quality to the instrument is the registration of work-dose in combination with work related psychosocial factors and MSC. Recommendations and further improvements: a thorough introduction to the logbook is needed, what number the first day of registration is in the row of working days should be registered, the task sheet needs a more user-friendly lay-out or simplification.

- In the cluster randomized intervention study implementing transfer technique alone or in combination with physical fitness training did not, when compared to a control group show any statistical differences according to self reported LBP, pain level and sick leave at a 12 month follow-up. Improvements were seen, thus the intervention group adhering to protocol improved their knowledge of transfer technique and the transfer technique/physical training group improved according to the disability score. Recommendations and further improvements: introducing transfer technique as a change of work technique among hospital nurses has to thorough considered. Additional or other methods seem to be needed for the purpose of reducing LBP. The study indicates that work-site interventions may have to focus more on reducing the consequences of LBP instead of reduce the number of episodes.

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