Work-related neck-shoulder pain

The role of cognitive-behavioural factors and remotely supervised treatment

M.H.A. Huis in ‘t Veld

Address of correspondence:

Rianne Huis in ’t Veld
Roessingh Research and Development
PO Box 310
7500 AH Enschede
The Netherlands
+31-(0)53-4875740
r.huisintveld@rrd.nl

Lay out and cover designed by Mariël Pronk, Nijverdal.
Printed by Gildeprint Drukkerijen B.V. Enschede (www.gildeprint.nl)

ISBN 978-90-365-2584-8

WORK-RELATED NECK-SHOULDER PAIN

THE ROLE OF COGNITIVE-BEHAVIOURAL FACTORS AND REMOTELY SUPERVISED TREATMENT

PROEFSCHRIFT

ter verkrijging van
de graad van doctor aan de Universiteit Twente,
op gezag de rector magnificus,
prof. dr. W.H.M. Zijm,
volgens het besluit van het College voor Promoties
in het openbaar te verdedigen
op vrijdag 14 december 2007 om 15.00 uur

door

Maria Hendrika Aleida Huis in 't Veld
geboren op 02 januari 1980
te Almelo

Dit proefschrift is goedgekeurd door:

Prof. dr. ir. H.J. Hermens (promotor)

Dr. M.M.R. Vollenbroek-Hutten (assistent-promotor)

De promotiecommissie is als volgt samengesteld:

Voorzitter	
Prof. dr. ir. J. van Amerongen	Universiteit Twente
Secretaris	
Prof. dr. ir. A.J. Mouthaan	Universiteit Twente
Promotor	
Prof. dr. ir. H.J. Hermens	Universiteit Twente
Assistent-promotor	
Dr. M.M.R. Vollenbroek-Hutten	Roessingh Research and Development
Leden	
Prof. dr. ir. D.M. Konstantas	University of Geneva, Switzerland
Prof. dr. A.J. van der Beek	VU Amsterdam
Prof. dr. ir. L.J.M. Nieuwenhuis	Universiteit Twente
Prof. dr. M.J. Ijzerman	Universiteit Twente
Prof. dr. J.S Rietman	Universiteit Twente
Dr. R.J.E.M. Smeets	Revalidatiecentrum Blixembosch
	Universiteit Maastricht

Paranimfen:

MSc. PT. J.A. van Til

MSc. A.I.R. Kottink-Hutten

The publication of this thesis was generously supported by:
Roessingh Research and Development, Enschede
Het Roessingh, Centre for rehabilitation, Enschede
Chair Biomedical Signals and Systems, University of Twente, Enschede
Twente Medical Systems International (TMSi), Oldenzaal
IlcaMedia, Dalfsen

Veni etinam

(Tot hier ben ik gekomen)

Contents

Chapter 1 13
General Introduction

Chapter 2 25
The role of the fear-avoidance model in female workers
with neck-shoulder pain related to computerwork

Chapter 3 43
Coping profiles in female workers suffering from neck-shoulder pain

Chapter 4 63
The receptiveness toward remotely supervised myofeedback treatment

Chapter 5 81
A systematic review of the methodology of telemedicine evaluation in
patients with postural and movement disorders

Chapter 6 101
A staged approach evaluation of remotely supervised myofeedback treatment
in women with neck-shoulder pain related to computerwork

Chapter 7 117
Determinants of successful telemedicine implementations: a literature study

Chapter 8 135
General Discussion

Summary 153
Samenvatting [Dutch]
Dankwoord [Dutch]
Curriculum Vitae [Dutch]
Progress range

CHAPTER 1

General Introduction

1 | General Introduction

Neck-shoulder pain related to computer jobs is an increasing problem in the industrialized western society. In the Netherlands, the prevalence of self-reported neck-shoulder pain at the workplace is 23.4%, which is rather comparable to the European mean prevalence of 22.8%[1].

Pain is defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience, associated with actual or potential tissue damage, or described in terms of such damage"[2]. This definition implies that pain may exist even when no physical substrate can be demonstrated. Moreover, the IASP definition states that pain is a subjective experience. The World Health Organization defines that disorders are work-related when the work activities and work conditions significantly contribute to their development or exacerbation but are not the sole determinant of causation[3].

The aetiology of work-related neck-shoulder pain related to computerwork is multifactorial with a physiological, psychosocial and individual component[4-6]. Physiological components include factors like cervical spine posture, range of movement, sitting duration, and frequency of breaks etcetera[7 8]. Psychosocial components include the personal perception of factors such as stress at the workplace, low social support and job control, and high time pressure[9]. Gender, age, and domestic (work) load are among the individual factors[10]. It is known that neck-shoulder complaints are more prevalent in female workers than in male workers[11]. This is among other reasons due to the fact that the trapezius muscle is especially susceptible for emotional stimuli (such as stress) caused by psychosocial factors, which in general are more prominent in women[12]. Moreover, the chance of having neck pain is twice as large in persons older than 30 years[6].

Apart from the personal suffering, neck-shoulder pain related to computerwork constitute a frequent contributor to the ever increasing financial strain on society[13]. Increased health care consumption, loss of productivity, and inability to (return to) work make the problem of occupational musculoskeletal disorders costly. Computer-related jobs are among one of the ten fastest growing jobs in the period 2000-2010[14]. Due to this

expected increase in computer-related jobs, the costs which are associated with neck-shoulder disability are likely to increase.

In the Netherlands, work-related complaints in the neck and shoulder are commonly treated with medications (e.g. muscle relaxants), ergonomic interventions and/or physiotherapy[15]. Ergonomic interventions involve adjustment of workstations and/or (re-) design of work organization, tasks and techniques[16]. The physiotherapies applied span a wide spectrum such as manipulation, mobilization, and massage but all therapies strive for proper use of the trapezius muscle[17]. Whereas these interventions achieve beneficial effects in some subjects, in many disabilities remain. In a cohort of subjects of working age consulting primary care for non-specific back or neck pain, pain and disability recurred or continued at 5 years follow up in about half of the population[18].

One element contributing to this limited effectiveness might be the fact that many interventions are predominantly focusing on somatic components of pain whereas cognitive-behavioural models also emphasize the important contribution of psychological variables to pain experience and behaviour[19 20]. Treatment, based on these models, aims to change both the individual's view of pain as well as his/her way in coping with the pain. One such cognitive-behavioural model is the fear-avoidance model developed by Vlaeyen *et al*. (1995)[21]. It assumes that an individual with acute musculoskeletal pain will tend to reduce or avoid physical activity because he/she fears that these activities will increase the pain and suffering. Avoidance behaviour occurs in anticipation and expectation on pain; instead of a response to it[22]. As a result, subjects no longer perform their feared activities which lead to a detriment in physical condition (i.e. muscle activation, strength, mobility). In turn, the pain experienced by the individual becomes more severe and thus reinforces fear and further avoidance behaviour completing the fear-avoidance circle. Psychological consequences may include depression, social isolation and/or loss of self-esteem. Confrontation with fearful activities is considered to be an adaptive response, in which the individual returns to normal activity and thus achieves recovery.
Another cognitive-behavioural model is the avoidance-endurance model. This model assumes that subgroups of subjects exist who use a variety of (mal-)adaptive coping strategies. Besides avoidance coping, the avoidance-endurance model postulates another maladaptive coping profile namely endurance coping[23 24]. Similar to the fear-avoidance

model, avoidance behaviour is considered to be a maladaptive strategie to cope with musculoskelatal complaints, and confrontation is considered to be adaptive strategy. In contrast to avoidance coping, a subgroup of subjects suffering from musculoskeletal pain deliberately attempts to suppress their pain by positive self-talk and continuation of their activities they have started. As a consequence, these subjects risk extreme overuse of the painful region.

From a psychological point of view, maladaptive cognitions are activated quite early on in the process of musculoskeletal pain and are found to play a major role in the transition towards chronic pain[25]. Consequently, cognitive-behavioural interventions arranged in the work setting while people are still working might be valuable. However, to date studies examining the role of cognitive-behavioural models in well-functioning (still working), i.e. "non-patient" populations are lacking. Instead, the cognitive-behavioural models have been validated mainly in clinical populations suffering from low back pain with high levels of pain intensity and disability[26]. Yet, there are some preliminary indications that these models could be applied in subjects with neck-shoulder pain who are still functioning at the workplace. George *et al*. (2001)[27] explored fear-avoidance beliefs in subjects with non-traumatic work-related complaints and showed that these beliefs are comparable between cervical spine and lumbar spine pain. Fritz *et al*. (2001)[28] confirmed these findings and demonstrated fear-avoidance beliefs to be present in patients with work-related musculoskeletal pain.

Another element contributing to the limited effectiveness of conservative treatment in neck-shoulder pain might be the fact that treatment is not specific enough due to a lack of individual tailorization and continuation at the workplace. Most treatments are provided on a weekly basis with a maximum duration of about 30-60 minutes. Subjects might not receive a sufficient amount of feedback to be able to change their maladaptive pain-related behaviour. It is known that increased practice and experience are associated with better acquisition of a (motor) skill (i.e. muscle relaxation)[29]. It is suggested that a more intensive training approach, i.e. continuous training, further improves outcome. Given the strain currently placed on the health care system, more intensive hands-on treatment is highly improbable. Theoretically, if a particular process (e.g. muscle relaxation) can be measured and used as feedback[30], then subjects can learn to voluntarily control this process[29] without the regular interference of a therapist.

A portable biofeedback system which can be used during normal daily activities, like work, can make the treatment more intensive without the continuous attendance of the therapist. One such a feedback device is the Cinderella-based[31] myofeedback system which has been proven to be a clinically effective device[32-34]. According to the Cinderella hypothesis[31], insufficient relaxation of the upper trapezius muscle contributes to the persistence of neck-shoulder pain. As the contraction levels are quite low, subjects are not very aware of a lack of relaxation. The ambulatory training based on this principle consists of continuous measurement of surface electromyography (sEMG) of the trapezius muscle. The ambulatory device provides an auditory and vibratory feedback when muscle relaxation is insufficient and thereby assists subjects to learn the (motor) skill which is needed to avoid that feedback and learn to relax their muscle.

A disadvantage of the myofeedback treatment (MT) is the fact that subjects have to travel to the clinic for counselling sessions. Travel distances might be large, especially when the clinic is a regional facility. Large travel times and associated productivity loss might be costly for the subjects and/or the company. Prior to the counselling session sEMG data are not available for the therapists but need to be downloaded manually from the system when the subject is at the clinic. As a consequence, therapists can not prepare the counselling sessions optimal. In order to optimize these disadvantages, MT has been extended. The extension of MT is a result of advanced development(s) in the area of information and communication technology (ICT). As such, the ambulant myofeedback system is equipped with a (secured) wireless connection over which sEMG signals can be send to a secured server which is accessible by the myofeedback therapist at any place and at any time. The fact that the medical data of the individual is remotely accessible for the therapist implies that the conservative in vivo visits between the individual and therapist can be replaced by remote consultations, which can be as simple as using the telephone or as complex as using real-time web-based videoconferencing. Consequently, remotely supervised myofeedback treatment (RSMT) is believed to increase the efficiency of care and to save costs because travel-times are reduced. In addition, the effectiveness of care is hypothesized to increase because the professionals can prepare the counselling sessions more optimal.

However, as teletreatment such as RSMT is a very new treatment concept in healthcare in general and work-related neck-shoulder pain in specific, it is important to examine which factors are relevant in the acceptance of these types of interventions by potential

end-users, i.e. therapists and subjects with neck-shoulder pain[35]. Acceptance of information technology is defined as "an individual's psychological state with regard to his or her voluntary or intended use of a particular technology"[35]. A prominent line of behavioural research, useful to understanding usage of information technology, draws on intention-based models that focus on the behavioural intentions of subjects to predict use[36].
According to these models, the best predictor for human behaviour (i.e acceptance of RSMT) is the intention to do so. One of these models is the social-psychological oriented Attitude - social Support - self Efficacy model (ASE)[37]. The intention for adhering to RSMT is seen as being directly affected by three main determinants: attitude, social support and self-efficacy. Subjects with a positive attitude, high levels of self-efficacy of succeeding in providing (therapist) and receiving (client) the intervention and high social support are more likely to adhere to RSMT.
Of particular interest in the development of RSMT in health care is the emphasis on evidence-based medicine[38]. According to the ideals of evidence-based medicine, clinical practice should be "proven" by scientific evidence; preferably by a meta-analysis of randomized controlled trials. Given the broad spectrum of possible effects of RSMT (quality, access, and costs), appropriate effect evaluation pose challenges to traditional methodology[38]. The far-reaching consequences of telemedicine not only makes it difficult to evaluate its effects, but also presents challenges for RSMT implementation[39]. In spite of the promising benefits, the development of telemedicine services is immature[39] and a lot of all telemedicine initiatives do not survive after the research stage[40 41].

Outline of thesis

Neck-shoulder pain related to computerwork, particularly in elderly female workers, is a major medical and economic problem. A lot of subjects still experience complaints even after treatment.

The aim of the present thesis is to contribute to more effective and more efficient treatment of neck-shoulder pain related to computer work. Two different approaches have been followed. In the first part of this thesis, the focus was on obtaining a better understanding of the role of cognitive behavioural factors in subjects who are still working despite their neck-schoulder pain. More specific, in Chapter 2 the role of the cognitive-behavioural oriented "fear-avoidance model" in the maintenance of neck-shoulder

pain disability is examined. The role of the fear-avoidance model is generally accepted in clinical musculoskeletal pain rehabilitation, especially in low back pain. Little research has been conducted to the role of fear-avoidance beliefs in subjects suffering from neck-shoulder pain related to computer work, who are still functioning at work. In literature coping strategies other than avoidance as postulated in the "fear-avoidance model" are described, suggesting the existence of subgroups of musculoskeletal pain sufferers. Subgroups of neck-shoulder pain workers using different coping strategies to deal with their complaints are examined in Chapter 3.

In the second part of the current thesis a new concept for treatment has been investigated. Earlier experiences have shown that a very intensive myofeedback treatment might be successful in the treatment of neck-shoulder pain. It was considered that this treatment could be more effective and more efficient when remote consultation would be feasible. As this concerns a new approach on treatment, its viability with respect to the susceptibility of the end-users (both subjects with neck-shoulder pain and professionals) (Chapter 4) as well as the proper research methodology (Chapter 5) is investigated before a pilot (Chapter 6) could be carried out on the feasibility and changes in clinical outcomes. Chapter 7 describes the determinants that influence the successful implementation of these remote treatment concepts.

Finally, Chapter 8 presents a general discussion on how to progress toward new approaches for effective treatment for subjects with neck-shoulder pain who are still working.

Reference List

1. Paoli P, Merllié D. Third European survey on working conditions [Web Page]. 2002; Available at http://www.eurofound.eu.int/pubdocs/2001/21/en/1/ef0121en.pdf.

2. International Association for the Study of Pain (IASP). Classification of chronic pain. Description of pain syndromes and definitions of pain terms. Pain Suppl. S3 1983.

3. World Health Organization (WHO). Identification and control of work-related diseases. 1985; 174.

4. Devereux JJ, Vlachonikolis IG, Buckle PW. Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. Occup Environ Med 2002; 59(4):269-77.

5. Andersen JH, Kaergaard A, Frost P et al. Physical, psychosocial, and individual risk factors for neck/shoulder pain with pressure tenderness in the muscles among workers performing monotonous, repetitive work. Spine 2002; 27(6):660-7.

6. Cagnie B, Danneels L, Van Tiggelen D, De Loose V, Cambier D. Individual and work related risk factors for neck pain among office workers: a cross sectional study. Eur Spine J 2007; 16(5):679-86.

7. Hush JM, Maher CG, Refshauge KM. Risk factors for neck pain in office workers: a prospective study. BMC Musculoskelet Disord 2006; 7:81.

8. Bergqvist U, Wolgast E, Nilsson B, Voss M. The influence of VDT work on musculoskeletal disorders. Ergonomics 1995; 38(4):754-62.

9. Bongers PM, Kremer AM, ter Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist?: A review of the epidemiological literature. Am J Ind Med 2002; 41(5):315-42.

10. Fredriksson K, Alfredsson L, Koster M et al. Risk factors for neck and upper limb disorders: results from 24 years of follow up. Occup Environ Med 1999; 56(1):59-66.

11. Treaster DE, Burr D. Gender differences in prevalence of upper extremity musculoskeletal disorders. Ergonomics 2004; 47(5):495-526.

12. Ostergren PO, Hanson BS, Balogh I et al. Incidence of shoulder and neck pain in a working population: effect modification between mechanical and psychosocial exposures at work? Results from a one year follow up of the Malmo shoulder and neck study cohort. J Epidemiol Community Health 2005; 59(9):721-8.

13. Blatter BM, Houtman, I, van den Bossche, S, Kraan, K, van den Heuvel, S. Gezondheidsschade en kosten als gevolg van RSI en psychosociale arbeidsbelasting in Nederland (Report on demand of the Dutch Ministry of Social Affairs and Employment) [Web Page]. 2005; Available at www.//home.szw.nl/actueel/dsp_publicatiesindex.cfm.

14. de Hecker DE, Occupational Employment projections to 2010 [Web Page]. 2001; Available at http://www.bls.gov/opub/mlr/2001/11/art4full.pdf.

15. Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D. Survey of chronic pain in Europe: Prevalence, impact on daily life, and treatment. European Journal of Pain 2006; (10):287-333.

16. Karsh BT, Moro FBP, Smith MJ. The efficacy of workplace ergonomic interventions to control musculoskeletal disorders: a critical analysis of the peer-reviewed literature. Theoretical Issues in Ergonomic Science 2001; 2(1):23-96.

17. Gross AR, Kay T, Hondras M et al. Manual therapy for mechanical neck disorders: a systematic review. Man Ther 2002; 7(3):131-49.

18. Enthoven P, Skargren E, Oberg B. Clinical course in patients seeking primary care for back or neck pain: a prospective 5-year follow-up of outcome and health care consumption with subgroup analysis. Spine 2004; 29(21):2458-65.

19. Turk DC, Meichenbaum D, Genest M. Pain and behavioural medicine, a cognitive-behavioural perspective. New York: Raven Press, 1983.

20. Turk DC, Meichenbaum D. A cognitive-behavioural approach to pain management. In P.D. Wall & Melzack R. (Eds) Textbook of Pain. Edinburgh: Churchill Livingstone, 1994.

21. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995; 62(3):363-72.

22. Sullivan MJ, Stanish W, Waite H, Sullivan M, Tripp DA. Catastrophizing, pain, and disability in patients with soft-tissue injuries. Pain 1998; 77(3):253-60.

23. Hasenbring M, Marienfeld G, Kuhlendahl D, Soyka D. Risk factors of chronicity in lumbar disc patients. A prospective investigation of biologic, psychologic, and social predictors of therapy outcome. Spine 1994; 19(24):2759-65.

24. Hasenbring M, Hallner D, Klasen B. Psychologische mechanismen im prozess der schermzchronifizierung: unter- oder überbewertet? [Psychological mechanisms in the transition from acute to chronic pain: over- or underrated?]. Schmerz 2001; 15(6):442-7.

25. Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000; 85(3):317-32.

26. Crombez G, Vlaeyen JW, Heuts PH, Lysens R. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. Pain 1999; 80(1-2):329-39.

27. George SZ, Fritz JM, Erhard RE. A comparison of fear-avoidance beliefs in patients with lumbar spine pain and cervical spine pain. Spine 2001; 26(19):2139-45.

28. Fritz JM, George SZ, Delitto A. The role of fear-avoidance beliefs in acute low back pain: relationships with current and future disability and work status. Pain 2001; 94(1):7-15.

29. Schmidt RA, Lee TD. Motor control and learning: A behavioural emphasis. San Francisco, United States of America: Human Kinetics, 1999.

30. Skinner BF. The behavior of organisms: an experimental analysis . New York, United States of America: Appleton Century Crofts, 1938.

31. Hägg GM. Static work loads and occupational myalgia: a new explanation model. Anderson P.A., Hobart D.J., Danoff (eds). Amsterdam: Elsevier Science Publishers B.V. (Biomedical Division), 1991: 141-3.

32. Hermens HJ, Hutten MMR. Muscle activation in chronic pain: its treatment using a new approach of myofeedback. Int J Indust Ergon 2002; 30:325-36.

33. Voerman GE, Sandsjö L, Vollenbroek-Hutten MM, Larsman P, Kadefors R, Hermens HJ. Effects of Ambulant Myofeedback Training and Ergonomic Counselling in Female Computer Workers with Work-Related Neck-Shoulder Complaints: A Randomized Controlled Trial. J Occup Rehabil 2007.

34. Voerman GE, Vollenbroek-Hutten MM, Hermens HJ. Changes in pain, disability, and muscle activation patterns in chronic whiplash patients after ambulant myofeedback training. Clin J Pain 2006; 22(7):656-63.

35. Hu PJ, Chau PY. Physician acceptance of telemedicine technology: an empirical investigation. Top Health Inf Manage 1999; 19(4):20-35.

36. Kukafka R, Johnson SB, Linfante A, Allegrante JP. Grounding a new information technology implementation framework in behavioral science: a systematic analysis. Journal of Biomed Inform 2003; 36:218-27.

37. de Vries H, Dijkstra M, Kuhlman P. Self-efficacy: The third factor besides attitude and subjective norm as a predictor of behavioural intentions. Health Educ Res 1988; 3(3):273-82.

38. Timmermans S , Berg M. The gold standard: an exploration of evidence-based medicine and standardization in health care. Philadelphia, United States of America: Temple University Press, 2003.

39. Barlow J, Bayer S, Curry R. Implementing complex innovations in fluid multi-stakeholder environments: experiences of “telecare”. Technovation 2006; 26:396-406.

40. Berg M. Patient care information systems and health care work: a sociotechnical approach. Intern Journ of Med Inform 1999; 55:87-101.

41. Tanriverdi H, Iacono CS. Diffusion of telemedicine: a knowledge barrier perspective. Telemed J 1999; 5(3):223-44.

CHAPTER 2

The role of the fear-avoidance model in female workers with neck-shoulder pain related to computerwork

M.H.A. Huis in 't Veld [1]
M.M.R. Vollenbroek-Hutten [1]
C.G.M. Groothuis-Oudshoorn [1]
H.J. Hermens [1,2]

[1] Roessingh Research and Development, Enschede, The Netherlands
[2] Faculty of Electrical Engineering, Mathematics and Computer Science, University of Twente, Enschede, The Netherlands

Clinical Journal of Pain
23(1):28-34, 2007

2 | Fear-avoidance model

Abstract

This study explores the fear-avoidance model in a sample of women with neck-shoulder pain related to computerwork who were still functioning at the workplace. Exploring this model in this population could produce starting points for new treatment approaches in occupational health. Fifty-eight women with work-related neck-shoulder pain and 45 healthy controls were included. Differences in components of the fear-avoidance model between cases and controls were computed using t-tests. In addition, correlations were calculated and structural equation modeling (SEM) techniques were performed to investigate the fear-avoidance model in the case group.

In line with the fear-avoidance model, cases had lower performance levels and felt significantly more disabled compared to their controls but showed, in contrast to the model, significantly lower levels of catastrophizing thoughts. Of the fear-avoidance beliefs measures, all correlations were significant, except between catastrophizing and fear of movement. Fear-avoidance beliefs about work seem to play an important role in disability levels of work-related neck-shoulder pain patients as illustrated by the high(est) association with disabilities. The results of the present study also showed that the original fear-avoidance model proposed in subjects with work-related neck-shoulder pain who are still functioning at the workplace could only be confirmed by one of the three fit indices. Interestingly, adding an extra path between fear-avoidance beliefs and disability in the original model approached good model fit as shown by all three fit indices. In line with the fear-avoidance model, the current results addressed the importance of pain-related fear in subjects with neck-shoulder pain disability related to computerwork. Interestingly, and not in accordance with the fear-avoidance model, fear-avoidance beliefs directly influence disability levels in the current sample; regardless of lower levels of performance that is, physical impairment.

Introduction

Neck-shoulder pain is frequently reported among workers with repetitive and/or static manual tasks such as computer work. For instance, data from the European Foundation for the Improvement of Living and Working Conditions, obtained in 15

European countries, showed that 25% of the workers reported work-related neck-shoulder pain[1]. The complaints mainly occur within the older population of female computer workers[2] [3] [4]. In the Netherlands, management of these disorders at the workplace, that commonly takes place before absenteeism occurs, generally consists of ergonomic interventions. These are mainly concentrated on improving work environment and/or work techniques and include workplace redesign, postural instructions and education on how to (re-)organize work tasks. In occupational health, the basic philosophy underlying these interventions is the model of functional capacity and functional demands[5]. This model assumes that the individual workload should not exceed a person's capacities. However, despite these early interventions the complaints are often persistent and develop into chronic work-related neck-shoulder pain. In contrast to the ergonomic interventions provided at the workplace, subjects with chronic complaints often receive treatment in clinical settings mainly based on cognitive-behavioural models. One such model is the fear-avoidance model developed by Vlaeyen *et al*. (1995)[6] which offers a framework conceptualizing the process of developing chronic musculoskeletal pain. Avoidance and confrontation are postulated as two extreme responses to painful experiences. Avoidance is considered as a maladaptive response, characterized by the avoidance of activities, resulting in poor behavioural performance, increased disability, and a subsequent reinforcement of catastrophic thoughts, completing the fear-avoidance circle. This is especially the case in subjects who interpret pain as threatening (pain catastrophizing) and exhibit "fear of movement" (kinesiophobia)[7] [8]. In contrast, confrontation is considered as an adaptive response, in which the individual returns to normal activity, and thus achieves complete recovery.

The fear-avoidance model has been widely investigated, and is accepted to explain the development of chronic low back pain[9] [10]. There are some indications, that the model may be valid in subjects with (work-related) neck-shoulder pain, but this research is scarce. For example, George *et al*. (2001)[11] found no significant difference in fear-avoidance beliefs between cervical spine patients and patients with lumbar spine pain. Fritz *et al*. (2001)[12] found that fear-avoidance beliefs seem to be present in patients with work-related as well as in non-work-related musculoskeletal pain. In addition, recent literature[13] reports comparable levels of fear-avoidance beliefs in patients with sub-acute and chronic low back pain suggesting that these beliefs already

appear at an early stage and contribute to the transition from acute to chronic low back pain.

Further exploration of this model in people with neck-shoulder complaints related to computerwork is considered worthwhile, because this could result in starting points for new effective approaches for treatment in occupational health. Therefore, the objective of the present study was to investigate the fear-avoidance model in employees with neck-shoulder pain related to computer work, who are still working.

Methods

Subjects

Three hundred and ten female workers, performing computer work predominantly, were contacted by telephone and one hundred and seventy volunteered to participate. Of these, 49 did not meet the inclusion criteria and were therefore excluded from participation. Of the 121 employees who met the inclusion criteria, 18 dropped out because of lack of time, family circumstances or because they were tired of all the medical visits they already have had to make due to their pain. Finally, 103 subjects completed the study.

Female workers, between 40 and 62 years of age, were included if they worked for a minimum of 20 hours a week, mainly doing computer work. Subjects were included on their response of a questionnaire, which was derived from the Nordic Questionnaire and contained questions about work and health[14]. Based on their self-reported existence of neck-shoulder pain related to work, two subgroups were created; cases and controls. Subjects were included in the case group if they had experienced complaints in the neck-shoulder region related to computerwork for more than 30 days during the previous 12 months. Subjects were excluded from the case group when they experienced complaints for more than 30 days in more than three parts of the body because otherwise the role of neck-shoulder complaints in perceived disabilities would be unclear. Subjects were included in the control group if they had experienced complaints in the neck-shoulder region for less than 7 days during the previous 12 months, and excluded if they had experienced complaints for more than 30 days during the previous 12 months in any other part of the body. The reliability and validity of the Nordic questionniare has been proven to be acceptable[15].

Procedures and measures

The study was approved by the Medical Ethics Committee of the Roessingh Rehabilitation Centre. All subjects gave their written informed consent before participating in this cross-sectional study.

Besides some information on demographic variables, information was gathered with respect to the different components of the fear-avoidance model: pain intensity, catastrophizing, pain-related fear (kinesiophobia, fear-avoidance beliefs about physical activity and work), behavioural performance and disability.

Pain intensity: The level of pain intensity at the time of the experiment was measured using a 10-point numerical rating scale with written anchors at the two extremes: "no pain" and "the worst pain ever experienced". A lower score was associated with less pain intensity.

Catastrophizing (CSQ-CA): The subscale "catastrophizing" of the Dutch version of the Coping Strategies Questionnaire was used[16 17]. This subscale was found to be reliable and internally consistent[3 16].

Kinesiophobia (TSK): The Dutch version of the Tampa Scale for Kinesiophobia[18] was used to measure fear of movement in subjects with work-related neck-shoulder pain. The TSK is a 17-item 4-point Likert scale questionnaire which measures fear of (re)injury due to movement. Vlaeyen *et al*. (1995)[6] found the Dutch TSK to be reliable and valid. An adapted version of the TSK (mTSK) was used for individuals with no pain[19]. The phrasing of this scale was slightly different from that of the TSK for subjects with pain because of the more "suggestive" character of the questions, but the same norms were applicable.

Fear-Avoidance Beliefs Questionnaire (FABQ): The Dutch version of the FABQ was used[20]. The FABQ is a 16-item 7-point measure aimed at quantifying a person's beliefs about how work and physical activity affect pain, and whether they believed that it should be avoided[21]. In addition to a total FABQ score, two sub-scales within the FABQ were also used; a 4-item scale measuring fear-avoidance beliefs (FABQ-PA) about physical activity, and a 7-item scale assessing fear-avoidance beliefs about work

(FABQ-W). A modified version of the FABQ (mFABQ) was used for individuals with no pain. The mFABQ was constructed using four of the five items from the subscale that assesses fear-avoidance beliefs about physical activity[22].

Behavioral performance (MVC): The level of behavioral performance was assessed with a static maximal shoulder elevation test. Shoulder elevation is the most important function of the trapezius muscle. This test was chosen because it is expected that the performance of this muscle is affected by neck-shoulder complaints, and considered to provoke fear for subjects with work-related neck-shoulder pain. The subject was asked to perform one maximal voluntary contraction (MVC) of the trapezius muscle. Only one MVC test was performed in the present study because avoidance, characterized by the fear-avoidance model, is expected to diminish with repeated exposures, thus resulting in better performance. To ensure a straight, upright sitting posture and to avoid lateral flexion, the subject was seated in a chair with a straight back. A maximum of standardization was pursued by using a chair that was adjustable in height. The height was adjusted so that the subject's feet had no contact with the floor, in order to ensure that the applied force was derived from the trapezius muscle and not from the legs. The subjects were instructed to look straight ahead. Two Bofor dynamometers were fixed to the wall and placed on the lateral edge of each acromion. The subject was instructed to build up the force over five seconds, then to keep up the pressure for about two seconds, and then to lower the force to zero. Direct continuous feedback was given about the level of force on a computer screen.

Neck Disability Index (NDI): A Dutch translation of the NDI was used[23]. The NDI is a 10-item 6-point scale measuring difficulty in performing daily activities. Its reliability and validity was proven to be satisfactory[23 24 25].

Analysis

Descriptives

All data were analyzed in SPSS Version 11.5 (SPSS, Inc., Chicago, IL, USA). Differences in demographic variables and components of the fear-avoidance model between cases and controls were investigated with a t-test when normally distributed. To test the relationships between the components of the fear-avoidance model, Pearson's cor-

relations among pain intensity, TSK, FABQ-W, FABQ-PA, MVC and NDI were calculated for the cases.

Model estimation

A confirmatory path analysis of the fear-avoidance model was performed with structural equation modeling (SEM) software (EQS 6.1). Path diagrams are fundamental to SEM because they make it possible to diagram the hypothesized set of relationships. The path diagram for the fear-avoidance model is shown in Figure 2.1. The measured variables, also called indicators are represented by rectangles. Factors have two or more indicators, also called latent variables, and these are presented by circles. The relationships between variables are indicated by lines, and a line with one arrow represents a hypothesized direct relationship between two variables. In the first step of the SEM analysis relationships between pain intensity, catastrophizing (CSQ-CA), the latent variable pain-related fear with three indicators (FABQ-W, FABQ-PA and TSK), the performance (MVC) and the disabilities (NDI) were assessed by calculating path coefficients. Catastrophizing (CA), pain intensity, and disability (NDI) were included in SEM without error variances, because these variances are unknown for this kind of study population (non-clinical subjects with neck-shoulder pain). To achieve covariances between the variables that are of comparable sizes the MVC was multiplied by 0.1 in the analyses. The path coefficient between FABQ-PA and fear-avoidance was fixed at 1.00 in order to set the scale for the measurement of the latent factor "fear-avoidance"[26].

In the second step of the SEM analysis the adequacy of the fear-avoidance model in cases with neck-shoulder complaints related to computerwork was tested using robust maximum likelihood estimation, a technique for small sample sizes and/or non-normal distributed data[27]. Model fit was evaluated on the basis of three parameters: 1) the Yuan Bentler, p values >0.05 indicates good fit of the fear-avoidance model[28 29]; 2) the root mean square error of approximation (RMSEA) indicating good model fit when < 0.06[30]; and 3) the comparative fit index (CFI). CFI values greater than 0.95 are often indicative of good-fitting models[31]. For small sample sizes the Yuan-Bentler statistic is recommended. RMSEA and CFI are considered to be less sensitive to sample size than others[27]. In the third step of the SEM analysis it was tested whether modifications such as adding extra paths improve the goodness-of-fit of the hypothesized model[27].

Results

Descriptives

The sample consisted of 58 cases and 45 controls. The demographic and occupational variables are presented in Table 2.1. The mean duration of the complaints experienced by subjects in the case group was 66 months (range 2-204, SD=61.4). The mean pain intensity score in the case group was 2.7 (range 0-8, SD=2.4).

Table 2.1 Demographic and occupational characteristics of the study population: mean and SD (n=103)

	Case (n=58)	**Control (n=45)**
Age (yrs)	49.34 (5.02)	51.11 (4.84)
Height (cm)	168.28 (6.16)	169.20 (6.59)
Weight (kg)	73.35 (14.67)	71.48 (9.24)
Work (h/wk)	29.28 (8.24)	30.29 (8.39)
Workhistory (months)	112.93 (15.23)	121.44 (18.31)

The two groups were comparable with regard to age, height, weight and number of working hours per week, since no significant differences were found.

The mean scores for the (scales of the) questionnaires and performance test, and the results of the statistical tests to indicate differences between cases and controls, are presented in Table 2.2.

Table 2.2 Mean scores and standard deviations for cases and controls on catastrophizing (CSQ-CA), kinesiophobia (TSK), fear-avoidance beliefs (mFABQ, FABQ-PA, FABQ-W), performance (MVC) and disability (NDI) (n=103). (m)= modified version used for the control group.

	Case (n=58) mean (SD)	**Control (n=45) mean (SD)**	**t-test**	**sig. (2-tailed)**
CSQ-CA	9.14 (8.63)	13.78 (9.53)	2.586	.011*
(m)TSK	31.78 (7.21)	32.42 (6.631)	0.467	.641
(m)FABQ	10.88 (6.23)	10.40 (5.98)	-0.394	.694
FABQ-W	14.67 (8.71)	--	--	--
FABQ-PA	10.14 (6.13)	--	--	--
MVC	169.87 (92,34)	206.33 (79.27)	2.097	.004*
NDI	9.45 (5.55)	2.40 (2.36)	8.706	.000*

*p<0.05

All parameters, except for NDI and CSQ-CA, were normally distributed. In line with the fear-avoidance model, cases reported significant higher levels of NDI (t=8.71, p=0.00) and significant lower levels of MVC (t=2.10, p=0.00) compared to the controls. Remarkable, significant lower levels of catastrophizing (CSQ-CA) were found in the case group (t=2.59, p=0.01).

Correlation coefficients between the components of the fear-avoidance model in the case group are presented in Table 2.3. All relationships between the variables were in the hypothesized direction. All relationships in the fear-avoidance model were significant, except the relationship between catastrophizing and pain-related fear. The highest correlation was found between FABQ-W and disabilities (NDI) (*r*=0.455, p=0.00).

Table 2.3 Pearson's correlation coefficients (r) for pain-intensity in the neck, catastrophizing (CSQ-CA), kinesiophobia (TSK), fear-avoidance beliefs about physical activity (FABQ-PA) and work (FABQ-W), performance (MVC) and disability (NDI) in the case group (n=58).

	NDI	CSQ-CA	TSK	FABQ-W	FABQ-PA	MVC
NDI	--	--	--	--	--	--
CSQ-CA	.358**	--	--	--	--	--
TSK	.272*	.213	--	--	--	--
FABQ-W	.455**	.270*	.402*	--	--	--
FABQ-PA	.233	-.038	.460**	.362	--	--
MVC	-.354**	-.152	-.368**	-.358**	-.186	--
Pain intensity	.441**	.360**	.290*	.204	.181	-.205

* p<0.05, **p<0.01

In the control group, none of the associations as postulated in the fear-avoidance model was found to be significant, except for CSQ-CA and MVC (*r*=-0.303, p=0.05).

Model estimation

The fear-avoidance model with significant parameter estimates in standardized (and unstandardized) form is presented in Figure 2.1. All of the path coefficients between the measured variables and factors in the model are significant, except the path between catastrophizing and fear-avoidance. Pain intensity was predictive of catastrophic thoughts (standardized coefficient = 0.35), and higher levels of pain-related fear lead to lowered levels of performance (standardized coefficient = -0.47).

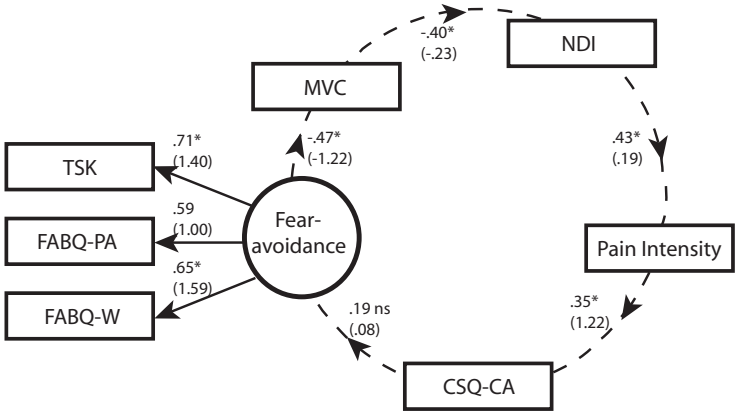

Figure 2.1 Results of the SEM analyses of the fear-avoidance model (Vlaeyen et al., 1995) for cases (n=58); standardized (unstandardized) path coefficients between pain-intensity in the neck, catastrophizing (CSQ-CA), kinesiophobia (TSK), fear-avoidance beliefs about physical activity (FABQ-PA) and work (FABQ-W), performance (MVC) and disability (NDI). * p<0.05

Lowered levels of performance lead to higher levels of disability (standardized coefficient = -0.40). Disability was predictive of pain intensity (standardized coefficient = 0.43). Only one of the three goodness-of-fit indices, the Yuan-Bentler Chi-square test (χ^2=18.887, df=13, p=0.13), indicated good fit of the fear-avoidance model. Poor fit was indicated by the root-mean square error of approximation (RMSEA=0.132, 90% CI 0.05–0.205) and the comparative fit index (CFI=0.835).

Post-hoc model modifications were performed in an attempt to achieve a better fit. Interestingly, on the basis of the Lagrane Multiplier Test one path was added, namely between fear-avoidance and disabilities indicating that higher levels of fear-avoidance beliefs lead directly to higher levels of disability (χ^2=24.647, df=1, p=0.00). When adding the direct path between fear-avoidance disability, the chi-square decreases (but remains non-significant as it should) and now all indicators approach good fit as shown by the Yuan-Bentler Chi-square test (χ^2=13.18, df=13, p=0.36), the lowered RMSEA (0.069, 90% CI 0.00–0.160) and the higher CFI (0.958) indices. Another remarkable result is that when a direct path between fear-avoidance beliefs and disabilities is added, the relationship between MVC and NDI losses significance.

Discussion

The present study investigated the fear-avoidance model in a sample of subjects with neck-shoulder complaints related to computerwork, who were still functioning at the workplace. Exploring the fear-avoidance model in this population could result in starting points for new approaches to treatment in occupational health.

The results of the present study showed that the original fear-avoidance model proposed in subjects with work-related neck-shoulder pain who are still functioning at the workplace could only be confirmed by one of the three fit indices. Interestingly, adding an extra path between fear-avoidance beliefs and disability in the original model lead to good model fit as indicated by all three goodness of fit indices.

In line with the fear-avoidance model, the current results support the maladaptive role of pain-related fear in disability[6 21 32]. Remarkably and not in accordance with the fear-avoidance model, when a direct path between fear-avoidance beliefs and disabilities was added to the model, the significant association between performance and disability disappeared. In other words, fear-avoidance beliefs directly influence disability levels; regardless of lower levels of performance i.e. physical impairment in the current sample. A hypothetical explanation for this finding could be that the population included in the present study applied other avoidance strategies to deal with their pain than behavioural focused avoidance. A possible avoidance strategy applied could be "cognitive emotional avoidance" as illustrated by the direct path between fear-avoidance beliefs and disability. Despite their neck-shoulder complaints, subjects included in the present study might have been continuing their work in order to avoid aversive (emotional) consequences such as work loss, conflicts and negative evaluation of colleagues. In literature, numerous studies have already addressed the negative consequences of subjects' attempts to control or avoid emotions and thoughts in ways that are unsuccessful leading to, distress, frustration and hypervigilance[33 34 35].

As illustrated by the highest (significant) correlation, of all the fear-avoidance measures applied in the present study (TSK, FABQ-PA, FABQ-W) fear-avoidance beliefs about work (FABQ-W) appeared to be the most relevant in work-related neck-shoulder pain disability. In contrast to kinesiophobia, as postulated in the fear-avoidance model, fear-avoidance beliefs about work could be regarded as a different construct. The

questions in the FABQ-W do not directly refer to fear of "physical activity/movement" but are applicable to fear regarding "work conditions" in general (for example item 7: "my pain increases because of my work"). Future research is necessary to target the specific maladaptive cognitions, among is which work-related fear, and related avoidance behavior of subjects with neck-shoulder complaints related to computer-work. As illustrated by the range of the average levels of fear-avoidance beliefs, there are subjects with higher levels of fear-avoidance beliefs. Clinical implications of these findings must be viewed as tentative but would suggest that in the occupational treatment of neck-shoulder pain subjects who report elevated levels of maladaptive cognitions and fear, cognitive-behavioural techniques could be of beneficial value.

The significantly lower levels of catastrophizing in the case group compared to the control group (mean 13.78) are interesting and surprising. In clinical low back pain literature, the mean scores on the catastrophizing subscale of the Coping Strategies Questionnaire (CSQ-CA) varied from 8.4 till 15.6 among different pain patient samples[36]. This indicates that the average level (mean score of 9.14) found in our case group is in the lower part of this range. This is probably due to the fact that the subjects were rather mildly disabled. Moreover, as neck-shoulder complaints due to computer work are not related to a traumatic experience, but develop gradually, the role of catastrophizing in fear-avoidance might be less likely to occur[6 10 32]. It is difficult to explain the elevated levels of catastrophic thoughts (mean score of 13.78) found in the control group. In answering the questions concerning the coping strategies that they usually apply when they experience pain, controls might have referred to more acute and general painful experiences, not particularly involving neck-shoulder pain. In acute pain, these levels of catastrophizing thoughts could be beneficial as it might prevent from further tissue damage.

There are some limitations in the present study that should be taken into consideration. First, the small sample size reduces the power of the current study. We tried to overcome this by applying SEM statistics that are suitable for small samples and non-normal distributed data. Second, the fear-avoidance questionnaires (TSK, FABQ) used in our study to assess fear-avoidance beliefs could be less appropriate for subjects with work-related neck-shoulder pain, because they were originally designed for

subjects with low back pain. Irrespective of the specific instructions they were given, subjects could have had trouble relating questions referring to "back pain" to their neck-shoulder pain[11]. However, these questionnaires have been used in studies focusing on pain syndromes other than low back pain[7 11 12], without experiencing that they are less suited. On the same note, selecting people who are still working despite their complaints may have under-represented the target population in the fear-avoidance model. Most studies investigating the fear-avoidance model recruited patient samples from pain units or rehabilitation centers, and these patients were often on sick-leave and help-seeking. Therefore, it is difficult to compare our data with data obtained from these studies. Population-bias ("healthy worker effect") might be another explanation related to this point. Due to the selection criteria, our sample consisted of older subjects who were still working despite their rather chronic neck-shoulder complaints (average duration of 66 months) and their relatively high age (mean age 49 years). Because of these limitations, we recommend to replicate the present study in subjects with higher levels of fear-avoidance beliefs and disability, both working and on sick leave.

In conclusion, in line with the fear-avoidance model the results of the present study addressed the importance of pain-related fear in subjects with neck-shoulder pain disability related to computerwork. For occupational health, this could mean that a treatment aimed at increasing a subject's performance (for example by means of ergonomic interventions) might not immediately result in reduced disability unless the underlying maladaptive cognitions and emotions are dealt with. Interestingly, the goodness of fit of the fear-avoidance model could be increased by adding a direct path between fear-avoidance and disability. Adding this extra path resulted in the lack of significance between performance and disabilities. Therefore, we hypothesized that subjects who are still working despite their complaints apply more "cognitive emotional focused avoidance" strategies in order to deal with their pain instead of behavioural focused avoidance strategies. Further research should be aimed at investigating these different avoidance strategies.

Acknowledgements

The present study was performed within the framework of the European Shared Cost project “Neuromuscular Assessment in the Elderly Worker” (NEW) (QLRT-2000-00139).

Reference list

1. de Kraker H, Bladder BM. Prevalence of RSI-complaints and the occurrence of risk factors in 15 European countries. Tijdschrift Gezondheidswetenschappen 2005; 83:8-15.

2. Kamwendo K, Linton SJ, Moritz U. Neck and shoulder disorders in medical secretaries. Part I. Pain prevalence and risk factors. Scand J Rehabil Med 1991; 23(3):127-33.

3. Jensen IB, Bergstrom G, Ljungquist T, Bodin L. A 3-year follow-up of a multidisciplinary rehabilitation programme for back and neck pain. Pain 2005; 115(3):273-83.

4. Tornqvist EW, Karlkvist L, Hagberg M et al. Working Conditions and musculoskeletal complaints in computer-users. In: The 2nd Proceeding symposium: Prevention of muscle disorders in computer users. Götenborg, Sweden: National Institute for Working Life/West, 2001.

5. van Dijk FJH, van Dormolen M, Kompier MAJ, Meijman TF. Herwaardering model belasting en belastbaarheid [Revalue the model of demands and capacity] . Tijds Soc Gezondhz 1990; 68:3-10.

6. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995; 62(3):363-72.

7. Sullivan MJ, Stanish W, Waite H, Sullivan M, Tripp DA. Catastrophizing, pain, and disability in patients with soft-tissue injuries. Pain 1998; 77(3):253-60.

8. Kori SH, Miller RP, Todd DD. Kinesiophobia: a new view of chronic pain behaviour. Pain Management 1990; Jan/Febr:35-43.

9. Vlaeyen JW, Crombez G. Fear of movement/(re)injury, avoidance and pain disability in chronic low back pain patients. Man Ther 1999; 4(4):187-95.

10. Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000; 85(3):317-32.

11. George SZ, Fritz JM, Erhard RE. A comparison of fear-avoidance beliefs in patients with lumbar spine pain and cervical spine pain. Spine 2001; 26(19):2139-45.

12. Fritz JM, George SZ, Delitto A. The role of fear-avoidance beliefs in acute low back pain: relationships with current and future disability and work status. Pain 2001; 94(1):7-15.

13. Swinkels-Meewisse IE, Roelofs J, Verbeek AL, Oostendorp RA, Vlaeyen JW. Fear-avoidance beliefs, disability, and participation in workers and non-workers with acute low back pain. Clin J Pain 2006; 22(1):45-54.

14. Sandsjö L, Larsman P, Vollenbroek-Hutten MM et al. Comparative assessment of study groups of elderly female computer users from four European countries: questionnaires used in the NEW study. Eur J Appl Physiol 2006; 96(2):122-6.

15. Kuorinka I, Jonsson B, Kilbom A et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987; 18(3):233-7.

16. Spinhoven P, Linssen ACG. Coping met Pijn Vragenlijst [Dutch version of the Coping Strategies Questionnaire]. Lisse, The Netherlands: Swets and Zeitlinger B.V., 1994.

17. Rosenstiel AK, Keefe FJ. The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. Pain 1983; 17(1):33-44.

18. Miller RP, Kori SH, Todd DD. The Tampa Scale. Unpublished Report 1991.

19. Vlaeyen JW, Crombez G. The modified Tampa Scale for authorized Dutch/Flemisch version. 1998.

20. Vendrig A, Duetz P, Vink I. Nederlands vertaling en bewerking van de Fear-Avoidance Beliefs Questionnaire (FABQ) [Dutch translation and modification of the Fear-Avoidance Beliefs Questionnaire]. Nederlands Tijdschrift Voor Pijn En Pijnbestrijding 1998; 18:11-4.

21. Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993; 52(2):157-68.

22. Linton SJ, Buer N, Vlaeyen J, Are fear-avoidance beliefs related to the inception of an episode of back pain? A prospective study. Psych Health 2000; 14:1051-9.

23. Hains F, Waalen J, Mior S. Psychometric properties of the neck disability index. J Manipulative Physiol Ther 1998; 21(2):75-80.

24. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. J Manipulative Physiol Ther 1991; 14(7):409-15.

25. Stratford PW, Riddle DL, Binkley JM, Spadony G, Westaway MD, Padfield B. Using the Neck Disability Index to make decisions concerning individual patients. Physiother Can 1999; 51:107-12.

26. Kline RB. Principle Practices of Structural Equation Modelling. New York, United States of America: The Guilford Press, 1998.

27. Tabachnik BG, Fidell LS. Using Multivariate Statistics. Boston, United States of America: Allyn and Bacon, 2001.

28. Bentler PM, Yuan K-H. Structural equation modeling with small samples; test statistics. Multivariate Behavioural Research 1999; 34:181-97.

29. Yuan K-H. Fit indices versus test statistics. Multivariate Behavioural Research 2001; 40:115-48.

30. Brown MW, Cudeck R. Alternative ways of assessing model fit. In: Bollen KA, Long JS, eds. Testing Structural Models. Newbury Park: Sage publications, 1993.

31. Hu LT, Bentler PM, Kano Y. Can test statistics in covariance structure analysis be trusted? Psychol Bull 1992; 112(2):351-62.

32. Crombez G, Vlaeyen JW, Heuts PH, Lysens R. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. Pain 1999; 80(1-2):329-39.

33. Brandstäter J, Rothermund K. The life-course dynamics of goal pursuit and goal adjustment: a two-process framework. Development Review 2002; 22:117-50.

34. McCracken LM. A Contextual Analysis of Attention to Chronic Pain: What the Patient Does With Their Pain Might Be More Important Than Their Awareness or Vigilance Alone. J Pain 2007; 8(3):230-6.

35. De Vlieger P, Crombez G, Eccleston C. Worrying about chronic pain. An examination of worry and problem solving in adults who identify as chronic pain sufferers. Pain 2006; 120(1-2):138-44.

36. Lawson K, Reesor KA, Keefe FJ, Turner JA. Dimensions of pain-related cognitive coping: cross-validation of the factor structure of the Coping Strategy Questionnaire. Pain 1990; 43(2):195-204.

CHAPTER 3

Coping profiles in female computer workers suffering from neck-shoulder pain

M.H.A. Huis in 't Veld [1]
M.M.R. Vollenbroek-Hutten [1]
C.G.M. Groothuis-Oudshoorn [1]
K.M.G. Schreurs [1,2]
H.J. Hermens [1,3]

[1] Roessingh Research and Development,
Enschede, The Netherlands
[2] Roessingh Rehabilitation Centre,
Enschede, The Netherlands
[3] Faculty of Electrical Engineering,
Mathematics and Computer Science,
University of Twente,
Enschede, The Netherlands

Submitted for Publication

3 | Coping profiles

Abstract

Work-related neck-shoulder pain due to computerwork is an increasing problem in the industrialized countries, particular in elderly female workers. As illustrated by differential treatment responses, subgroups of patients are believed to exist suggesting that there is probably not one treatment that fits all. It is known from literature that subjects differ on coping strategies and, related to this, show different behaviour to deal with and/or adjust to their pain. If subgroups of pain subjects can be discerned based on these coping strategies, treatments could be tailored to their specific needs which might further improve its effectiveness. The aim of the present study was to explore the assumption that clusters of subjects with work-related neck-shoulder pain could be differentiated based on the coping strategies they apply. It was subsequently examined whether these subgroups differed with respect to fear avoidance beliefs, disabilities and physical performance. A sample of 58 female workers with neck-shoulder pain related to computerwork was included. In addition to the Coping Strategies Questionnaire (CSQ), subjects completed the Fear-Avoidance Beliefs Questionnaire Work-subscale (FABQ-W) and Neck Disability Index (NDI), and performed a shoulder-elevation test (MVC). The coping strategies used were analyzed using principal component factor analysis of the CSQ items. Factor scores were subsequently subjected to k-means cluster analysis to identify subgroups which differed on pain coping profile. The findings suggested three factorially distinct subscales of the CSQ; "distraction", "suppression and ignorance", and "catastrophizing and worrying". Three clusters of coping profiles could be differentiated labeled "worried suppressors", "suppressors" and "minimized copers", which tended to differ on FABQ-W, NDI and MVC and seem to have theoretical meaning.

Introduction

Upper extremity musculoskeletal complaints represent a common occupational problem, particularly among office workers. The prevalence of work-related neck-shoulder pain in Europe is 22.8%[1]. The population of computer workers mostly at risk for neck-shoulder pain is the elderly population[2], especially females[3]. These complaints

are associated with individual's suffering and enormous costs. For the Netherlands, the total costs of upper extremity disorders are estimated at 2.1 billion euros per year[4]. Due to the expected increase in computer-related jobs and aging of the working population, the prevalence of neck-shoulder pain related to computer work and the financial burden on society is expected to increase as well[5 6].

The aetiology of work-related neck-shoulder pain is multifactorial with a somatic, psychological and individual component[7] and is complicated in terms of prevention and treatment[8]. As a consequence, many treatment modalities are used in daily practice to treat these subjects. Examples of common interventions are medications, physical therapy, and ergonomic adjustments[9]. Much of the existing treatment modalities focus on the somatic aspects of pain. Although all of these interventions can be effective in some subjects, in a considerable part of the subjects the pain persists even after treatment[10].

Despite commonalities in the somatic aspects of neck-shoulder pain, it is suggested that subjects not necessary share the same psychological characteristics. More specific, cognitive-behavioural literature suggests that subjects may differ on the way they belief and think about their pain[11 12 13]. In psychology, the beliefs and thoughts of subjects about their pain are called cognitions. In relation to pain experience this means that subjects employ different (un)conscious cognitive strategies and show differences in associated pain-related behaviour to modify their pain experience. Based on these differences, subgroups of pain subjects are discerned in literature[11].

Interestingly, within the avoidance-endurance model[14 15] a distinction is made between subjects who show avoidant behaviour related to catastrophic thoughts and fear of movement (corresponding to the fear-avoidance model[16]), and subjects who persist in activity and (physically) overload dependent on denial or suppressive thoughts.

Possible discrimination between subgroups of neck-shoulder pain subjects might add to the knowledge base on differences in treatment responses. Moreover, the effectiveness of treatment of neck-shoulder pain is expected to increase if subgroups of patients could be identified and treatment could be tailored to subgroup-specific pain-related mechanisms[9 17].

The objective of the present study was to investigate whether subgroups of subjects with work-related neck-shoulder pain could be differentiated based on the coping strategies they use in dealing with their pain. A statistical procedure, such as cluster

analysis, is a possible way to classify subjects who display similar patterns of response to the coping strategies assessment instrument into different groups. One way to validate the meaning of the classification is to demonstrate that subjects with distinct coping profiles respond different on diverse and theoretically valuable outcome measures. In line with the avoidance-endurance model[14], differences between the clusters in fear avoidance beliefs, disability and physical performance outcomes were examined. Since no instruments are available to assess the use of pain coping strategies at the workplace, an instrument generally accepted to assess coping strategies in clinical pain patients is used: the Coping Strategies Questionnaire (CSQ)[18].

Methods

Subjects

Subjects were recruited by telephone for participation and included based on the Nordic Questionnaire, which concerned questions about work and health[19]. Subjects, aged between 40 and 62 years, were included if they experienced complaints in the neck-shoulder region due to computerwork for more than 30 days during the last 12 months and worked for minimal 20 hours a week, performing predominantly computerwork. In order to exclude subjects with generalized pain syndromes (such as fibromyalgia and arthrosis), subjects were excluded when they experienced complaints for more than 30 days in more than three body parts. Of the 76 included subjects, 18 participants dropped out because of lack of time, family circumstances or being tired of all medical visits they already have had due to their pain. Finally, 58 subjects with neck-shoulder pain related to computerwork completed the study.

Procedures and measures

The study was approved by the Medical Ethics Committee of the Roessingh Rehabilitation Centre. All subjects gave their written informed consent before participating in this cross-sectional study. Besides some demographic variables and historical pain-related data (duration of pain, intensity of pain), information regarding coping strategies, fear about work, behavioural performance, and disability was obtained.

Coping Strategies Questionnaire (CSQ): The Dutch version of the Coping Strategies Questionnaire (CPV) was used to assess the extent to which subjects reported the use

of coping strategies when they felt pain and consists of 44 items[20]. The main difference between the original CSQ[18] and the Dutch adaptation was the number of items of the behavioural coping subscale (2 for the CPV, and 6 for the CSQ), and the use of a different answering format. Subjects marked 10 cm visual analogue scales with the end points defined in the same way as on the original 7-point Likert-type scale, as "never do" and "always do that". At the end of the questionnaire, subjects were asked to make two ratings of the overall effectiveness (pain control and ability to decrease pain).

Fear-Avoidance Beliefs Questionnaire - subscale work (FABQ-W): Fear-avoidance beliefs were assessed using the Dutch language version of the 7-item 7-point FABQ-work subscale that aims at identifying beliefs concerning the influence of work on pain[21]. Fear-avoidance beliefs about work are believed to be relevant in subjects with work-related neck-shoulder pain[22]. The FABQ has proven to be psychometrically sound[23 24].

Behavioural performance (MVC): The level of behavioural performance was assessed with a static maximal shoulder elevation test. Shoulder elevation is the most important function of the trapezius muscle. This test was chosen because it is expected that the performance of this muscle is affected by neck-shoulder complaints, and considered to provoke fear in subjects with work-related neck-shoulder pain. The subject was asked to perform three maximal voluntary contractions (MVC) of the trapezius muscle. Only the first MVC test was used as the test result in the present study because avoidance, a central concept in by the fear-avoidance model, is expected to diminish with repeated exposures, thus resulting in better performance. To ensure a straight, upright sitting posture and to avoid lateral flexion, the subject was seated in a chair with a straight back. A maximum of standardization was pursued by using a chair that was adjustable in height. The height was adjusted so that the subject's feet had no contact with the floor, in order to ensure that the applied force was derived from the trapezius muscle and not from the legs. Subjects were instructed to look straight ahead. Two Bofor dynamometers were fixed to the wall and placed on the lateral edge of each acromion. The subject was instructed to build up the force over five seconds, then to keep up the pressure for about two seconds, and then to lower the force to zero. Direct continuous feedback was given about the level of force on a computer screen.

Neck Disability Index (NDI): A Dutch translation of the NDI was used[25]. The NDI is a 10-item 6-point scale measuring difficulty in performing daily activities. Its reliability and validity was shown to be satisfactory[25 26 27].

Analysis

The CSQ scales (i.e. coping strategies) have varied in terms of composite variables across samples. For instance, the 8-factor structure of the CSQ[20] that was originally developed to assess coping strategies in low back pain patients, yielded factors that could not be replicated and/or appeared to be uninterpretable in a whiplash sample[28]. Instead of the 8-factor solution, the 5-factor solution was the most interpretable[28]. The variability in findings in factor-solution is probably caused by differences in pain problems, pain chronicity, age and/or education across samples[28]. To examine specific coping strategies in new samples, component analysis of the individual CSQ items is recommended[29]. In line with this recommendation, the first part of the data analysis consisted of the identification of the scales (i.e. coping strategies) of the Dutch version of the CSQ by means of an item-based principal component analysis (PCA). Intercorrelations among the 44 items were computed and then the factors were extracted, using principal component analysis. Factors with eigenvalues greater than one are typically retained in the factor structure whereas factors with eigenvalues less than one are not. Because this approach can lead to retention of more or fewer factors than is necessary or desirable, examination of a scree plot[30] is a secondary method for determining the optimal number of factors[31]. Both indices were used in making determinations about the factor structure. The extracted factors were rotated to obtain a simple structure using the Varimax procedure. An item was included in a factor if it (1) correlated with the factor at a level of 0.32 or larger, and (2) it had a loading lower than 0.32 on any other factor[32]. To determine the reliability of each of the factors identified in our sample, Cronbach's alphas were computed. A Cronbach's alpha between 0.70 and 0.95 was considered to be sufficient.

In the second part of the data analysis, the assumption was tested that clusters of subjects could be differentiated by a combination of the identified coping strategies, i.e. the factors of the Dutch version of the CSQ. Therefore, K-means cluster analysis was conducted to identify the clusters. K-means cluster analysis is a clustering tech-

nique that is based on the maximization of the difference between within-cluster and between-cluster variance. The number of clusters was set at 3 a priori based on the coping profiles discerned in the avoidance-endurance model, namely fear-avoidance coping, endurance coping and adaptive coping[33]. Kruskall-Wallis tests were conducted to investigate differences between the three clusters with respect to demographic and occupational variables, pain intensity, disabilities (NDI), performance (MVC) and fear-avoidance beliefs about work (FABQ-W). Bonferroni corrections of the p levels were applied in case of multiple comparisons. The chosen level of significance was $p<0.05$ in all analyses. All statistical analyses were conducted using SPSS (SPSS Inc. Headquarters, Chicago, IL, USA).

Results

The sample consisted of 58 cases. Demographic and occupational variables are presented in Table 3.I. The mean duration of the pain complaints experienced by participants was 66 months (range 2-204, SD=61.4). The mean pain intensity score in the sample was 2.7 (range 0-8, SD=2.4). Of the participants 12% was living alone, 4.9% was living single with children, 45.6% was living with another adult, and 37.9% was living with another adult and children.

Table 3.1 Demographic variables of the study sample (n=58)

	Sample (n=58)
Age (yrs)	49.3 (5.0)
Height (cm)	168.3 (6.2)
Weight (kg)	73.4 (14.7)
Working hours (h/wk)	29.3 (8.2)
Work history (months)	112.9 (15.2)

The PCA resulted in nine factors with eigenvalues greater than 1. However, analysis of the scree plot revealed a clear 3-factor structure. The 3-factor solution also proved to be more interpretable and internally consistent compared to the other solutions, including the 5 and 8 factorial solution.

The loadings of individual items on the principal components are presented in Table 3.2. With a cut-off point of 0.32 for inclusion of an item, 13 of the 44 items did not met the before mentioned criteria. All factor loadings were onto the principal component

at a level of 0.35 or greater. The principal component analysis, with a three factor structure as shown, accounted for 44.0% of the variance in questionnaire responses.

Table 3.2 The Varimax 3-factor solution of the 44 items of the Dutch version of the CSQ (n=58). Loadings under 0.32 were replaced by --.

Factor	**Component measures: When I feel pain…**	**Factor loadings**		
		1	2	3
1	*Distraction*			
	I think of people I enjoy doing things with	.82	--	--
	I think of things I enjoy doing	.78	--	--
	I try to be around other people	.75	--	--
	I do something I enjoy, such as watching TV or listening to music	.71	--	--
	I try to think of something pleasant	.70	--	--
	I do something active, like household chores or projects	.68	--	--
	I don't think of it as pain but rather a dull or warm feeling	.62	--	--
	I read	.62	--	--
	I leave the house and do something, such as going to the movies or shopping	.57	--	--
	I tell myself I can overcome pain	.56	--	--
	I imagine that the pain is outside of my body	.38	--	--
	I have faith in doctors that someday there will be a cure for my pain	.36	--	--
	I rely on my faith in God	.36	--	--
	I try not to think of it as my body, but rather as something separate from me	.35	--	--
2	*Suppression and ignorance*			
	I just go on as if nothing happened	--	.85	--
	Although it hurts, I just keep on going	--	.84	--
	I ignore it	--	.75	--
	I pretend it's not here	--	.75	--
	I tell myself I can't let the pain stand in the way of what I have to do	--	.70	--
	I don't pay any attention to the pain	--	.64	--
	I tell myself to be brave and carry on despite the pain	--	.63	--
	I don't think about the pain	--	.59	--
	No matter how bed it gets, I know I can handle it	--	.51	--
3	*Catastrophizing and Worrying*			
	It's awful and I feel that it overwhelms me	--	--	.74
	I feel I can't stand it anymore	--	--	.73
	I feel like I can't go on	--	--	.70
	I worry all the time about whether it will end	--	--	.64
	It is terrible and I feel it's never going to get any better	--	--	.55
	I feel my life isn't worth living	--	--	.46
	I try to think years ahead, what everything will be like after I've gotten rid of the pain	--	--	.41
	I pray to God it won't last long	--	--	.36

The first factor accounted for 17.8% of the total variance in scores on the CSQ items. As shown by the items described in Table 3.2, individuals with high scores on the first factor use a wide variety of distracting activities that serve to take their mind away from the pain. These activities include cognitive escape ("when I have pain I think of people I enjoy doing things with") and/or behavioural escape ("when I have pain I leave the house and do something"). This factor was labeled "distraction".
The second factor accounted for 15.3% of the variance. Individuals with high scores on this factor try to suppress feelings of pain by self-statements ("when I feel pain I tell myself to be brave and carry on despite the pain") and ignorance in order to continue their activities despite the pain ("although it hurts, I just keep on going"). The nomenclature of this second factor is "suppression and ignoring" of pain sensations.
The third factor accounted for 10.9% of the variance. Individuals with high scores on this factor report worrying thoughts ("when I have pain I worry all the time about whether it will end"), and signs of catastrophic thoughts ("when I have pain it's terrible and I feel it's never going to get any better"). The third factor is named "worrying and catastrophizing".

The internal-consistency of the factors of the CPV in the current sample was investigated. As illustrated in Table 3.3 the subscales were sufficiently reliable (Cronbach's α=0.74-0.87).

Table 3.3 Alpha coefficients and mean ratings for the 3 principal components of the Dutch version of the CSQ identified in subjects with neck-shoulder pain related to computerwork (n=58)

Principal components	Number of items	Alpha (α) coefficient	Mean rating (SD)
Distraction	14	.87	3.8 (1.9)
Suppression and ignoring sensations	9	.84	5.8 (2.0)
Catastrophizing and worrying	8	.74	1.5 (1.3)

As illustrated by the mean scores in Table 3.3, subjects used coping strategies of "suppression and ignorance of sensations" and "distraction" most often in coping with their neck-shoulder pain related to computerwork.

For each cluster the mean scores and standard deviations on the empirically derived subscales of the CSQ are presented in Figure 3.1 as well as the significant differences ($p<0.05$, marked by an asterisk) between the clusters for each subscale. The 3-cluster solution produced groups of reasonable size. Distraction coping was equally used by all participants and is not discriminating among the clusters. Subjects in cluster 1 (n=20, 35% of the total sample) are characterized by significantly higher levels of "catastrophizing and worrying" ($p=0.00$) compared to the other two clusters and high levels of "suppression and ignorance". Therefore, the coping profile in cluster 1 is labeled "worried suppression". Subjects in cluster 2, labeled "suppressors" (n=25, 43% of the total sample) are characterized by "suppression and ignorance" coping. In contrast to cluster 1, subjects in cluster 2 do not use "catastrophizing and worrying" strategies in dealing with their pain. In cluster 3 (n=13, 22% of the total sample), subjects reported significantly lower levels of "suppression and ignorance" and moderate levels of "catastrophizing and worrying" and "distraction" compared to the other two clusters. Therefore, the nomenclature of this coping profile is "minimized coping".

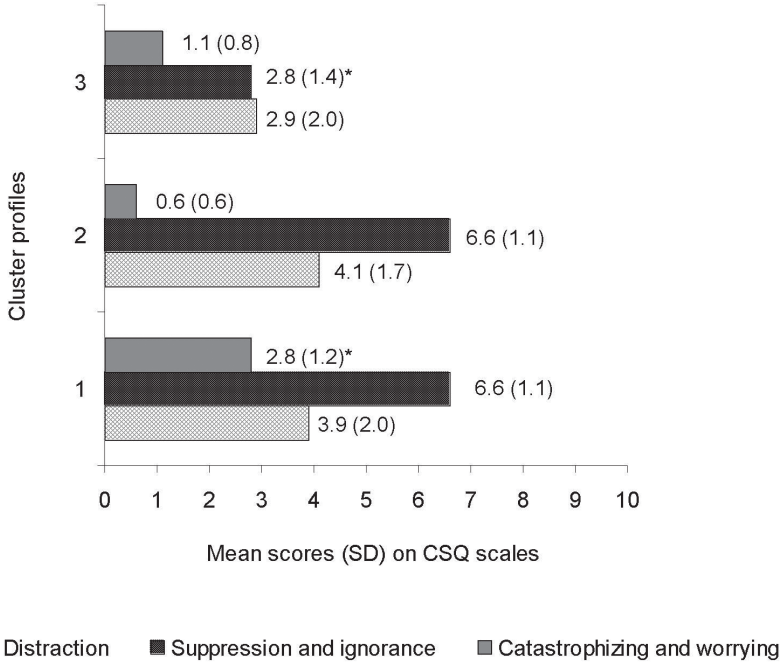

*Figure 3.1 Results of the K-means clusteranalysis (n=58) p<0.05**

As shown in Table 3.4, the clusters did not differ in age, pain history and working hours a week. As illustrated by the high standard deviations, the inter-individual variability was large demanding large differences between groups in order to find significant differences. Nevertheless, subjects in cluster 1 tended to report the highest level of pain intensity compared to the other clusters. Interestingly, subjects in cluster 2 tended to work the most hours per week.

Table 3.4 Mean scores of the subgroups on age, pain intensity, pain history, working hours, disabilities (NDI), performance (MVC) and fear-avoidance beliefs about work (FABQ-W) (n=58)

	Cluster 1 (n=20) Worried Suppression	**Cluster 2 (n=25) Suppression**	**Cluster 3 (n=13) Minimized Coping**
Age	48.6 (4.7)	50.2 (5.3)	48.9 (5.3)
Pain intensity	3.4 (2.8)	2.0 (2.0)	2.7 (1.9)
Pain history (months)	65.6 (61.6)	76.2 (66.6)	42.4 (45.3)
Work (hrs/wk)	28.3 (7.7)	30.5 (8.2)	28.4 (9.4)
NDI	11.0 (6.3)	8.2 (4.1)	9.5 (6.4)
MVC	153.8 (72.1)	177.0 (94.0)	181.4 (88.0)
FABQ-W	16.1 (8.0)	13.5 (7.4)	14.8 (12.0)

Table 3.4 shows on average, lower levels of disability (NDI) for subjects in cluster 2 and higher levels of behavioural performance (MVC) scores for subjects in cluster 2 and cluster 3, whereas higher levels of fear-avoidance beliefs (FABQ-W) were found for subjects in cluster 1. However, none of these absolute differences appeared to be significant.

Discussion

The aim of the present study was to explore the assumption that clusters of subjects with work-related neck-shoulder pain could be differentiated based on the coping strategies they apply. If so, it was subsequently examined whether these subgroups differed with respect to fear avoidance beliefs, disabilities and physical performance. Coping strategies were measured by means of the Dutch version of the Coping Strategies Questionnaire (CSQ)[20]. In the current sample, the CSQ was found to contain three coping strategies which were labeled “distraction”, “suppression and ignorance” and “catastrophizing and worrying”. Based on these coping strategies, three clusters of

coping profiles could be discerned within the current sample of female workers. Each of the three profiles was characterized by a specific combination of the 3 CSQ coping strategies identified.

The coping strategies used by subjects with neck-shoulder pain due to computerwork show resemblances with those identified in a clinical whiplash sample studied by Swartzman *et al*. (1994)[28]. In line with their analysis, our coping strategy "distraction" suggests that cognitive distraction (i.e diverting attention) and behavioural distraction (i.e increasing activity) appear to comprise one coping strategy rather than 2 coping strategies. Moreover, the coping strategy "catastrophizing and worrying" like it was identified in our study contained all 6 items from the corresponding "catastrophizing" subscale and our coping strategy "suppression and ignorance" contained 4 of their 8-item "ignoring sensations" scale[28]. These three coping strategies accounted for 44% of the variance in our sample, which is rather comparable to 48% found by Swartzman *et al*. (1994)[28]. However, further research is needed in larger sample sizes as well as to investigate differences and/or similarities in patterns of coping between clinical and non-clinical samples of subjects with non-specific neck-shoulder pain.

As mentioned before, three clusters of coping profiles are discerned in the current sample. Theoretical relationships among the a priori coping profiles and at least two of the identified clusters can be drawn.

One of the clusters (cluster 1 worried suppression, 35% of the total sample) was made up of subjects who used catastrophic and worrying thoughts about their pain along with suppression coping. In line with the fear-avoidance model, they tended to show lowered levels of behavioural performance and reported higher levels of fear-avoidance beliefs about work, pain intensity and disability. It could be hypothesized that subjects in this cluster catastrophize about what further adversity their pain might lead to but actively avoid these aversive consequences (e.g. work loss, conflicts at work) of their pain[22]. They use "suppression and ignorance" coping to do so. Despite their attempts to "solve" their "feared" pain problem their complaints persist. These repetitive failed attempts to decrease their problem (of pain) could lead to frustration, a negative focus on self or even negative mood[34 35]. In the avoidance-endurance model, a subgroup of suppressive copers with a negative mood has been identified

previously[14 36]. The hypothesized negative mood can not be verified in cluster 1 of our sample as no mood scales have been included but it is worth mentioning that the original CSQ catastrophizing subscale[20], similar to the one emerged in the present study, is better conceptualized as an index of psychological distress and found to be highly related to measures of negative mood[37 38].

The largest subgroup of subjects with neck-shoulder pain (cluster 2 suppression, 43% of the total sample) identified in this study consisted of individuals that reported high levels of "suppression and ignorance" coping. Subjects in this subgroup reported using "catastrophizing and worrying" significantly less often compared to subjects in the aforementioned subgroup (cluster 1). Instead, they predominantly use encouraging self-statements in order to deal with their pain and try to ignore the pain by denying pain-related sensations. In low painful conditions, suppression and ignorance might be an adaptive strategy in order to cope with the pain as it allows continuing "normal" (physical) functioning. However, subjects who extremely suppress and ignore their pain even in high painful conditions might risk (task) persistence and/or (physical) over-exertion. Indeed, subjects in cluster 2 tended to report the longest working hours per week compared to the other clusters, and higher performance levels compared to cluster 1. It should be mentioned that none of these differences was found to be significant; perhaps as a function of the small sizes of the clusters and the high standard deviations. The suppression coping profile (cluster 2) is hypothesized to correspond with the "minimizing thought" profile as postulated in the avoidance-endurance model[14].

Subjects in cluster 3 (minimizing coping, 22% of the total sample) reported low to moderate scores on each of the coping strategies. Therefore, this subgroup was speculated to correspond with the adaptive copers as postulated in both the fear-avoidance[39] as well as the avoidance-endurance model[14]. Contrary to this speculation, they did not report the lowest level of disability, fear-avoidance beliefs and pain intensity compared to the other clusters. Interestingly, subjects in this cluster tended to report the shortest pain history compared to the other subjects. In combination with their mild levels of disability, their strategies for coping with pain might not be very outspoken yet. However, their mean pain duration was 42 months, which is still rather chronic. This might indicate the existence of a subgroup of subjects with neck-shoulder pain due to computerwork without outspoken coping behaviour. Subjects in cluster 3 might

therefore be comparable to subjects classified as “average” by the Multidimensional Pain Inventory[40].

An interesting finding of the present study is the fact that the use of “distraction” coping did not differ significantly between the three clusters. However, in literature it is known that distractors, that are experienced by subjects to be interesting and pleasant, are associated with higher levels of perceived control and ability to decrease pain[41 42]. In other words, the (mal-)adaptiveness of distraction coping is influenced by motivational and emotional states of subjects. Although similar levels of distraction coping were found among the clusters, the (mal-)adaptiveness of distraction coping might be different. Based on the hypothesized negative mood of subjects belonging to the “worried suppression”, one might expect distraction coping to be less adaptive compared to the other clusters. In future research, motivational and emotional scales are recommended to be included in classifying subjects based on their coping profiles.

Some limitations of this study need to be mentioned. First, the small sample size could have affected the power. Second, formal principal components analysis and cluster analysis are exploratory statistical tools to generate a classification solution. Based on theoretical assumptions one has to a-priori “define” the number of clusters, so we did not “discover” three clusters of coping profiles by cluster analytic tools[43]. Nevertheless, the subgroups classified do have clinical and theoretical face-validity. Third, although the CSQ-scales appear to be useful, they need to be evaluated in comparison to other pain-relevant instruments. Related to this, despite the fact that the CSQ is generally accepted and assesses the use of coping with pain in daily life (e.g. “I tell myself I can’t let the pain stand in the way of what I have to do” , “I feel like I can’t go on”), it does not explicate the manner in which individuals cope with pain at work. Further examination of the coping strategies identified and their implications for coping with pain at work is needed. Fourth, due to the cross-sectional study design no conclusions can be drawn about the (mal-)adaptiveness of the coping profiles identified. Therefore, prospective studies need to be conducted to further explore the effectiveness of the three coping profiles on pain experience and disability. Fifth, the present study included a non-clinical, i.e. working sample, sample with neck-shoulder

pain whereas the majority of literature on cognitive-behavioural models is focused on subjects with clinical low-back pain. Nevertheless, indications exists that (part of) these models are applicable to other types of musculoskeletal pain problems[44 45], including work-related[46] and neck-shoulder pain[22 47]. Extending existing literature on pain coping and associated subgroups to a working population could help to design new treatment modalities for both management of pain and prevention of getting sick-listed due to the pain.

In conclusion, the present study suggests the existence of subgroups of coping profiles in a population of subjects with neck-shoulder pain related computerwork, who are still functioning at the workplace. These subgroups also tended to differ on cognitive (fear-avoidance beliefs) as well as behavioural (working hours, performance) factors. Knowledge about the existence of subgroups sharing particular thoughts and beliefs about their pain, coping strategies and pain-related behaviour might help to tailor treatment to their specific needs and/or pain-related working mechanisms. Thereby, the effectiveness of treatment in neck-shoulder pain could be increased. Although statistical tools are useful instruments to obtain insight in subgroup-unique characteristics, the clinical utility of statistical instruments for therapists to objectively classify subjects in daily practice is very limited. In order to be of clinical utility, the development of easy-to-use screening measure(s) most associated with subgroup characteristics should be among the future research priorities.

Acknowledgements

This work has been supported by the European Shared Cost Project "Neuromuscular Assessment of Elderly Workers" (NEW) (QLRT-2000-00139). The authors would like to thank Professor M. Hasenbring for the opportunity to reflect and discuss their findings.

Reference List

1. Paoli P, Merllié D. Third European survey on working conditions [Web Page]. 2002; Available at http://www.eurofound.eu.int/pubdocs/2001/21/en/1/ef0121en.pdf.

2. Cagnie B, Danneels L, Van Tiggelen D, De Loose V, Cambier D. Individual and work related risk factors for neck pain among office workers: a cross sectional study. Eur Spine J 2007; 16(5):679-86.

3. Korhonen T, Ketola R, Toivonen R, Luukkonen R, Hakkanen M, Viikari-Juntura E. Work related and individual predictors for incident neck pain among office employees working with video display units. Occup Environ Med 2003; 60(7):475-82.

4. Blatter, BM, Houtman, I, van den Bossche, S, Kraan, K, van den Heuvel, S. Gezondheidsschade en kosten als gevolg van RSI en psychosociale arbeidsbelasting in Nederland (Report on demand of the Dutch Ministry of Social Affairs and Employment) [Web Page]. 2005; Available at www.//home.szw.nl/actueel/dsp_publicatiesindex.cfm.

5. de Hecker DE, Occupational Employment projections to 2010 [Web Page]. 2001; Available at http://www.bls.gov/opub/mlr/2001/11/art4full.pdf.

6. United States Department of Labor. BLS releases new 2004-2014 employment projections [Web Page]. 2005; Available at http://www.bls.gov/news.release/archives/ecopro_12072005.pdf.

7. Andersen JH, Kaergaard A, Frost P et al. Physical, psychosocial, and individual risk factors for neck/shoulder pain with pressure tenderness in the muscles among workers performing monotonous, repetitive work. Spine 2002; 27(6):660-7.

8. Devereux JJ, Vlachonikolis IG, Buckle PW. Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. Occup Environ Med 2002; 59(4):269-77.

9. van Tulder M, Malmivaara A, Koes B. Repetitive strain injury. Lancet 2007; 369(9575):1815-22.

10. Enthoven P, Skargren E, Oberg B. Clinical course in patients seeking primary care for back or neck pain: a prospective 5-year follow-up of outcome and health care consumption with subgroup analysis. Spine 2004; 29(21):2458-65.

11. Jensen MP, Turner JA, Romano JM, Karoly P. Coping with chronic pain: a critical review of the literature. Pain 1991; 47(3):249-83.

12. Turk DC, Meichenbaum D. A cognitive-behavioural approach to pain management. In P.D. Wall & Melzack R. (Eds) Textbook of Pain. Edinburgh: Churchill Livingstone, 1994.

13. Lousberg R, Groenman N, Schmidt A. Profile characteristics of the MPI-DLV clusters of pain patients. J Clin Psychol 1996; 52(2):161-7.

14. Hasenbring M, Hallner D, Klasen B. Psychologische mechanismen im prozess der schermzchronifizierung: unter- oder überbewertet? [Psychological mechanisms in the transition from acute to chronic pain: over- or underrated?]. Schmerz 2001; 15(6):442-7.

15. Hasenbring M, Marienfeld G, Kuhlendahl D, Soyka D. Risk factors of chronicity in lumbar disc patients. A prospective investigation of biologic, psychologic, and social predictors of therapy outcome. Spine 1994; 19(24):2759-65.

16. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995; 62(3):363-72.

17. Fritz JM, Brennan GP. Preliminary examination of a proposed treatment-based classification system for patients receiving physical therapy interventions for neck pain. Phys Ther 2007; 87(5):513-24.

18. Rosenstiel AK, Keefe FJ. The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment. Pain 1983; 17(1):33-44.

19. Kuorinka I, Jonsson B, Kilbom A et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987; 18(3):233-7.

20. Spinhoven P, Linssen ACG. Coping met Pijn Vragenlijst [Dutch version of the Coping Strategies Questionnaire]. Lisse, The Netherlands: Swets and Zeitlinger B.V., 1994.

21. Vendrig A, Duetz P, Vink I. Nederlands vertaling en bewerking van de Fear-Avoidance Beliefs Questionnaire (FABQ) [Dutch translation and modification of the Fear-Avoidance Beliefs Questionnaire]. Nederlands Tijdschrift Voor Pijn En Pijnbestrijding 1998; 18:11-4.

22. Huis in 't Veld RM, Vollenbroek-Hutten MM, Groothuis-Oudshoorn KC, Hermens HJ. The role of the fear-avoidance model in female workers with neck-shoulder pain related to computer work. Clin J Pain 2007; 23(1):28-34.

23. Swinkels-Meewisse EJ, Swinkels RA, Verbeek AL, Vlaeyen JW, Oostendorp RA. Psychometric properties of the Tampa Scale for kinesiophobia and the fear-avoidance beliefs questionnaire in acute low back pain. Man Ther 2003; 8(1):29-36.

24. Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993; 52(2):157-68.

25. Vos CJ, Verhagen AP, Koes BW. Reliability and responsiveness of the Dutch version of the Neck Disability Index in patients with acute neck pain in general practice. Eur Spine J 2006; 15(11):1729-36.

26. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. J Manipulative Physiol Ther 1991; 14(7):409-15.

27. Hains F, Waalen J, Mior S. Psychometric properties of the neck disability index. J Manipulative Physiol Ther 1998; 21(2):75-80.

28. Swartzman LC, Gwadry FG, Shapiro AP, Teasell RW. The factor structure of the Coping Strategies Questionnaire. Pain 1994; 57(3):311-6.

29. Lawson K, Reesor KA, Keefe FJ, Turner JA. Dimensions of pain-related cognitive coping: cross-validation of the factor structure of the Coping Strategy Questionnaire. Pain 1990; 43(2):195-204.

30. Cattell RB. The scientific use of factor analysis in behavioral and life sciences. New York, United States of America: Plenum Press, 1978.

31. Tabachnik BG , Fidell LS. Using Multivariate Statistics. 3rd ed. Boston, United States of America: Allyn and Bacon, 2001.

32. Tabachnik BG , Fidell LS. Using Multivariate Statistics. 5th ed. Boston, United States of America: Allyn and Bacon, 2007.

33. Hasenbring MI, Plaas H, Fischbein B, Willburger R. The relationship between activity and pain in patients 6 months after lumbar disc surgery: Do pain-related coping modes act as moderator variables? Eur J Pain 2006; 10(8):701-9.

34. Pincus T, Morley S. Cognitive-processing bias in chronic pain: a review and integration. Psychol Bull 2001; 127(5):599-617.

35. De Vlieger P, Crombez G, Eccleston C. Worrying about chronic pain. An examination of worry and problem solving in adults who identify as chronic pain sufferers. Pain 2006; 120(1-2):138-44.

36. Grebner M, Breme K, Rothoerl R, Woertgen C, Hartmann A, Thome C. Coping und genesungsverlauf nach lumbaler bandscheibenoperation [Coping and convalescence course after lumbar disk operations]. Schmerz 1999; 13(1):19-30.

37. Hirsh AT, George SZ, Riley JL 3rd, Robinson ME. An evaluation of the measurement of pain catastrophizing by the coping strategies questionnaire. Eur J Pain 2007; 11(1):75-81.

38. Sullivan MJ, D'Eon JL. Relation between catastrophizing and depression in chronic pain patients. J Abnorm Psychol 1990; 99(3):260-3.

39. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995; 62(3):363-72.

40. Lousberg R, Groenman N, Schmidt A. Profile characteristics of the MPI-DLV clusters of pain patients. J Clin Psychol 1996; 52(2):161-7.

41. Eccleston C, Crombez G, Aldrich S, Stannard C. Worry and chronic pain patients: a description and analysis of individual differences. Eur J Pain 2001; 5(3):309-18.

42. Buck R, Morley S. A daily process design study of attentional pain control strategies in the self-management of cancer pain. Eur J Pain 2006; 10(5):385-98.

43. Buckelew SP, Shutty MS Jr, Hewett J, Landon T, Morrow K, Frank RG. Health locus of control, gender differences and adjustment to persistent pain. Pain 1990; 42(3):287-94.

44. Linton SJ, van Tulder MW. Preventive interventions for back and neck pain problems: what is the evidence? Spine 2001; 26(7):778-87.

45. Muller W, Schneider EM, Stratz T. The classification of fibromyalgia syndrome. Rheumatol Int 2007; 27(11):1005-10.

46. Swinkels-Meewisse IE, Roelofs J, Verbeek AL, Oostendorp RA, Vlaeyen JW. Fear-avoidance beliefs, disability, and participation in workers and non-workers with acute low back pain. Clin J Pain 2006; 22(1):45-54.

47. George SZ, Fritz JM, Erhard RE. A comparison of fear-avoidance beliefs in patients with lumbar spine pain and cervical spine pain. Spine 2001; 26(19):2139-45.

CHAPTER 4

The receptiveness toward remotely supervised myofeedback treatment

M.H.A. Huis in 't Veld [1]
G.E. Voerman [1]
H.J. Hermens [1,2]
M.M.R. Vollenbroek-Hutten [1]

[1] Roessingh Research and Development, Enschede, The Netherlands
[2] Faculty of Electrical Engineering, Mathematics and Computer Science, University of Twente, Enschede, The Netherlands

Telemedicine and eHealth
13(3): 293-302, 2007

4 | Receptiveness remotely supervised myofeedback

Abstract

Remotely supervised myofeedback treatment (RSMT) is considered to be a potentially valuable alternative to the conventional myofeedback treatment, as it might increase the efficiency of care. This study was aimed at examining the receptiveness of potential end-users (patients and professionals) with respect to RSMT. By doing so, protocols of RSMT can be developed which fit to the needs of end-users and enhance treatment adherence. For both end-user groups, questionnaires were developed focusing on two components of the Attitude - social Support – self-Efficacy (ASE) model. Fifteen patients with neck-shoulder complaints previously treated with conventional myofeedback and 21 professionals participated in the present study. Results showed positive attitudes toward RSMT in 53% of the patients, and 67% of them were willing to participate in RSMT. Of the 21 professionals included in the study, 43% reported a positive attitude. In addition, 40% of the patients and 100% of the professionals believed their self-efficacy level to be sufficient for RSMT. In addition to remote consultations, 40% percent of the patients suggested that the optimal frequency of structural in vivo contact with their therapist would be once per two weeks, which is less frequent compared to the weekly in vivo contacts in the conventional myofeedback treatment. Professionals emphasized the importance of non-verbal communication and physical interaction (as in in vivo contact) in remote treatment concepts.

Introduction

As neck-shoulder complaints are related to high costs for healthcare and society, there is an urgent need for well-developed and efficient treatment programs for these complaints. A relatively new treatment is the myofeedback treatment based on the Cinderella-hypothesis of Hägg[1]. This hypothesis states that insufficient relaxation of the neck-shoulder muscles contributes to the chronification of neck-shoulder pain. As the muscle contraction levels are quite low, subjects are not very aware of a lack of relaxation. The ambulatory training based on this principle consists of continuous measurement of surface ElectroMyoGraphy (sEMG) of the trapezius muscle, and providing feedback when insufficient muscle relaxation occurs in a certain time frame. A

garment is equipped with dry sEMG electrodes and connected to a storage and processing unit (Figure 4.1). Within this unit, raw sEMG data are processed into percentage of relaxation time and the unit provides auditory and vibratory feedback when relaxation time is not sufficient[2].

Effect studies in work-related musculoskeletal disorders (WMSD) and whiplash (WAD) patients showed clinically relevant decreases in pain intensity and disability in the neck and shoulder regions after four weeks of myofeedback treatment[2 3].

Figure 4.1 The myofeedback harness with dry sEMG electrodes

In the protocol for conventional myofeedback treatment, subjects wear the system for four weeks during daily activities and they continuously receive feedback from the system when their muscle relaxation is insufficient. This system permits patients to receive intense treatment in their own environment. These are considered major advantages compared to the intramural therapy. Each week when the subject is visited by the therapist, the system is connected with the computer to download the sEMG data. These data are then discussed, guided by an activity diary which the subject fills out manually every day the system is worn. This is experienced as a disadvantage of the conventional myofeedback treatment. The visits are relatively short – about thirty minutes. However, the travel time from the patient's home to the clinic is time consuming. This time consumption is costly and limits the geographical area in which patients can be treated. Moreover, the professionals have no time to prepare the data interpretation of the sEMG in combination with the activity diary which could affect the effectiveness of treatment. Therefore, the myofeedback system was recently designed to automatically download the sEMG data on a secured server, which is remotely accessible for the myofeedback therapist (Figure 4.2). This creates the possibility to replace the weekly visits between professionals and patients by a remote consult, called remotely supervised myofeedback training (RSMT). It is likely that this will increase the efficiency of care.

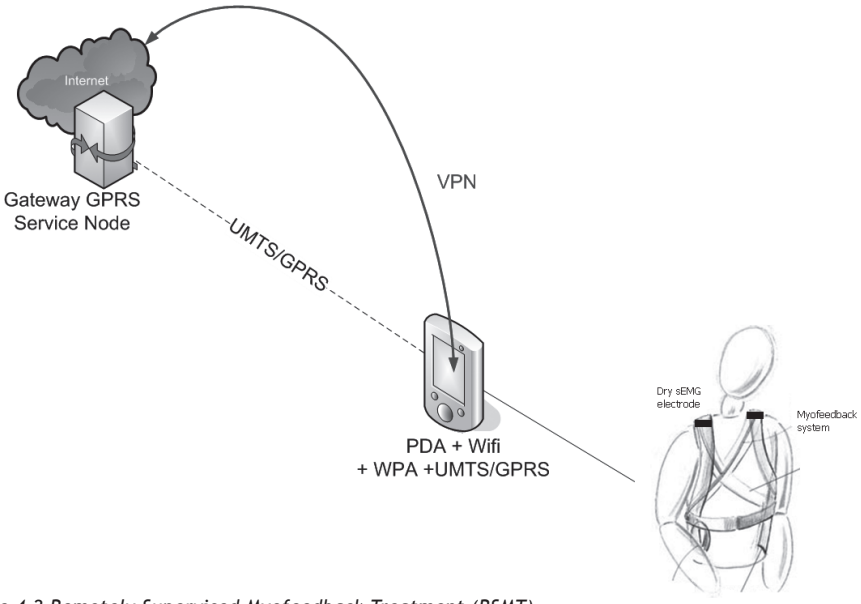

Figure 4.2 Remotely Supervised Myofeedback Treatment (RSMT)

It is hypothesized that remote treatment is technically possible, but the main question is whether or not patients and professionals are receptive to it?

In literature, different models exist that postulate determinants of an individual's receptiveness toward new treatments. One of these models is the social-psychological oriented Attitude - Social support - self Efficacy model (ASE)[4] that originated from Fishbein and Ajzen's theory of reasoned action[5] and Bandura's social cognitive theory[6]. According to this theory, the best predictor of human behaviour is the intention to do so. Likewise, in the ASE model "intention to treatment receptiveness" is considered to be a mediator of "actual treatment receptiveness". The intention for future treatment adherence is seen as being directly affected by three main determinants: attitude, social support and self-efficacy. Subjects with a positive attitude toward the new treatment, high levels of self-efficacy of succeeding in the new treatment, and high social support are likely to adhere to the new treatment.

Insight in the determinants of the ASE model would provide valuable information on how people can be stimulated to perform desired behaviour, for instance, with regard to RSMT. As stated by Berg (1999)[7] the involvement of end-users in the early stages of developing treatment is recommended, as their interesting and useful views are believed to be important for successful implementation.

Within this framework, the objective of the current study was to explore the attitude and self-efficacy of both patients as well as professionals with regard to the remote myofeedback treatment. Social support is kept outside the scope of the present study, as it was hypothesized that it would be hard for subjects to estimate the perceived support from significant others on a treatment that has not fully been developed yet. Moreover, according to the Diffusion of Innovations Theory[8], positive social support will be experienced when the innovative treatment is perceived by the patient to be positive and effective.

Methods

Patient population

Twenty-two subjects with musculoskeletal disorders in the neck-shoulder region of varying origin (WMSD, n=18 and WAD, n=4) were approached for participation in this study. Subjects were recruited from an existing database of patients who recently participated in the conventional myofeedback treatment (between 6 and 12 months posttreatment). It was assumed that selecting subjects who actually underwent conventional myofeedback treatment had quite good understandings of the procedures when providing the myofeedback remotely.

Subjects were eligible for participation if they were females between 18 and 65 years of age, with chronic neck-shoulder complaints (>6 months), and a stable medical condition reflected in an absence of large fluctuations in pain and/or disability. In addition, subjects were excluded when they had insufficient understanding of the Dutch language.

Professional population

Professionals were recruited from the pain division of a local rehabilitation centre. Among these professionals, both direct providers of the conventional myofeedback treatment (n=4) as well as professionals with the authorization to refer patients to the myofeedback treatment (n=17) were approached. All professionals were acquainted with the principles and protocol of the conventional myofeedback treatment.

Measurements

Two questionnaires were developed: one for the patients and one for the professio-

nals. The questions were similar in origin, but they were specified to the target group, i.e. patients and professionals. The ASE model formed the theoretical background of the questionnaire. In the ASE-model, three determinants for intention of treatment adherence are postulated. The questionnaire developed focused on two of the three determinants of the ASE model, namely attitude and self-efficacy. Self-efficacy can be defined as one's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances[6]. Within this context, patients' self-efficacy is the degree to which patients expect themselves to be capable of applying the relaxation skills and/or exercises provided by their myofeedback therapist during future remote consultation(s). A professionals' self-efficacy is the degree to which myofeedback therapists consider themselves capable of communicate the relaxation skills and/or exercises to their patients via ICT. The self-efficacy questions are aimed at providing insight in the optimum frequency of communication and preferred mode for remote consultation. For the professionals, the attitude questions were asked to all professionals, both the therapists providing the conventional myofeedback (n=4) and the direct referring professionals (n=17). The self-efficacy questions were asked solely to the myofeedback therapists (n=4), as those are the ones who need to provide the RSMT. The questions including (abbreviated) answering methodology are presented in Appendix 4.1 and 4.2.

Analysis

Results of the open questions were analyzed and presented in a mainly qualitative way. Questions measured at an ordinal scale were described using frequency distributions.

Results

Twenty-two questionnaires were sent to 18 WMSD and four WAD patients. Fifteen questionnaires were filled out and returned (response rate 68%). The mean age of the patients was 53.8 years (range 43-58). In addition, 26 questionnaires were sent to professionals working within the field of pain rehabilitation. Of these 26 questionnaires, 21 were returned (response rate 81%). Among the responding professionals were physiotherapists, social workers, psychologists, occupational therapists, rehabilitation doctors, and vocational investigators. The mean age of the professionals was 39.6 years (range 25-54). Fifty-three percent of the respondents were male.

Patient population

Attitude

In total, 53% of the patients with neck-shoulder pain were "positive" (40%) to "very positive" (13%) about the myofeedback treatment following the conventional approach (see Table 4.1). Twenty-seven percent of the patients had a "negative" to "very negative" attitude towards the conventional myofeedback treatment. This "negative" attitude was largely related to experienced technical failures and low usability of the system during the conventional myofeedback treatment.

Table 4.1 Patients' attitude toward conventional (MT) and remote myofeedback (RSMT) (n=15)

Attitude of patients	Very positive	Positive	Neutral	Negative	Very negative
MT	13 %	40 %	20 %	20 %	7 %
RSMT	0 %	53 %	20 %	20 %	7 %

As shown Table 4.1, an equal amount of patients with a positive attitude toward the conventional myofeedback treatment also reported a positive attitude toward the RSMT. So, 53% of the patients had a "positive" attitude toward remote treatment of their neck-shoulder complaints. Similar to the conventional myofeedback, 27% of the patients reported a "negative" to "very negative" attitude towards the RSMT. Twenty percent of the patients had a "neutral" attitude towards it, indicating that they did not prefer this type of treatment but also did not have an aversion toward it.

As presented in Figure 4.3, 67% of all patients were willing to participate in RSMT. Interestingly, more patients were willing to undergo the RSMT (67%) than the ones who reported a "positive" to "very positive" attitude towards it (53%; see Table 4.1).
This difference was hypothesized to be related to the geographical distance between patient and therapist: subjects who lived at a longer distance from their therapist are probably more favorable to report willingness to undergo RSMT. Data inspection revealed no difference in the distance from the therapist and the time needed to commute to receive care between these additional patients (range 15-134 km, range 18-100 min) (14% increase) and the other 53% of the patients (range 0-115 km, range 5-78 min) who reported a positive attitude toward the conventional myofeedback.

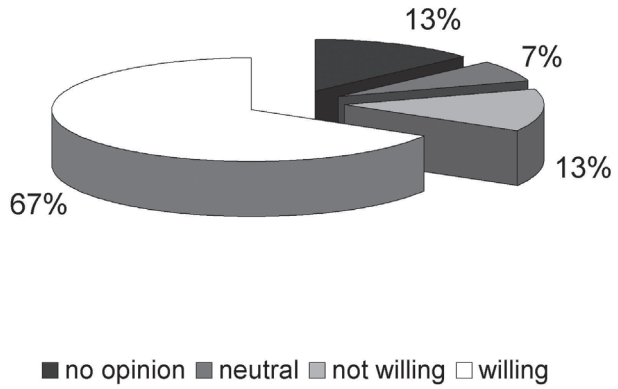

Figure 4.3 The intention of patients with respect to participation in remotely supervised myofeedback treatment (RSMT) (n=15).

Twenty percent of the patients reported that they did not have a clear opinion about participating in a RSMT, whereas 13% is not willing to participate. No specific arguments were mentioned. Patients reported that a reduced travel time, for either the patient herself or the therapist, was one of the major advantages of the RSMT compared to the conventional treatment. In addition, some patients assumed the remote treatment to be more effective because of its potentially high treatment intensity as muscle relaxation patterns can be viewed by their therapists continuously.

Self-efficacy

Despite the limitation concerning the lack of in vivo contact in RSMT, 40% of the patients believed they could still learn the required skills of the myofeedback principles remotely, and 20% reported doubt. Thirty-three percent of the subjects reported that they would not be capable of learning the instructions provided in the RSMT. In addition, 7% did not have any opinion with regard to their self-efficacy levels, which might indicate that they have difficulty in imagine the concept of remote myofeedback. Lack of in vivo contact was believed to make the contact less personal, resulting in lower treatment compliance.

With regard to the frequency of contact with the professional, a minority (13%) of the patients believed structural in vivo contact would not be necessary with the RSMT. Forty percent of the patients suggested that the optimal frequency of structural in

vivo contact with their professional would be once per two weeks (Figure 4.4), which is less frequent compared to the conventional myofeedback treatment during which the therapists and patients meet each week.

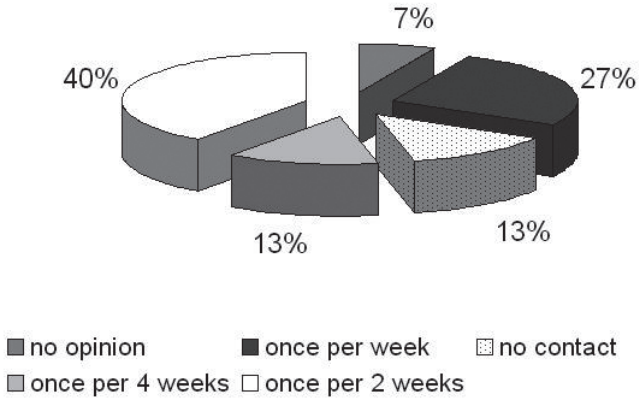

Figure 4.4 The percentage of preferred frequency of structural in vivo contact with the myofeedback therapist in remotely supervised myofeedback treatment (RSMT) of patients (n=15).

Patients were also asked for the frequency of other forms of contact. Patients reported that this could be valuable, in particular when their myofeedback therapist thought it to be necessary and in the early stages of the treatment.
The preferred communication mode of learning the myofeedback skills in RSMT is email and/or telephone (80%) above other types of communication modes such as chat and short message services (SMS), which made up the other 20%.

Professional population

Attitude

Forty-three percent of all professionals familiar with myofeedback treatment reported a positive attitude toward the RSMT (Figure 4.5). According to the professionals, the major advantages of the RSMT were the reduced travel times and ability to treat several patients simultaneously. Healthcare was considered to become more accessible for patients, because professionals believed the threshold for consulting the therapist to be lower when communication media other than in vivo contact (for example email) could be applied.

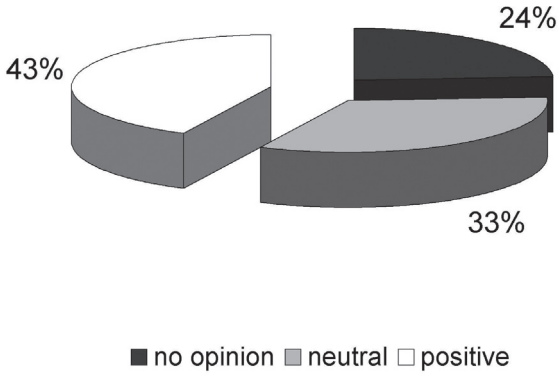

Figure 4.5 The attitude of professionals (acquainted with conventional myofeedback) toward remotely supervised myofeedback treatment (RSMT) (n=21)

Self-efficacy

The expectations toward self-efficacy of providing the RSMT was assumed to be mainly dependent on the mode and frequency of communication. All four myofeedback therapists felt they would be able to provide the RSMT on condition that the technical feasibility of the system has been proven to be reliable. Similar to patients, professionals reported the possible lack of in vivo contact to be a major disadvantage of the RSMT. In vivo contact is considered to be stimulating for patients, and enhances treatment compliance. Inherently, professionals assume that there is an increased risk of drop-outs, and they stated that non-verbal communication, which occurs during in vivo consultations, provides important clinical input for the myofeedback therapist.

Similar to patients, the majority (three out of four) myofeedback therapists preferred telephone, and to a lesser extent, email contact above SMS and chat. One therapist believed that chat could be valuable in remote consultations.

In addition to the mode of communication, the frequency of contact between patient and professional is considered to be very important. Professionals believed that in RSMT the frequency and the intensity of the communication could easily be adapted to individual needs; two out of the four myofeedback therapists preferred to have in vivo contact at least once per two weeks; two preferred to have in vivo contact with the patient at the start and end of the treatment. The number of in vivo contacts could be reduced by alternating it with remote consultations. However, the total numbers of contacts are preferred to be comparable to the frequency of contact in the weekly

conventional myofeedback treatment. Finally, the lack of current computer skills and facilities at the professionals' workplace was considered to be problematic.

Discussion

Remotely supervised myofeedback training (RSMT) is suggested to be a valuable alternative to the conventional myofeedback treatment because it has the potential to increase the efficiency and effectiveness of care. In the present explorative study the ASE model[4] served as framework to investigate the receptiveness of both patients and professionals towards RSMT. The study sample consisted of 15 neck-shoulder pain patients previously treated with conventional myofeedback, 17 therapists familiar with and four therapists actually providing the conventional myofeedback. This sample was chosen because it had actually experienced the myofeedback treatment and is expected to understand the (future) procedures of providing it remotely (RSMT).

Results showed positive attitudes towards RSMT in 53% of the patients, and 67% of them were willing to participate in future RSMT. Of the 21 professionals included in the present study, 43% reported a positive attitude. In addition, 40% of the patients and 100% of the professionals believed their self-efficacy level to be sufficient for RSMT. Counter to our expectations, several patients reported to intent to participate in remote myofeedback, although they did not report a positive attitude toward the conventional myofeedback. A possible explanation for this finding is that these patients assume an improvement of technical reliability of the remote myofeedback system compared to the conventional myofeedback system. Another explanation might be the fact that they prefer remote consultations above the in vivo contacts because of its time-saving character which is the major difference between the conventional myofeedback and RSMT.

Professionals emphasized the importance of non-verbal communication and physical interaction (in vivo contact) in remote treatment concepts. In literature, non-verbal communication was found to be important in shaping and defining relationships between patients and professionals[9]. In turn, affective behavior was positively associated with patients' satisfaction[10 11]. It is yet to be determined, whether the content of communication patterns in a remote communication mode allowing non-verbal communication, differs from in vivo consultation, and how these affect the therapeutic

relationship. The therapeutic relationship, which a professional builds with the patient, is considered to be a cornerstone of treatment compliance[12]. Therefore, besides a communication mode allowing non-verbal communication, other factors might need to be applied to RSMT to increase patients' compliance. It is suggested that patients' decisions to modify or discontinue therapy can be reduced by committing themselves to attain specific treatment goals[13]. By formulating goal intentions, people translate their noncommittal desires into binding goals. This so-called "theory of Implementation Intention" principles to bridge the gap between treatment intentions ("I intend to achieve x") and actual adherence to the treatment (actual behaviour).
In order to add non-verbal communication in remote consultations, videoconferencing is recommended. However, further research should be aimed at getting insight in the optimal communication mode for myofeedback teleconsultations by taking into account the clinical communication context. This context will differ across specialty settings in terms of the scope of issues and the duration of relationships between patients and providers[14]. Communication differs in "richness" with face-to-face communication being richest, while other communication tools capable of sending fewer cues (voice, gestures, chat) or providing feedback slower (voice-mail, e-mail) are "leaner"[14]. Therefore, the appropriate mode is dependent on the task that needs to be performed[14]. In the course of the four-week RSMT there is a high chance that the task c.q the function of the (tele-)consultation changes. For example, the amount of instructions of the myofeedback therapist is expected to be larger in the initial phase of the RSMT.

Despite the fact that only two of the three determinants of the ASE-model, attitude and expectations towards self-efficacy, were addressed in the present study, the results revealed some interesting "end-user views".
A limitation of the present study was the relatively small sample size. Therefore, the results need to be interpreted with caution. Despite this limitation, the present study revealed some important recommendations which are likely to contribute to increased adherence of (future) remote myofeedback treatment. First, as the negative attitudes about the conventional myofeedback treatment were primarily due to technical failures of the myofeedback system, instruction sessions and well-organized technical support should be part of the RSMT. Second, non-verbal communication and physical

interaction are considered to be essential and are therefore recommended to remain part of the RSMT protocol.

Acknowledgements

This study was supported by a grant from the SenterNovem provided to the Exozorg project (TSIT 1014). SenterNovem is an agency of the Dutch Ministry of Economic Affairs.

Reference List

1. Hägg GM. Static work loads and occupational myalgia: a new explanation model. Anderson PA, Hobart DJ, Danoff (eds). Amsterdam: Elsevier Science Publishers B.V. (Biomedical Division), 1991: 141-3.

2. Hermens HJ, Hutten MMR. Muscle activation in chronic pain: its treatment using a new approach of myofeedback. Int J Indust Ergon 2002; 30:325-36.

3. Voerman GE, Vollenbroek-Hutten MM, Hermens HJ. Changes in pain, disability, and muscle activation patterns in chronic whiplash patients after ambulant myofeedback training. Clin J Pain 2006; 22(7):656-63.

4. de Vries H, Dijkstra M, Kuhlman P. Self-efficacy: The third factor besides attitude and subjective norm as a predictor of behavioural intentions. Health Educ Res 1988; 3(3):273-82.

5. Fishbein M, Ajzen I. Belief, attitude, intention and behaviour: an introduction to theory and research. Boston, United States of America: Addison-Wesley Publishers, 1975.

6. Bandura A. Social foundations of thought and interaction: A social cognitive theory. Englewood Cliffs: NJ: Prentice Hall, 1986.

7. Berg M. Patient care information systems and health care work: a sociotechnical approach. Intern Journ of Med Inform 1999; 55:87-101.

8. Rogers EM. Diffusion of innovations. New York, United States of America: The Free Press, 1995.

9. Stefani, LA. June 2007; Available at http://www.grossmont.edu/lisastefani/Comm%20120/Elements%20of%20Human%20Communication%206%20p.pdf.

10. Meryn S. Improving doctor-patient communication. Not an option, but a necessity. BMJ 1998;316(7149): 1922.

11. Onor ML, Misan S. The clinical interview and the doctor-patient relationship in telemedicine. Telemed J E Health 2005; 11(1):102-5.

12. Leach MJ. Rapport: a key to treatment success. Complement Ther Clin Pract 2005; 11(4):262-5.

13. Gollwitzer PM. Implementation intentions; Strong effects of simple plans. Comp Ther Clin Practice 1999; 54:493-503.

14. Katz SJ, Moyer CA. The emerging role of online communication between patients and their providers. J Gen Intern Med 2004; 19(9):978-83.

Appendix 4.1 Questionnaire for the patients

	Questionnaire patients	Answering format
	Attitude	
1	What is your attitude towards RSMT?	□ very positive □ positive □ neutral □ negative □ very negative
2	What are the potential advantages and disadvantages of RSMT?	…… ……
3	What are possible solutions to solve these problems?	…… ……
4	Would you be interested in participation?	□ yes □ no □ neutral □ no opinion
	Self-efficacy	
5	Do you think that you can learn the required skills during RSMT?	□ yes □ no □ not sure
6	Frequency of personal (in vivo) contact between expert professional and patient	…… ……
7	Incidence of other forms of contact between professional and patient	…… ……
8	Which forms of contact between professional and patient are preferred	□ chat □ email □ telephone □ sms □ other

Appendix 4.2 Questionnaire for the professionals

	Questionnaire professionals	**Answering format**
	Attitude	
1	What is your attitude towards RSMT?	□ very positive □ positive □ neutral □ negative □ very negative
2	What are the potential advantages and disadvantages of RSMT?	…… ……
3	What are possible solutions to solve these problems?	…… ……
	Self-efficacy	
4	Do you think that you will be able to provide RSMT?	□ yes □ no □ not sure
5	Frequency of personal (in vivo) contact between expert professional and patient	…… ……
6	Incidence of other forms of contact between professional and patient	…… ……
7	Which forms of contact between professional and patient are preferred	□ chat □ email □ telephone □ sms □ other
8	Requirements for optimal compliance	…… ……

CHAPTER 5

A systematic review of the methodology of telemedicine evaluation in patients with postural and movement disorders

M.H.A. Huis in 't Veld [1]
H. van Dijk [1]
H.J. Hermens [1,2]
M.M.R. Vollenbroek-Hutten [1]

[1] Roessingh Research and Development,
Enschede, The Netherlands
[2] Faculty of Electrical Engineering,
Mathematics and Computer Science,
University of Twente,
Enschede, The Netherlands

Journal of Telemedicine and Telecare
12(6): 289-297, 2006

5 | Methodology telemedicine evaluation

Abstract

We reviewed the methodology used in telemedicine research concerning patients with postural and movement disorders. Literature searches were performed using various computerized databases through to October 2005. Twenty-two studies met the criteria for review. Two broad models of telemedicine delivery were represented in the literature: (i) telemedicine between healthcare professionals at each telemedicine site (n=16) and (ii) telemedicine between healthcare professionals and a patient at a remote site (n=6). Disparate research methodologies were used to investigate these two models. Most studies were limited to investigating the technical feasibility and acceptability of a telemedicine service rather than focusing on the overall effect of introducing the telemedicine service in routine healthcare. Nonetheless, it is possible to conclude that telemedicine is acceptable for both patients and professionals when used in rehabilitation. Since the two models of telemedicine evaluation tend to explore different outcomes (diagnostic accuracy versus health status), it is recommended that separate methodologies should be used. In contrast to evaluations of telemedicine model (ii), randomized controlled trials appear to be less valuable for telemedicine model (i).

Introduction

In general, two broad models of telemedicine delivery can be discerned in telemedicine: (i) between healthcare professionals at each telemedicine site and (ii) between healthcare professionals and a patient at a remote site. For example, a rural general practitioner may consult a remote expert (i) or patients at home may be supported by a physiotherapist at a distance (ii).

Despite much development work, the implementation of telemedicine in routine healthcare is scarce[1-5]. This may be due, among other things, to a lack of well designed methodologies for telemedicine research. In clinical and pharmaceutical research, the Food and Drug Administration has developed a three-staged model of drug evaluation for increased scientific evidence. The stages of this model moves from animal (preclinical) studies, to pharmacokinetic studies in individuals (phase 1), to studies in

diseased individuals (phase 2), to comparisons against standard therapy for diseased individuals (phase 3)[6].

We have conducted a systematic review to describe the quality of the research methodology used in the field of telemedicine for patients with postural and movement disorders. The present review focused on telemedicine evaluation studies concerning patients in the field of rehabilitation.

Methods

Computerized literature searches were performed using the Medline, Cinahl and Cochrane databases through to October 2005. The keywords (all fields) are shown in Table 5.1. In addition to this literature search, the references of relevant publications (also reviews) were carefully checked and a manual search was conducted using the online version of the Journal of Telemedicine and Telecare (March 1996 - October 2005).

Table 5.1 Search strategy

Step	Search term
1	telemed$ (all fields) OR telehealth$ (all fields) OR telecare$ (all fields) OR telerehabilitation$
2	teleconsultat$ (all fields) OR telemonitor$ (all fields) OR teleconference$ (all fields) OR teletreatment$ (all fields)
3	1 AND 2

Selection criteria

The present review included articles which examined the benefits of telemedicine delivery between healthcare professionals at each telemedicine site and between healthcare professionals and patients at a remote site.

The following inclusion criteria were applied:

- studies concerning patients with postural and movement disorders
- telemedicine research related to consulting, assessment, conferencing, monitoring or treatment
- English, French, German and Dutch articles.

The following were excluded:

- studies concerning radiology
- studies regarding telemedicine for emergency care or minor accidents

- studies regarding educational or administrational purposes (e.g. electronic patient records)
- studies mainly aimed at the technical specifications of telecommunications
- studies primarily focusing on economic analysis of telemedicine interventions
- articles that were duplicates of other published studies.

Initial screening of the articles was based on the content of the abstracts. Two reviewers read all abstracts independently. When an abstract did not give sufficient information about the study, the full-text article was obtained for further review. Full-text articles were then evaluated independently by the reviewers, who reached a consensus about whether or not the article should be included. When disagreement persisted, the third independent reviewer made the final decision. From a practical point of view, articles were not blinded for authors and journals.

Methodology assessment

Since there are no widely agreed quality criteria for assessing telemedicine evaluation studies, a list was developed based on a recently published criteria list[7] (see Appendix 5.1). This list included items developed by the Cochrane Collaboration for observational studies and randomized clinical trials, and was completed using the framework for assessing validity described by Altman *et al*. (2001)[8] and Van Tulder *et al*. (2000)[9]. The list was divided into five parts: research question, study design, intervention, outcome measures and statistics.

Two important modifications were made in the "intervention" part and one modification was made in the "outcome measures" part. In these parts differences are believed to exist between the two models of telemedicine delivery. The modifications are described below:

- the "intervention" part was extended by items relating to the description of the experimental group, control group and professionals.
- the "intervention" part was extended by adding items concerning time period and usage of telemedicine intervention since they provide information about the maturity of the application and the possibility of novelty effects.
- the "outcome measures" part was subdivided in patient-, professional- and technical-related outcomes.

Two reviewers independently scored the methodology of the included studies. To determine the methodological quality of the study, each item was graded. If (adequate) information was available the item was rated positive (+). If information was not adequate the item was rated negative (-). Items concerning partially presented information were rated partially (+/-). The item was rated (x) when the item was not applicable.

Results

The Medline, Cochrane and Cinahl search collected 613 citations of which 549 non-duplicates were selected by reference checking. Selection revealed 188 abstracts to be screened, of which 60 abstracts were included for full-text consideration. Some journals were not available in The Netherlands. In order to receive the article, the majority of the authors were approached by email. Eventually, 45 full-text articles were retrieved. Twenty-eight articles were excluded additionally due to our inclusion and exclusion criteria. Final consensus was found without needing to consult the third reviewer. Five additional articles were included based on the manual literature search. They underwent the same process for determining inclusion and exclusion. Thus, in total, 22 articles were included in the final review.

General study characteristics

The main characteristics of the 22 articles included in the present review are presented in Table 5.2 (a+b). The study population mainly concerned patients with a variety of orthopaedic[10-17] and musculoskeletal problems[18-20], stroke[21-24], spinal cord injury[25 26] rheumatology[27 28], traumatic brain injury[29], upper extremity disorders surgery[30] and hip replacement[31].

In 16 of the 22 studies, the telemedicine intervention concerned professional-professional telemedicine delivery (i). All these studies concerned videoconferencing and were aimed at diagnosing the patients and/or discussing the management plans. In six of the 22 studies, the telemedicine intervention concerned telemedicine delivery between a professional and the patient (ii) and were aimed at monitoring and/or training[15 22 24 25 29 31].

The scores of the methodological quality of the articles are presented in Table 5.3.

Table 5.2a General characteristics of the studies included in the present review (n=22)

Article	Study population	Sample size case	Sample size control	Telemedicine intervention	Number of consultations	Intervention period
Corcoran *et al.*[10]	Orthopaedic: foot problems	49	49	Videoconferencing between hospital and residential home for podiatric interventions	99	8 months
Baruffaldi *et al.*[11]	Orthopaedic: problems in upper limbs, lower limbs and spine	51	14	Videoconferencing between orthopaedic hospital and three units of the national insurance organization for accidents at work for orthopaedic second opinions	65	20 months
Couturier *et al.*[12]	Orthopaedic: femoral neck fractures, hearing problems, visual deficits, other orthopaedic problems	15	15	Videoconferencing between university hospital orthopaedic surgeon and a remote patient in order to perform a clinical examination	15	unclear
Aarnio *et al.*[13]	Orthopaedic: back and joint problems	29	29	Videoconferencing between a general hospital and an orthopaedic hospital	29	3 months
Haukipuro *et al.*[14]	Orthopaedic: arthrosis, back pain, other orthopaedic problems	76	69	Videoconferencing between an orthopaedic specialist and a general practitioner	76	18 months
Russell *et al.*[15]	Orthopaedic: total knee replacement	10	11	Videoconferencing to provide a telerehabilitation intervention program to patients with total knee replacement. Motion analysis tools enable remote assessment of physical measures.	36	6 months
Vuolio *et al.*[16]	Orthopaedic: arthritis, back problems, other orthopaedic problems	58	55	Videoconferencing between a surgical outpatient and municipally health centre	145	Follow up
Lambrecht *et al.*[17]	Orthopaedic: fractures, ligamentous injury, joint swelling and infection, postoperative evaluation	410	No control	Videoconferencing between an orthopaedic expert and rural clinicans	410	24 months
Savard *et al.*[18]	Musculoskeletal: stroke, parkinson, cerebral palsy, spinal cord injured, muscular atrophy, sclerosis	75	No control	Videoconferencing between rehabilitation centre and rural clinicians to provide telerehabilitation consultations	117	unclear

Table 5.2b General characteristics of the studies included in the present review (n=22)

Article	Study population	Sample size case	Sample size control	Telemedicine intervention	Number of consultations	Intervention period
Lemaire *et al.*[19]	Musculoskeletal: gait problems, orthotics, prosthetics, arm weakness	47	No control	Videoconferencing between several community hospitals and a specialized physical rehabilitation hospital to provide physical rehabilitation consultations	47	21 months
Engbers *et al.*[20]	Musculoskeletal: children with complex movement and postural disorders	20	No control	Videoconferencing between four paediatric physiotherapists in three different institutions	>32	8 months
Wiborg *et al.*[21]	Stroke	153	470	Videoconferencing between stroke unit and 7 rural hospitals for assessing stroke patients'clinical status and providing therapeutic recommendations	153	19 months
Kiefer *et al.*[22]	Stroke	18	No control	Videophone between a hospital and a general practitioner, and patients at home for improving stroke care	157	6 months
Buurke *et al.*[23]	Stroke	12	No control	Remote consultation between experts to determine the suitability for surgery in stroke rehabilitation	12	unclear
Lai *et al.*[24]	Stroke	19	No control	Physiotherapeutic intervention for patients by means of videoconferencing	64	8 week
Phillips *et al.*[25]	Spinal cord injured	11	No control	Videophone rehabilitation facility for spinal cord injured patients at home	198	>6 weeks – 23 weeks
Patterson *et al.*[26]	Spinal cord injured	1	No control	Videoconferencing for managing patients with neurosurgical emergencies	unclear	6 weeks
Davis *et al.*[27]	Rheumatological	52	No control	Videoconferencing between a rural health centre and specialist rheumatologist centre to discuss diagnosis and appropriate management plans	5	+/- 6 months
Graham *et al.*[28]	Rheumatological	20	20	Videoconferencing between a junior doctor with a remote patient in order to come to a diagnosis	20	4 months
Forducey *et al.*[29]	Traumatic brain injury	1	No control	Telephysiotherapy	24	12 weeks
Abboud *et al.*[30]	Orthopaedic: upper extremity disorders	100	100	Telemedicine consultation in patients with upper extremity disorders	100	6 months
Sharma *et al.*[31]	Orthopaedic: hip replacement	100	No control	Telephone interviews to follow up patients after total hip replacement	100	unclear

Table 5.3 The methodological quality of the studies included (n=22)

Telemedicine type	Research question	Study design						Telemedicine intervention								Outcome measures				Statistics		
(1) professional-professional	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Abboud *et al.*[30]	+	+/-	+/-	-	-	+	+	+/-	-	-	-*	-	+	+	-	-	+	-	+	-	+	+
Buurke *et al.*[23]	+	+/-	+	-	-	+	X	+/-	+	-	X	-	+	+	-	+	+	-	X	-	-	-
Corcoran *et al.*[10]	+/-	+	+/-	-	-	+	+	+/-	+	+/-	+/-*	-	+	+	-	-	+/-	+	+	-	-	-
Engbers *et al.*[20]	+/-	-	-	-	-	+	X	+/-	+	-	X	-	+	+	-	-	+	+	X	-	-	-
Savard *et al.*[18]	-	+/-	-	-	-	+	X	+/-	-	+/-	X	-	+	-	-	-	-	-	X	-	-	-
Vuolio *et al.*[16]	+/-	+	+	+	+	+	+	+	-	+/-	+/-	-	+	+	+^	+	-	-	+	-	-	-
Wiborg *et al.*[21]	+/-	+	+/-	-	+	+	+/-	+	-	+	+	+/-	+	+	-	+/-	+/-	+	-	-	-	+
Baruffaldi *et al.*[11]	-	+/-	-	-	-	+	-	+	-	-	-	+/-	+	+	-	-	+/-	+	+	-	+	-
Davis *et al.*[27]	-	+/-	-	-	-	+	X	+	-	+/-	X	-	-	+	-	-	-	-	X	-	-	-
Lemaire *et al.*[19]	-	+/-	-	-	-	+	X	+	-	+/-	X	-	+	+	-	+	+	+	X	-	+	+
Graham *et al.*[28]	+/-	+	-	-	-	+	+	+/-	-	+/-	+/-*	+/-	+	+	-	-	+/-	+	+	-	-	-
Haukipuro *et al.*[14]	+/-	+	+	+	-	+	+	+	-	+/-	+/-	-	+	+	-^	+/-	+/-	+	+	-	+	+
Patterson *et al.*[26]	+/-	+	-	-	-	+	X	+	-	+	X	-	-	+	+	+	-	-	X	-	-	-
Aarnio *et al.*[13]	+/-	+/-	-	-	-	+	+	+	-	+/-	+/-*	-	+	+	-	+	+	+	+	-	+	-
Couturier *et al.*[12]	+/-	+	-	-	-	+	+	+	-	+/-	+/-*	-	+	-	-	+/-	+/-	+	+	-	+	+
Lambrecht *et al.*[17]	-	+	-	-	-	+	X	+	+	+/-	X	+/-	+	+	-	-	-	+	X	-	-	-
(2) professional-patient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Sharma *et al.*[31]	+	+/-	-	-	+	+	X	+	-	+/-	X	-	+	+	+	+	-	+	+	-	+	+
Lai *et al.*[24]	+	+/-	+	-	-	+	X	+	-	+	X	-	+	+	-	+	-	-	X	-	+	+
Forducey *et al.*[29]	+/-	+	-	-	-	+	X	+/-	-	+	X	-	+	+	-	+	-	-	X	-	-	-
Kiefer *et al.*[22]	+/-	+/-	+	-	-	+	X	+	+	+	X	-	+	+	-	+	-	+	X	-	+	-
Russell *et al.*[15]	+/-	+	+	+	-	+	+	+/-	-	+	+	-	+	+	-	+	-	-	+	-	+	+
Philips *et al.*[25]	+/-	+	-	-	-	+	X	+/-	-	+	X	+/-	+	+	-	-	-	+	X	-	+	-

* similar cases and controls
^ The study of Vuolio *et al.* (2003) is a follow-up of the study of Haukipuro *et al.* (2000)

Research question: Seventeen of the 22 included studies clearly described the research question and five did not[11 17-19 27].

Hypothesis: Few of the research questions were supported by hypotheses, although in most studies an idea was presented about the possible effects of the telemedicine intervention.

Source population: In 11 studies, the source population was well defined in a way that background information was provided about the population from which the included patients were drawn[10 12 14-17 21 25 26 28 29].

In- and exclusion criteria: Only six studies explicitly specified inclusion and exclusion criteria for selecting their patients[14-16 22-24]. Among these, three of the six studies concerned telemedicine delivery between professionals and patients[15 22 24]. Because this model of telemedicine delivery focuses on patients' functional improvement, defining sharp in- and exclusion criteria for patients is important. However, in telemedicine delivery between professionals, the focus is often on diagnosing the patient and the definition of criteria that influence the diagnostic skills of professionals might be valuable.

Participation rates: The majority (n=19) of the included studies did not record participation rates, only three studies did[16 21 31]. Participation rates provide information about the willingness of subjects to undergo health care delivery by telemedicine.

Study design:

(i) All 16 studies evaluating telemedicine delivery between professionals studies were cross-sectional studies, except one case-study[26]. In six of these 15 studies, only a telemedicine group was included in the evaluation[17-20 23 27].

In five of the 16 studies, subjects served both as case and as control because they underwent both the conventional as well as the telemedicine intervention[10 12 13 28 30]. A separate control group was included besides a telemedicine group in the remaining four studies[11 14 16 21].

(ii) Of the six studies concerning telemedicine delivery between professionals and

patients, only one study included a separate control group and conducted a randomized clinical trial, including pre- and post-test measurements[15]. In the remaining five studies only a telemedicine group was included[22 24 25 29 31], of which one was a case study[29]. In two of these studies, pre- and post-test measurements were conducted[22 24]. Methodologically, only studies with pre-post test measurements can reach conclusions about the "functional improvement" of patients. In addition, randomized clinical trials can reach conclusions about differences in "functional improvement" between the groups.

Intervention and participants: The majority of the included studies described the equipment, setting and procedures. The maximum number of consultations was 410[17]. The time span of the telemedicine intervention varied from six weeks[26] to two years[17]. Sample sizes varied from one[26 29] to 410[17].

Only seven out of all studies provided some information about the study population other than the general characteristics (e.g. number, gender and age) such as clinical scores, computer experience and social status[15 21 22 24-26 29]. Among these, five of the seven studies were aimed at telemedicine delivery between a professional and a patient (ii) for which a clear description of the population is especially important[15 22 24 25 29]. Besides the location and specialization of the professional, few studies explicitly described the educational qualifications and/or diagnostic skills of the professionals involved[11 17 21 25 28]. Describing these characteristics is especially relevant in the evaluation of diagnostic capabilities under different conditions in telemedicine interventions between professionals (i).

Outcome measures: All studies included technical feasibility measures such as the duration of the contact, the quantity of data, the quality of image or sound. However, no standardized methods were used. Another commonly used outcome measure among all the studies was the satisfaction with the telemedicine delivery for both patients and professionals. Satisfaction was measured by means of self-constructed questionnaires and, to a lesser extent, by conducting semi-structured interviews. No standardized satisfaction questionnaires were found. Outcome measures differed for the two models of telemedicine delivery:

(i) In telemedicine delivery between professionals, the most frequently reported outcome measures are opinions about the diagnostic process and the accuracy of the diagnosis (agreement). Two different designs were used to compare the telemedicine delivery with conventional delivery. In the first design, the opinions from the professional using the telemedicine intervention and another professional using the conventional treatment were compared[28]. In this study, the same patients underwent the telemedicine and the conventional treatment.
In the second design, the observations of the professional about the telemedicine intervention were compared with observations of the same professional when providing the conventional treatment[10 30]. In these studies, patients underwent both the conventional as well as the telemedicine intervention. One study[23] investigated the learning process of professionals in expert consultation, which is considered to be an important effect in telemedicine delivery between professionals.
(ii) In five of the six studies concerning telemedicine delivery between professionals and patients, standardized clinical measurements were used[15 22 24 29 31]. Outcomes consisted of physical measurements[15 22 24], standardized functional tests[15], and standardized clinical questionnaires and/or rating scales[24 29 31].

Statistics: Data analysis contained descriptive statistics without any power calculations. In five of the 16 studies aimed at telemedicine delivery between professionals, non-parametric statistical tests were used to examine differences in satisfaction outcomes[12 14 19 21]. This might be due to the satisfaction questionnaires used which often comprises nominal or ordinal levels. In one study agreement in diagnosis and management plans between observations was tested parametrically[30]. Three out of four studies aimed at telemedicine delivery between professionals and patients, used parametric statistical tests to examine differences in patients' health[15 24 31].

Discussion

The main objective of the present systematic review was to summarize the methodology of telemedicine evaluation studies concerning patients with postural and movement disorders. Based on this, some recommendations can be made for optimizing the methodology in telemedicine evaluation.
The present review summarized the results of 22 studies that evaluated the effect of

telemedicine interventions for patients with postural and movement disorders. Two broad models of telemedicine delivery were represented in literature; (i) 16 studies describing healthcare professionals at each telemedicine site and (ii) six studies describing healthcare professionals and patients at a remote site. Outcome measures were predominantly related to acceptability (technical feasibility and satisfaction) of the telemedicine delivery. All included studies suggest that telemedicine is acceptable for patients and professionals. However, a clear definition of the concept of feasibility and satisfaction, and about the way it should be measured, is lacking. Therefore, we recommend to develop standardized and validated measurements.

Acceptability of the telemedicine intervention is an important pre-requisite for successful implementation. It has often been suggested that care, which is less satisfactory to the users, is also less effective, because dissatisfaction is associated with non-compliance[32]. However, evaluating satisfaction alone is not sufficient to lead to implementation of telemedicine delivery in routine healthcare. For that purpose, evaluations of telemedicine interventions should have a broader scope as suggested by DeChant *et al*. (1996)[2]. According to his staged approach, telemedicine assessment should address the technical feasibility of, and satisfaction with, the telemedicine service in the first stages of assessment, but in the later stages it should also examine the "overall effect" of introducing them into a healthcare delivery system[2]. Therefore, we strongly recommend formulating theoretical frameworks about the effects of telemedicine delivery because they are lacking currently and may differ between the two models of telemedicine delivery. We hypothesize that telemedicine delivery between professionals as a result of shared (diagnostic) decision making primarily contributes to increased efficiency, by avoiding unnecessary referrals for instance, whereas effectiveness of health care is primarily increased by telemedicine services between professionals and patients as a result of increased treatment intensity in the patients' own environment.

Another finding of the present study is that the different models of telemedicine delivery need to utilize different research methodologies. In studies concerning telemedicine delivery between professionals (model i), the majority of applications serve as a tool for facilitating the diagnostic process remotely and research is aimed at

examining the diagnostic validity of the telemedicine service. Two common outcome measures to quantify the diagnostic validity of a telemedicine application are sensitivity and specificity[33]. Together, sensitivity and specificity indicate the accuracy of the diagnostic tool. Investigating the diagnostic accuracy implies the comparison of the experimental condition with the "gold standard" (concurrent validity). In other words, the diagnosis as found by the standard test must be compared to the diagnosis found by the experimental test.
Besides diagnostic accuracy, the learning effect among professionals is an important outcome measure of telemedicine services because telemedicine applications aimed at professional-professional communication may also serve as a tool for discussing the treatment plan. In addition to the examination of the diagnostic accuracy, the content of the consultation and/or the learning effect (professionals' opinions, number of unnecessary referrals) should be investigated. The learning effect for professionals in expert-consultation was addressed in one study included in the present review[23].

In studies concerning professional-patient communication (model ii), the focus of the evaluation is on the patients' health status. Therefore, the evaluation of this type of telemedicine service is not very different from that of a new pharmaceutical drug or treatment procedure. Instead of freely admitting patients (as a prognostic cohort group), we recommend that patients should be randomly assigned to teletreatment and conventional treatment in a RCT. In addition, changes in health status within both groups can only be determined by performing pre and post test measurements.

In summary, the evaluation of the effects of telemedicine interventions is still in its early stages of development as illustrated by the emphasis on technical feasibility and acceptability. As suggested by DeChant *et al*. (1996)[2] research should also focus on other effects as well. The development of explanatory frameworks for the two models of telemedicine delivery, contribute in addressing other effects which need to be investigated[34]. In addition, the quality of the research methodology utilized in the majority of the studies need to be optimized dependent on the model of the telemedicine delivery service. Whereas RCTs can be applied in evaluating the effects of telemedicine services aimed at professional-patient communication (model ii), they are less relevant in telemedicine services aimed at professional-professional com-

munication (model i). Here, methodological designs for investigating sensitivity and specificity of the diagnostic test should be applied.

Acknowledgements

This study was supported by a grant from the Dutch Department of Economic Affairs provided to the ExO-Zorg project (TSIT 1014).

Reference List

1. Roine R, Ohinmaa A, Hailey D. Assessing telemedicine: a systematic review of the literature. CMAJ 2001; 165(6):765-71.

2. DeChant HK, Walid WG, Mun SK, Hayes WS, Schulman KA. Health systems evaluation of telemedicine: a staged approach. Telemedicine Journal 1996; 2(4):303-12.

3. Hersh W, Helfand M, Wallace J et al. A systematic review of the efficacy of telemedicine for making diagnostic and management decisions. J Telemed Telecare 2002; 8(4):197-209.

4. Wootton R. Telemedicine: a cautious welcome. BMJ 1996; 313(7069):1375-7.

5. Wootton R. Recent advances: Telemedicine. BMJ 2001; 323(7312):557-60.

6. Jovell AJ, Navarro-Rubio MD. [Evaluation of scientific evidence]. Med Clin (Barc) 1995; 105(19):740-3.

7. van der Hulst M, Vollenbroek-Hutten MM, Ijzerman MJ. A systematic review of sociodemographic, physical, and psychological predictors of multidisciplinary rehabilitation-or, back school treatment outcome in patients with chronic low back pain. Spine 2005; 30(7):813-25.

8. Altman DG. Systematic reviews of evaluations of prognostic variables. BMJ 2001; 323(7306):224-8.

9. van Tulder M, Malmivaara A, Esmail R, Koes B. Exercise therapy for low back pain: a systematic review within the framework of the cochrane collaboration back review group. Spine 2000; 25(21):2784-96.

10. Corcoran H, Hui E, Woo J. The acceptability of telemedicine for podiatric intervention in a residential home for the elderly. J Telemed Telecare 2003; 9(3):146-9.

11. Baruffaldi F, Gualdrini G, Toni A. Comparison of asynchronous and realtime teleconsulting for orthopaedic second opinions. J Telemed Telecare 2002; 8(5):297-301.

12. Couturier P, Tyrrell J, Tonetti J, Rhul C, Woodward C, Franco A. Feasibility of orthopaedic teleconsulting in a geriatric rehabilitation service. J Telemed Telecare 1998; 4 Suppl 1:85-7.

13. Aarnio P, Lamminen H, Lepisto J, Alho A. A prospective study of teleconferencing for orthopaedic consultations. J Telemed Telecare 1999; 5(1):62-6.

14. Haukipuro K, Ohinmaa A, Winblad I, Linden T, Vuolio S. The feasibility of telemedicine for orthopaedic outpatient clinics-a randomized controlled trial. J Telemed Telecare 2000; 6(4):193-8.

15. Russell TG, Buttrum P, Wootton R, Jull GA. Low-bandwidth telerehabilitation for patients who have undergone total knee replacement: preliminary results. J Telemed Telecare 2003; 9 Suppl 2:S44-7.

16. Vuolio S, Winblad I, Ohinmaa A, Haukipuro K. Videoconferencing for orthopaedic outpatients: one-year follow-up. J Telemed Telecare 2003; 9(1):8-11.

17. Lambrecht CJ, Canham WD, Gattey PH, McKenzie GM. Telemedicine and orthopaedic care. A review of 2 years of experience. Clin Orthop Relat Res 1998; (348):228-32.

18. Savard L, Borstad A, Tkachuck J, Lauderdale D, Conroy B. Telerehabilitation consultations for clients with neurologic diagnoses: cases from rural Minnesota and American Samoa. NeuroRehabilitation 2003; 18(2):93-102.

19. Lemaire ED, Boudrias Y, Greene G. Low-bandwidth, Internet-based videoconferencing for physical rehabilitation consultations. J Telemed Telecare 2001; 7(2):82-9.

20. Engbers L, Bloo H, Kleissen R, Spoelstra J, Vollenbroek-Hutten M. Development of a teleconsultation system for communication between physiotherapists concerning children with complex movement and postural disorders. J Telemed Telecare 2003; 9(6):339-43.

21. Wiborg A, Widder B. Teleneurology to improve stroke care in rural areas: The Telemedicine in Stroke in Swabia (TESS) Project. Stroke 2003; 34(12):2951-6.

22. Kiefer S, Schafer M, Schera F, Niederlander H, Rohm K. Saar Stroke Teleservice-pilot study for stroke after care with a home care platform. Biomed Tech (Berl) 2002; 47 Suppl 1 Pt 2:958-62.

23. Buurke JH, Kleissen RF, Nene A et al. A feasibility study of remote consultation to determine suitability for surgery in stroke rehabilitation. J Telemed Telecare 2004; 10(2):108-12.

24. Lai JC, Woo J, Hui E, Chan WM. Telerehabilitation - a new model for community-based stroke rehabilitation. J Telemed Telecare 2004; 10(4):199-205.

25. Phillips VL, Temkin AJ, Vesmarovich SH, Burns R. A feasibility study of video-based home telecare for clients with spinal cord injuries. J Telemed Telecare 1998; 4(4):219-23.

26. Patterson VH, Craig JJ, Wootton R. Effective diagnosis of spinal cord compression using telemedicine. Br J Neurosurg 2000; 14(6):552-4.

27. Davis P, Howard R, Brockway P. Telehealth consultations in rheumatology: cost-effectiveness and user satisfaction. J Telemed Telecare 2001; 7 Suppl 1:10-1.

28. Graham LE, McGimpsey S, Wright S et al. Could a low-cost audio-visual link be useful in rheumatology? J Telemed Telecare 2000; 6 Suppl 1:S35-7.

29. Forducey PG, Ruwe WD, Dawson SJ, Scheideman-Miller C, McDonald NB, Hantla MR. Using telerehabilitation to promote TBI recovery and transfer of knowledge. NeuroRehabilitation 2003; 18(2):103-11.

30. Abboud JA, Bozentka DJ, Beredjiklian PK. Telemedicine consultation for patients with upper extremity disorders is reliable. Clin Orthop Relat Res 2005; (435):250-7.

31. Sharma S, Shah R, Draviraj KP, Bhamra MS. Use of telephone interviews to follow up patients after total hip replacement. J Telemed Telecare 2005; 11(4):211-4.

32. Wilkin D, Hallam L, Doggett M. Measures of need and outcome for primary health care. New York, United States of America: Oxford University Press, 1994.

33. Armitage P, Berry G, Matthews JNS. Statistical methods in medical research, 4th edition. Londen, United Kingdom: Blackwell Science, 2002.

34. Chen T.H. Theory-driven evaluations. London, United Kingdom: Sage Publications, 1994.

Appendix 5.1 The methodological criteria for scoring telemedicine evaluation studies

	Methodological criteria	**Judgement**
1	Research question is well stated?	Yes: the aim of the study is clearly described, hypothesis are formed Partially: the aim of the study is clearly described, but a hypothesis and/or statement is absent No: the aim of the study was not clearly described
	Patient selection	
2	Is the source population well identifed?	Yes: Additional characteristics (i.e. gender distribution, age, other sociodemographic variables) of the study population are presented Partially: Only number and type of patients are presented, no additional characteristics No: There is no presentation of the characteristics of the study population
3	Are appropriate in- and exclusion criteria defined?	Yes: Specification of the in- and exclusion criteria are presented and the definitions of the criteria are clear Partially: There is an attempt to present the in- and exclusion criteria, but the definitions are unclear No: There is no presentation of the in- and exclusion criteria
4	Was there randomization?	Yes: Randomization sequence is used No: No random assignment sequence is used, or its inadequate (such as using birth date)
5	Is participation rate reported and appropriate?	Yes: Particpation rate is reported No: Participation rate is not reported
6	Are all subjects representative of the same underlying population?	Yes: All study groups are clearly from the same population base, background information provided Partially: The population base is very similar for the different study groups, or there are more than two groups and at least two are clearly from the same population No: The study groups are not from the same population base
7	Is baseline comparability of various groups reported?	Yes: Some form of comparability mentioned (age, gender, other variables i.e. computer skills) No: Comparability is not mentioned Not applicable: The study does not contain two different groups, i.e. cases and controls are the same

	Methodological criteria	Judgement
	Telemedicine intervention	
8	Is there an explicit description of the telemedicine intervention? (new added)	Yes: Explicit description of the telemedicine intervention suitable for replication (e.g. procedures, setting, equipment, involved persons) is provided or authors refer to another study with full description Partially: There is an attempt to described the intervention but unsuitable for replication. No: No description of the telemedicine intervention is provided
9	Are additional intervention/telemedicine effects mentioned (new added)	Yes: Additional effects are mentioned (e.g. learning effect of professionals in expert-consultation, alterations in client-professional relationship) No: Additional effects are not mentioned
10	Is there an explicit description of the experimental group? (new added)	Yes: Explicit description of the experimental group (age, gender, number, type of patient, sociodemographic information) Partially: There is an attempt to describe the experimental group but one of the items mentioned above is missing No: No description of the experimental group is provided
11	Is there an explicit description of the control group? (new added)	Yes: Explicit description of the control group (age, gender, number, type of patient, sociodemographic information) Partially: There is an attempt to describe the control group but one of the items mentioned above is missing No: No description of the control group is provided Not applicable: The study does not include two or more different groups
12	Is there an explicit description of the involved professionals? (new added)	Yes: Besides a description of the professional (s) involved additional information (e.g. qualification, computer skills) is provided Partially: A short description of the professional(s) involved is provided No: No information about the professional(s) involved is provided
13	Is usage of the telemedicine application mentioned? (new added)	Yes: Usage (e.g. number of consultations) is mentioned No: Usage is not mentioned
14	Was the time period of the telemedicine intervention mentioned? (new added)	Yes: The time period was mentioned No: The time period was not mentioned
15	Was there a follow-up? (short or long term)	Yes: Follow-up period and outcome presented Partially: Follow-up outcome presented but follow-up period is lacking No: No follow-up period or outcome presented

	Methodological criteria	Judgement
	Outcome measures	
16	Are patient outcome measures well defined and valid? (new added)	Yes: A clear operational definition of the outcome (type of measure and instrument) was provided (e.g. literature reference, full-text questionnaire including scoring format) Partially: There is an attempt at providing a clear operational definition of the outcome, but is not clear enough to allow study replication (e.g. topics mentioned but full-text items are lacking) No: There is no presentation of the patient's outcome definition
17	Are professional outcome measures well defined and valid? (new added)	Yes: A clear operational definition of the outcome (type of measure and instrument) was provided (e.g. literature reference, full-text questionnaire including scoring format) Partially: There is an attempt at providing a clear operational definition of the outcome, but is not clear enough to allow study replication (e.g. topics mentioned but full-text items are lacking) No: There is no presentation of the patient's outcome definition
18	Are professional outcome measures well defined and valid? (new added)	Yes: Technical outcome measures provided (both subjective as objective) No: There is no presentation of technical outcome definition
19	Are the same data used for all members?	Yes: The timing and method of outcome assessment in both groups is equal for all important outcome assessments No: The timing and method of outcome assessment in both groups is not equal for all important outcome assessments
	Statistics	
20	Does sample size provide adequate statistical power?	Yes: Power statistics mentioned No: No power statistics mentioned
21	Were point estimates and measures of variability presented for the primary outcomes?	Yes: Point estimates and measures of variability are both presented. With point estimates we mean: standard deviations, ranges, 95% confidence intervals etcetera. No: No point estimates and measures of variability are presented.
22	Is there control for statistical significance?	Yes: Statistical tests were applied for significance No: No statistical tests were applied for significance

CHAPTER 6

A staged approach evaluation of remotely supervised myofeedback treatment in women with neck-shoulder pain related to computer work

M.H.A. Huis in 't Veld [1]
B.C.H. Huijgen [1]
L. Schaake [1]
H.J. Hermens [1,2]
M.M.R. Vollenbroek-Hutten [1]

[1] Roessingh Research and Development,
Enschede, The Netherlands
[2] Faculty of Electrical Engineering,
Mathematics and Computer Science,
University of Twente,
Enschede, The Netherlands

Submitted for Publication

6 | Evaluation remotely supervised myofeedback

Abstract

Remotely supervised myofeedback treatment (RSMT) is a relatively new intervention aiming at reducing neck-shoulder pain and disabilities. Subjects are equipped with a garment which can be worn under the clothes during daily work. Dry surface electrodes incorporated in this garment measure muscle activation (sEMG) of the trapezius muscle. The garment is connected to an ambulant device which provides feedback to the subject when muscle relaxation is insufficient. sEMG data is also send to a secured server that is accessible by therapists for remote counseling purposes. In concordance with the evaluation stages of DeChant, RSMT was evaluated on technical feasibility, user satisfaction, and changes in clinical outcomes. In addition, subjects were asked about their willingness to pay (WTP). The study population consisted of ten female workers suffering from neck-shoulder pain related to computerwork. Results show that in 78% of the remote counseling sessions sufficient amounts of data were available at the server for the therapist to make an assessment of muscle tension needed for the remote counseling sessions. Subjects were highly satisfied about the usefulness and ease of use of the remote counseling. However, they were less satisfied with the technical functioning of the myofeedback system. Eighty percent of the subjects reported a reduction in pain intensity and disability directly after RSMT. Subjects were willing to contribute a maximum of 200 euro for RSMT. Based on this study, it can be concluded that RSMT is technically feasible and induces changes in clinical outcomes. However, further technical improvements and research into the clinical effectiveness is needed before this treatment can go into real deployment.

Introduction

The prevalence of work-related neck-shoulder pain among computer workers is high, particularly in females[1]. Despite the various conservative interventions such as physiotherapy and ergonomic adjustments at the workplace, neck-shoulder pain persist in a majority of computer workers. The development and introduction of new interventions is therefore desirable.

A new intervention addressing neck-shoulder pain is myofeedback treatment (MT).

MT uses a system enabling continuous recording of upper trapezius muscle activation patterns (surface electromyography, sEMG) by means of dry surface electrodes which are incorporated in a garment that can be worn under the clothes in normal daily life. The garment is connected to a signal processing and feedback unit which vibrates and creates a soft sound in case of insufficient muscle relaxation. MT has shown to be beneficial in reducing pain intensity and disability in neck-shoulder complaints[2 3].

An inefficient property of the current MT is the fact that the therapist has to manually download the sEMG data from the system making weekly in vivo counseling visits with the patients necessary. For this reason, MT was further developed into a remotely supervised myofeedback treatment (RSMT) in which sEMG data are remotely accessible. Thereby, conservative weekly in vivo visits can be replaced by remote (e-)counseling sessions. RSMT is hypothesized to positively affect multiple aspects of healthcare simultaneously. First, the quality of care might be improved. Because training can be provided ambulatory, it is applied with high intensity in the subjects own environment, which facilitates the generalization of learning into a variety of work tasks and activities of daily living. Second, since the data are available on a server at anytime and anywhere, myofeedback therapists are highly flexible in the preparation and conduction of counseling sessions. Consequently, the accessibility of care might be improved because the geographical area in which subjects can be treated is unlimited. Third, costs might be saved because remote counseling is less time-consuming as a result of reduced travel times for the patient. However, appropriate evaluation of RSMT is challenging because effect-outcomes are dependent on the (im)maturity of the technology. Technical failure in immature applications is likely to occur and could affect the true clinical effectiveness and accessibility of the service[4 5]. DeChant *et al*. (1996)[5] proposed a framework for telemedicine evaluation in which the type of assessment is tailored to the development life cycle of the technology. This so-called Staged Approach differentiates between telemedicine evaluation at application (stage 1-2) and global levels (stage 3-4). In each stage, the effect of the intervention on endpoints within the following domains is studied: quality, accessibility, and costs of care. A stage 1-2 evaluation, which should be considered the starting point of evaluation, aims at proving the technical efficacy and evaluating the primary objectives of the service in domains of access, quality or cost and is performed in the present study. Because some parts of the equipment applied

in RSMT were still in the prototype phase, the endpoints of evaluation were narrowly defined on an application level[5]. The objective of the present study was to examine RSMT on technical efficacy for clinical use (including accessibility of data and overall satisfaction), the changes in clinical outcome (pain intensity and disability), and the patients willingness to pay (WTP) for RSMT.

Methods

Study design and subjects

Subjects were recruited by means of local contact persons and by a publication in a national newspaper. The myofeedback therapist approached candidates by telephone to inform them about the treatment in more detail. Volunteers received a screening questionnaire, which was an adapted version of the Nordic Questionnaire[6], and was used to check the in- and exclusion criteria described elsewhere[7 8]. The study was approved by the Medical Ethical Committee. All participants gave their informed consent prior to participation in RSMT.

Intervention: RSMT was provided by two myofeedback therapists, who collaborated during the study to ensure that they would provide the RSMT as identical as possible. A technician, specialized in RSMT, assisted the myofeedback therapists in case of technical problems. The RSMT infrastructure consists of a Body Area Network (BAN), a wireless communication platform, and a back-end server (Figure 6.1). The BAN constitutes of the garment, the processing and feedback unit, and the PDA (Qteq9090) on which subjects could view their muscle activation and relaxation patterns for both sides of the trapezius muscle.

Subjects received four weeks of RSMT during which they noted their activities and pain intensity in a diary. The treatment protocol used during these four weeks has been described in detail elsewhere[7 8]. Weekly counseling sessions of approximately 30 minutes with the myofeedback therapist took place (by telephone) in which workers were taught about personal work style in relation to muscle tension and techniques to manage stressors at work and at home that may affect their musculoskeletal health. Measurements were taken at the baseline (T0), immediately after four weeks of RSMT (T1), and at one month follow-up (T2).

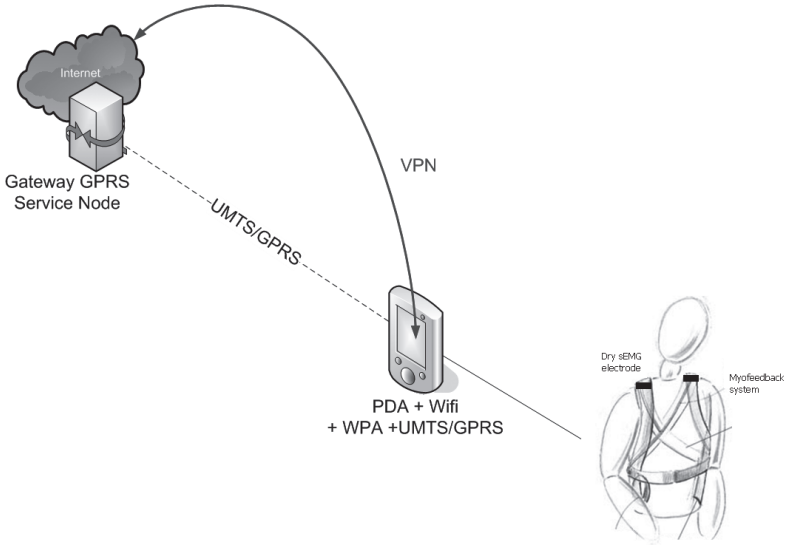

Figure 6.1 Schematic overview of remotely supervised myofeedback treatment (RSMT)[9]

Technical efficacy for clinical use: The evaluation of the technical efficacy consisted of logging technical failures of the system, the number of hours of sEMG data that was available at the server, and the manual actions of the patients on the PDA. For clinical use, a minimum of eight hours of data per patient per week is required to be available at the server for the therapist to be able to provide relevant counseling. The data should consist of datablocks of at least 15 minutes duration as this is considered an acceptable time span for activities to be analyzed and interpreted.

User satisfaction: Since no standardized and validated satisfaction measures were available, a questionnaire was developed based on the Technology Acceptance Model (TAM)[10] that comprised Likert-type items (1 = totally disagree, 7 = totally agree) to assess the subjects opinion on the perceived usefulness, and ease of use of the myofeedback system, and the remote counseling sessions in RSMT. In the current study, the measurement at T1 is used as an indicator of satisfaction as well as the difference between the user's expectations (T0) and experiences (T1).

Clinical effectiveness: Subjects were asked to rate the averaged pain experienced and the level of disability during the preceding week (at T0, T1, and T2). Pain intensity

in the neck, shoulder (left and right) and upper back was scored on a 10-point Likert scale, ranging from 0 (no pain) to 10 (worst pain ever experienced). The level of self-reported disability was assessed with the Neck Disability Index (NDI)[11 12] which is a 10-item self-reporting instrument, with a numerical rating scale (6-point).

Willingness to pay (WTP): A payment card technique was used to assess the willingness to pay for receiving the four-week RSMT as described in the patient information brochure. Subjects had to score the amount of money they were willing to pay on a voluntary basis as well as the maximum amount RSMT was worth. The amount on the payment card ranged from 0 to >250 euros. Subjects were told that the RSMT had to be paid for of their own pockets, rather than by a third party such as a health insurance company. WTP was assessed prior to the onset of RSMT (T0).

Analysis

The total duration (in hours) of sEMG data available at the server was automatically collected between consecutive counseling sessions, and the percentage useful data-blocks (>15 minutes duration) was extracted.

Regarding user satisfaction, the median satisfaction scores after RSMT (T1) and difference (Δ) scores between T1 and T0 were calculated. A negative Δ median score is defined as disappointment, whereas a positive median Δ score is defined as satisfaction. On a group level, the overall effect of RSMT over time, i.e. the three measures (T0, T1 and T2), on pain intensity in three body regions (neck, shoulder(s) and upper back) and neck pain disability was analyzed using a dependent non-parametric test for repeated measures (Friedman). Differences in pain intensity and disability scores before (T0) and after RSMT (T1) were compared using a paired non-parametric test (Wilcoxon). For the pain intensity in the neck region and disability level, an additional evaluation investigated the percentage of subjects with a clinical relevant improvement between T0 and T1, and T0 and T2. A change of five points on a maximum sum score of 50 (10%) is considered to be clinically meaningful for the NDI[13]. Likewise, a clinical relevant change of ≥10% of the maximum sum score of 10, i.e. a change of one point, was used as a clinical relevant difference in pain intensity[7]. SPSS 11.5 was used for statistical testing. Alpha was set at 0.05 for statistical significance.

Results

Eighteen subjects were approached for participation. Two subjects were excluded because of too short duration of complaints. Of the sixteen subjects which were included, five refrained from participation because of a self-reported reduction in neck-shoulder complaints since inclusion, lack of time, or family circumstances. During RSMT, one subject dropped out because of technical inconveniences with the BAN (connectivity problems). In total, 10 subjects completed the RSMT. The mean age was 38.1 years (range 22-51), mean height was 172.2 cm (range 164-187), and mean weight was 68.4 kg (range 59-84). On average, they worked 36.1 hours per week (range 25-40). The mean pain duration was 78.4 months (range 10-300).

One of the 10 subjects reported complaints in the neck only, two reported complaints in neck and shoulder, and seven reported complaints in the neck, shoulder and upper back.

Technical efficacy for clinical use: The median amount of hours of sEMG data that were available lay between 9.2 and 15.4 hours per week (Table 6.1). In 97.6% of the total amount of data available at the server (695 hrs), datablocks were larger than 15 minutes (total 678 hrs in current study). In 31 out of 40 remote counseling sessions (=78%) a sufficient amount of data (sEMG > 8 hours per week) were available at the secured server.

Table 6.1 The amount of sEMG data (hours per week) at the server available for remote counseling

	Hours sEMG per week available at server for myofeedback therapist	
RSMT	Median	Range
Week 1	14.6	0.3 – 55.1
Week 2	15.4	4.6 – 64.6
Week 3	14.0	2.6 – 40.2
Week 4	9.2	0.0 – 36.7

The technical problems encountered during the study period predominantly concerned the BAN, especially the bluetooth connection between the processing unit and the PDA. In 21.5% (range 7-44) of the n=555 manual start ups (= about 3 times a week per person), the BAN stopped functioning for other reasons than a manual stop such as power shortages, lock up of software, and loss of connectivity. Subjects complained about the relatively short battery life time of both the PDA (about 4 hours at maximum) and the processing and feedback unit (about 8 hours at maximum).

User satisfaction: The items presented in Table 6.2 will be discussed consecutively. Subjects were least satisfied about the technical functioning of the myofeedback system (median = 3.5 at T1). However, they were highly satisfied with the limited effort it took to use the myofeedback system during treatment (median = 6.0 at T1). Subjects were able to follow the instruction remotely (median = 6.5 at T1). According to the subjects, the remote consultation was believed to save time (median = 6.5 at T1). They were satisfied about the usefulness of the myofeedback system in reducing their neck-shoulder pain (median = 5.0 at T1). In addition, after RSMT the remote counseling sessions were thought (median = 6.0 at T1) to be more effective than they anticipated on prior to RSMT, at T0.

Table 6.2 Median satisfaction scores after RSMT (T1) and difference between experiences and expectations (Δ T1-T0) (n=10)

	Median (range) T1	**Median (range) difference Δ (T1-T0)**
Perceived ease of use		
The myofeedback system functions without any (technical) failures	3.5 (5)	- 1.0 (4)
Using the myofeedback takes little effort	6.0 (6)	- 0.5 (9)
Instructions and advices of my therapists during remote consultations can be followed as easily and well as if in vivo	6.5 (3)	0.5 (4)
Remote consultations are less time consuming compared to in vivo consultations	6.5 (3)	0 (3)
Perceived usefulness		
With the help of the myofeedback system the pain in my neck-shoulder region is reduced	5.0 (5)	0 (5)
Remote counseling sessions are as effective as in vivo counseling would have been	6.0 (3)	4.5 (2)

Clinical effectiveness: Figure 6.2 shows box plots of the pain intensity scores for the neck, shoulder(s) and upper back at T0, T1, and T2 at a group level. At T0, the highest median pain intensity score was found for the neck (6.0). A tendency for overall effect for RSMT on pain intensity in the neck over the three measures (T0, T1, T2) was found (χ^2=4.8, p=0.09). Additionally, a remarkable decrease in the median level of pain was reported at T1 for the neck and shoulder(s) compared to baseline (T0); from 6.0 to 2.5 for the neck, and from 4.5 to 3.0 for the shoulder(s). The decrease was significant for the neck (p=0.015) and close to significant for the shoulder(s) (p=0.057). Pain intensity scores of the upper back did not change significantly (p=0.611).

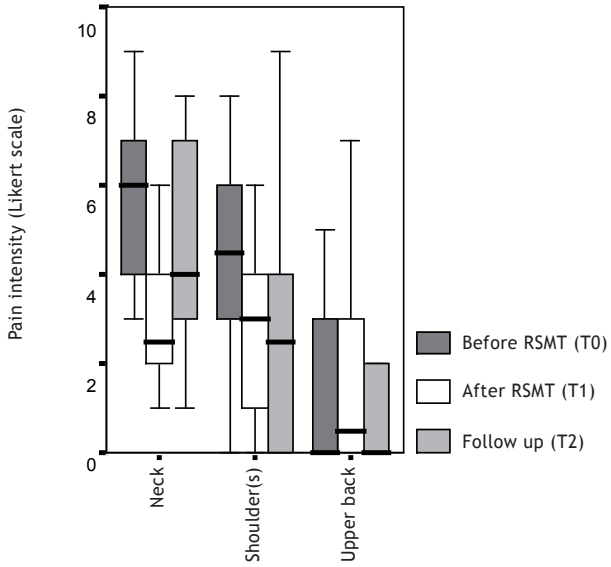

Figure 6.2 Box plots of pain intensity scores for neck, shoulder(s) and upper back before RSMT (T0), directly after RSMT (T1) and at four weeks follow up (T2) (n=10)

At the individual level, eight out of 10 subjects reported a clinically relevant decrease in pain intensity in the neck (T1). Compared to baseline (T0), one subject reported an equal amount of pain intensity and one subject deteriorated on pain intensity after RSMT (T1). At follow-up (T2) the clinically relevant positive effect remained in five out of these eight (63%) subjects. Of the two subjects who did not report a decrease in pain intensity after RSMT (T1), one further deteriorated at follow up (T2) and one had equal pain intensity she reported at baseline (T0).

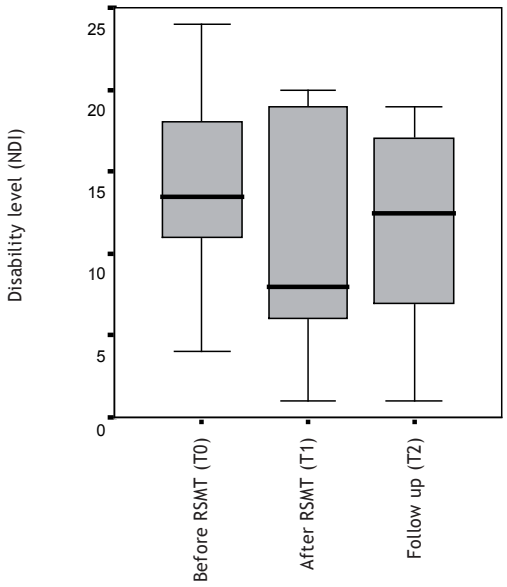

Figure 6.3 Box plots concerning the Neck Disability Index score before RSMT (T0), after RSMT (T1) and at four weeks follow up (T2).

Figure 6.3 shows the boxplots of the disability scores at T0, T1, and at (T2). Based on the median NDI score of 13.5 at the onset of RSMT (T0) subjects were classified to be mildly disabled (NDI score 5-14)[13]. On a group level, no overall effect of RSMT on disability over the three measures was found (χ^2=4.2, p=0.12). Nevertheless, after four weeks of RSMT (T1) subjects reported significantly lower levels of disability scores (median 8.0) compared to baseline (T0) (median 13.5) (p=0.021).
Eight out of 10 subjects reported a decrease in disability after RSMT (T1) compared to baseline (T0) and two out of 10 subjects reported higher levels of disability at T1. The improvement after RMST (T1) was clinically relevant in four out of these eight subjects (50%). At follow up (T2), five out of these eight subjects still reported a decrease in disability level (which was clinically relevant in three out of eight subjects, 38%). Of the two subjects who reported elevated levels of disability after RSMT (T1), both reported decreased levels of disability at follow up (T2) compared to baseline (T0).

Willingness to pay: From Table 6.3 it becomes clear that subjects are willing to contribute a maximum of 200 euros for a four-week period of RSMT. On a group level, the median amount of voluntary WTP is 75 euros.

Table 6.3 Willingness to pay for four-week period of remotely supervised myofeedback treatment (RSMT) (n=10)

	Socio-economic status		WTP four-week RSMT (euro)	
Subject	Income per month	Household size	Voluntary	Maximum
1	3500-4000	2	200	200
2	2500-3000	2	50	100
3	500-1000	1	0	0
4	2500-3000	4	0	0
5	2500-3000	2	100	140
6	> 4000	3	200	200
7	3500-3000	1	20	20
8	> 4000	2	200	200
9	> 4000	1	100	200
10	2000-2500	2	50	200

Discussion

The present study evaluated the technical feasibility, user satisfaction and clinical changes after remotely supervised myofeedback treatment (RSMT). Effect evaluation is a critical issue in telemedicine research[4 14] and designing a comprehensive evaluation protocol is still challenging. Inappropriate evaluation might have aversive consequences, i.e. obstruct the development and implementation of telemedicine interventions. A valuable framework for comprehensive evaluation of telemedicine systems is offered by a staged approach[5] which differentiates evaluation at application and global levels. As it is a theoretical framework, it does not offer a practical guidance. In our perspective, the present study provides a practical illustration of an evaluation which is conducted within the first two stages of this approach. In line with the iterative character of the staged approach, small study samples can be used to optimize certain aspects of the technology within a reasonable short time span[5].

With regard to the technical feasibility, the results of our study show that in a majority of RSMT sessions a sufficient amount of (sEMG) data was collected, wireless transmitted to and accessible at a remote location for counseling purposes. Subjects were satisfied with the ease of use (efficacy to follow instructions of therapist) and the usefulness (advices and time saving character) of remote counseling. Nevertheless, subjects were less satisfied about the technical functioning, i.e. stability of the BAN component (i.e. Bluetooth connection, power consumption), and ease of using the myo-

feedback equipment. Preceding further evaluation, the equipment needs to be improved according to the end-users recommendations resulting from this evaluation.

The clinical results suggest a beneficial effect of RSMT on perceived pain intensity and disability in a substantial number of subjects. Eighty percent of the subjects reported a clinical relevant reduction in pain intensity immediately after RSMT. Accordingly, eighty percent of the subjects reported lower disability levels, although the decrease in disability was clinically relevant in fifty percent of the subjects. Compared to studies on in vivo myofeedback treatment (MT) showing a clinical relevant improvement in pain intensity and disability in 30-50% of the subjects[2 3], our results might support the hypothesis that RSMT is equally or slightly more effective. At one month follow up, these effects diminished but a clinical relevant reduction in pain intensity and disability was maintained in roughly half of the sample (38-63%).
There are possible explanations for the positive result immediately after RSMT. One concerns providing subjects with more detailed information on their performance. As a result of technological advancements in RSMT, subjects can view their muscle activation and relaxation patterns for both the left and right side of the trapezius muscle on the visual display of the PDA. Along with "knowledge of results" (e.g. the sound and vibration), this so-called "knowledge of performance" is considered to be important in motor skill learning and could have played a strong motivating role[15]. Furthermore, as subjects are aware that the therapist is able to view their data on the server, treatment compliance could have been increased in RSMT.
Because of the small sample size included and the uncontrolled nature of the present study, the clinical findings need to be interpreted with caution.

Subjects were willing to spend a maximum of 200 euro for RSMT. However, the subjects included in the present study had a relatively high socio-economical status which might have affected their willingness to pay (WTP) and thus the generalizability of our findings. So, more research is needed to examine to what extent this WTP is typical for RSMT, or generalizable to effective neck-shoulder pain treatment in general.

In conclusion, RSMT was technically feasible, subjects were satisfied about the remote counseling sessions and the clinical changes tended to be equally or slightly

better compared to myofeedback when provided in vivo. In further evaluation of RSMT, a more global assessment of the RSMT is recommended in which the overall impact on health care is examined by integrating the domains of interest (i.e. quality, access, and costs) by means of high-quality research designs. Maximum WTP is important in (future) cost-benefit analyses[16].

Acknowledgements

Special thank goes to Gerlienke Voerman and the myofeedback therapists from The Roessingh Rehabilitation Centre for sharing their knowledge and experience regarding myofeedback. This study was supported by a grant from SenterNovem provided to the ExO-Zorg project (TSIT1014). SenterNovem is an agency of the Dutch Ministry of Economic Affairs.

Reference List

1. Blatter, BM, Houtman, I, van den Bossche, S, Kraan, K, van den Heuvel, S. Gezondheidsschade en kosten als gevolg van RSI en psychosociale arbeidsbelasting in Nederland (Report on demand of the Dutch Ministry of Social Affairs and Employment) [Web Page]. 2005; Available at www.//home.szw.nl/actueel/dsp_publicatiesindex.cfm.

2. Hermens HJ, Hutten MMR. Muscle activation in chronic pain: its treatment using a new approach of myofeedback. Int J Indust Ergon 2002; 30:325-36.

3. Voerman GE, Sandsjö L, Vollenbroek-Hutten MM, Larsman P, Kadefors R, Hermens HJ. Effects of Ambulant Myofeedback Training and Ergonomic Counselling in Female Computer Workers with Work-Related Neck-Shoulder Complaints: A Randomized Controlled Trial. J Occup Rehabil 2007.

4. Bashshur RL. On the definition and evaluation of telemedicine. Telemed J 1995; 1(1):19-30.

5. DeChant HK, Walid WG, Mun SK, Hayes WS, Schulman KA. Health systems evaluation of telemedicine: a staged approach. Telemedicine Journal 1996; 2(4):303-12.

6. Kuorinka I, Jonsson B, Kilbom A et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 1987; 18(3):233-7.

7. Voerman GE, Vollenbroek-Hutten MM, Hermens HJ. Changes in pain, disability, and muscle activation patterns in chronic whiplash patients after ambulant myofeedback training. Clin J Pain 2006; 22(7):656-63.

8. Hermens HJ, Hutten MMR. Muscle activation in chronic pain: its treatment using a new approach of myofeedback. Int J Indust Ergon 2002; 30:325-36.

9. Huis in 't Veld MHA, Voerman GE, Hermens HJ, Vollenbroek-Hutten MMR. The receptiveness towards remotely supported myofeedback treatment. Journ Telemed and EHealth 2007; 13(3): 293-302.

10. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quart 1989; 30(3).

11. Hains F, Waalen J, Mior S. Psychometric properties of the neck disability index. J Manipulative Physiol Ther 1998; 21(2):75-80.

12. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. J Manipulative Physiol Ther 1991; 14(7):409-15.

13. Stratford PW, Riddle DL, Binkley JM, Spadony G, Westaway MD, Padfield B. Using the Neck Disability Index to make decisions concerning individual patients. Physiother Can 1999; 51:107-12.

14. Dansky HK, Thompson D, Sanner T. A framework for evaluating eHealth research. Evaluation and Program Planning 2006; 29:397-404.

15. Schmidt RA, Lee TD. Motor control and learning: A behavioural emphasis. San Francisco, United States of America: Human Kinetics, 1999.

16. Foreit JR, Foreit KG. The reliability and validity of willingness to pay surveys for reproductive health pricing decisions in developing countries. Health Policy 2003; 63(1):37-47.

CHAPTER 7

Determinants of successful telemedicine implementations: a literature study

T.H.F. Broens [1]
M.H.A. Huis in 't Veld [2]
M.M.R. Vollenbroek-Hutten [2]
H.J. Hermens [2,3]
A.T. van Halteren [1,4]
L.J.M. Nieuwenhuis [1]

[1] University of Twente, Centre for Telematics and Information Technology, Enschede, The Netherlands
[2] Roessingh Research and Development, Enschede, The Netherlands
[3] University of Twente, Faculty of Electrical Engineering, Mathematics and Computer Sciences, Enschede, The Netherlands
[4] Philips Research, Department Information Processing Architectures (IPA) Sector Digital Lifestyle Technology, Eindhoven, The Netherlands

Journal of Telemedicine and Telecare
13(6):303-309, 2007

7 | Telemedicine implementation

Abstract

Telemedicine implementations often remain in the pilot phase and do not succeed in scaling-up to robust products that are used in daily practice. We conducted a qualitative literature review of 45 conference papers describing telemedicine interventions in order to identify determinants that had influenced their implementation. The identified determinants, which would influence the future implementations of telemedicine interventions, can be classified into five major categories: (1) Technology, (2) Acceptance, (3) Financing, (4) Organization and (5) Policy and Legislation. Each category contains determinants that are relevant to different stakeholders in different domains. We propose a layered implementation model in which the primary focus on individual determinants changes throughout the development life cycle of the telemedicine implementation. For success, a visionary approach is required from the multidisciplinary stakeholders, which goes beyond tackling specific issues in a particular development phase. Thus the right philosophy is: "start small, think big".

Introduction

Two major developments are influencing the way that healthcare will be provided in the future. The first development is the growing number of elderly and people with chronic disorders and the decreasing number of healthcare professionals[1] [2]. The second development is the increased quantity of information that patients have at their disposal, which is likely to change healthcare to a demand-driven process, tailored to the needs of the patient. Both developments will change the way that healthcare is provided in western societies.

Many people believe that telemedicine could be a quantitative and qualitative improvement for future healthcare provisioning, e.g. by improving access, reducing costs and raising quality[3] [4]. However, most telemedicine initiatives do not survive the research phase or they become a failure in daily practice[5]. Berg (1999)[6] showed that more than 75% of the telemedicine initiatives fail during the operational phase.

Apparently, the implementation of telemedicine initiatives in regular healthcare practice is difficult. Implementation is defined as putting an actual idea or concept into

actual practice[7]. Why is this so difficult and what goes wrong? The present study was conducted to identify the determinants that influence the implementation of telemedicine initiatives.

Methods

Search strategy

A qualitative literature study was undertaken. The telemedicine area is very broad and comprises a wide range of applications. To obtain a manageable sample of telemedicine research, the present study was limited to the studies published after the Telemed 2004 conference held in London, which we consider to be representative of telemedicine initiatives in Europe[8]. The aim of the literature study was to get an overview of determinants influencing the success of (future) telemedicine implementations without judging the importance of the determinants. Therefore, all studies were included, regardless of their methodological quality.

Assessment

Two reviewers read all studies independently. The reviewed studies were qualitatively analysed on determinants that influenced the future implementation of these telemedicine interventions. To classify the identified determinants, we employed the knowledge barriers categorization of Tanriverdi and Iacono (1999)[5]. The generic categories they proposed were behavioural, economical, technical and organizational. Selection and classification of the determinants was based on the information obtained from the study and was agreed on in discussion. When disagreement persisted, a third independent reviewer made the final decision. Articles were not blinded for authors. The chosen data for review consisted of 45 articles, which described multiple types of telemedicine implementations, ranging from remote monitoring of patients to supporting wearable devices and Web-based systems.

Results

Based on the theoretical model of Tanriverdi and Iacono (1999)[5], our study resulted in a more detailed classification of the determinants of the success of future telemedicine implementations. We introduced an additional category on policy and legislation (see Table 7.1).

Table 7.1 Applied category mapping

	Domains Tanriverdi and Iacono (1999)[5]	Domains and determinants present study
(1)	Technical	Technology 1.1 Support 1.2 Training 1.3 Usability 1.4 Quality
(2)	Behavioural	Acceptance 2.1 Attitude and usability 2.2 Evidence based medicine 2.3 Diffusion and dissemination
(3)	Economical	Financial 3.1 Provider and structure
(4)	Organizational	Organization 4.1 Intramural and extramural work practices
(5)	--	Policy & Legislation 5.1 Legislation and policy 5.2 Standardization 5.3 Security

The distribution of the identified determinants is shown in Figure 7.1. It shows that Technology and Acceptance were the two most reported determinants in the reviewed papers (together 66%) while Organization, Financing and Policy and Legislation comprised the remaining 34%.

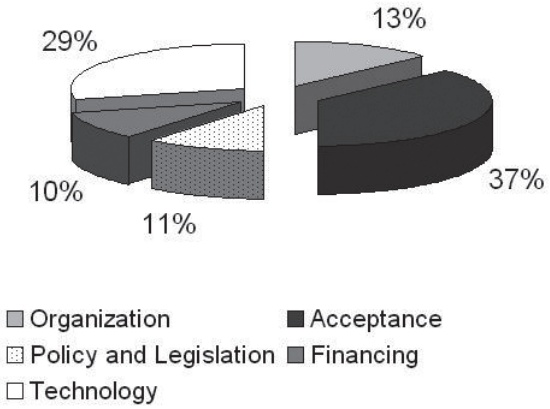

Figure 7.1 Categories of identified determinants

The following sections discuss the results of the literature study in more detail, sequentially structured by the determinant categories.

Technology

Support: The review showed that a major issue for technological acceptance of telemedicine systems was the availability of support to users[9-12]. This includes support for the deployment phase as well as the support throughout the operational phase. Support should be offered at the technical level on how to install and sustain the system but also on how to deal with errors and problem situations. Without support, problem situations during the use of the system lead to de-motivation and a high probability of abandoning the system[13].

Training: Training was also seen as an important requirement for the introduction of telemedicine systems[13-21]. Generally, users are not familiar with these new types of system which often include the use of difficult equipment[10 22]. The review indicated that there is a need for training users on how to use these novel types of systems. Such training is needed at all levels: from the managers who interpret data, to doctors who view vital signs and nurses who have to administer the practical parts of the telemedicine system[9].

Usability: The review indicated that the usability of the system is a major factor in success[10 20 23]. Patients should be comfortable wearing new kinds of (mobile) monitoring and treatment devices which do not hinder them in their daily life[24 25]. Supporting staff and doctors should be able to operate the devices and should have flexible access to services offered by the telemedicine system[26-29]. Currently, the information and the modality used are not tailored to the situation and skills of the patient and medical personnel.

Quality: Technical problems were a major barrier for successful implementation of telemedicine systems[9 12 21 23 26 28 30-34]. Technical problems included non-connecting or malfunctioning devices, power loss, and cable breakages[20 23 25]. There is a need for robust systems and their supporting infrastructures, which can scale from the pilot studies to a real-life operational situation. Poor technical feasibility often results in distrust by the users and low levels of satisfaction.

Acceptance

Attitude: The review showed that technology acceptance of both patients and professionals were influenced considerably by the patients' and professionals' attitudes towards telemedicine technology. Involvement of patients and professionals in the requirements analysis and the design process is crucial in order to fit telemedicine into their daily work practices[9 12 35-37]. Feelings of ownership, enjoyment, self-efficacy and feelings of pride could be augmented by involving users in the early stages of the developmental process[13 18 30 31 38-41]. Another frequently reported aspect in relation to acceptance is to communicate meaningful (correct, relevant and up to date) information and ideally personalize this information, especially for professionals. Professionals should be able to possess the right patient information at the right time[42-45]. Previous experience of patients and professionals with computers and associated computer skills should be taken into account in developing a telemedicine service as well as level of education and age because these aspects might influence the attitude of users[10 46].

Evidence Based Medicine: Among several studies, evidence-based medicine is regarded as a requirement for acceptance of a new drug or treatment, e.g. telemedicine intervention[9 17 30 31 40 45 47 48]. It is often recommended that the methodology with the highest quality should be employed, which is considered to be the randomized controlled trial (RCT). The results of the present review show that alternative designs might be needed to evaluate the efficacy of telemedicine interventions and to convince professionals, policy makers and insurance companies about implementation.

Diffusion and dissemination: Implementation will be easier when telemedicine applications are generic, i.e. applicable to other (unexpected) patient populations[33 44]. Another condition necessary for the diffusion and dissemination of telemedicine initiatives is creating familiarity with the intervention among the interested parties. The stimulating role of leading champions who are willing and motivated to experiment with the new technology is essential in the process of creating familiarity and enthusiasm[24 26]. The review reveals that different stages exist in the introduction of telemedicine interventions which might affect the process of diffusion. Two phases of usage of the telemedicine technology are common[38]. Initially, there is enthusiasm but thereafter the consideration phase begins which affects the users' motivation of working with

telemedicine, either positively or negatively. In addition, factors of the telemedicine interventions which are likely to create acceptance might be different from factors creating refusal[49]. It would be wise to keep this in mind during the dissemination process[49].

Financing

Provider and structure: Costs associated with telemedicine implementation are related to: (1) investments, (2) maintenance and (3) operational costs of the new system. In the research stages of telemedicine, these costs are funded. However, as soon as the projects are ended, there is a lack of continued working with the telemedicine systems due to lack of financing structure[9 12 13 17 26]. This is difficult as telemedicine is a new type of healthcare delivery for which most insurance companies do not have standard tariffs[10 14]. Several studies have stated that comprehensive cost-effectiveness studies are essential in developing future financing structures[45 47].

Organization

Intramural and extramural work practices: It became clear from the present review that telemedicine implementation is hampered by the fact that working protocols for telemedicine implementations are frequently lacking[50]. In addition, the introduction of telemedicine often influences the structure of the individual organization (intramural) combined with extended collaborations with other healthcare organizations (extramural). For instance, telemedicine might require changes in collaboration and (team) roles, rights and responsibilities[27 41]. Furthermore, the novel working practices introduced by telemedicine do not always fit with existing working protocols in traditional healthcare[14 23 26 42 51].

Policy and Legislation

Policy and legislation: Legislation and policy are a prerequisite for telemedicine implementation[11 12]. The results indicate that legislation and policy for certain aspects of telemedicine implementations are not available. Furthermore, legislation and policy in its current form seems unsuitable for all aspects of novel telemedicine implementations[52]. The results indicate that deployment of wide-scale telemedicine implementations is hard without suiting legislation and policy[36 51]. In addition, conforming to legislation and policy implies additional development effort which increases time-to-

market and costs compared to domains less influenced by legislation and policy[51].

Standardization: Standards form a mechanism to ensure quality and uniform practice[18]. The results show that standards are not yet available for all aspects of telemedicine[51]. Interoperability between telemedicine applications is important to support the current trend of transmural work practices and is not guaranteed without globally accepted standards[51].

Security: Security is important in two ways; patient physical safety and patient information[15 18 29 42 45]. For acceptance of telemedicine implementations adequate security mechanisms have to be taken into account. These security mechanisms should support the crucial trust relation between healthcare providers and patients[15]. The results show that there is also need for secure information transfer and authorization mechanisms[18].

Discussion

The aim of the present literature study was to obtain a comprehensive overview of the determinants which influence the success of telemedicine implementations. The results showed that the identified determinants can be classified into five major categories: (1) Technology, (2) Acceptance, (3) Financing, (4) Organization and (5) Policy and Legislation. Each category contains determinants, which are embedded in a national, cultural and social context. Different stakeholders from different organizations influence these determinants (Figure 7.2).

An inter-organizational multidisciplinary approach, covering all five determinants, would be helpful in developing successful future telemedicine implementations.
First, a core enabler of telemedicine implementations is the technology. Technical issues like, robustness, scalability and quality need to be taken into account, and need to be an integral part of the design of any telemedicine implementation. Given the technical complexity and novelty of telemedicine applications, appropriate training of all personnel regarding the use and technical support of the telemedicine system is required for success.

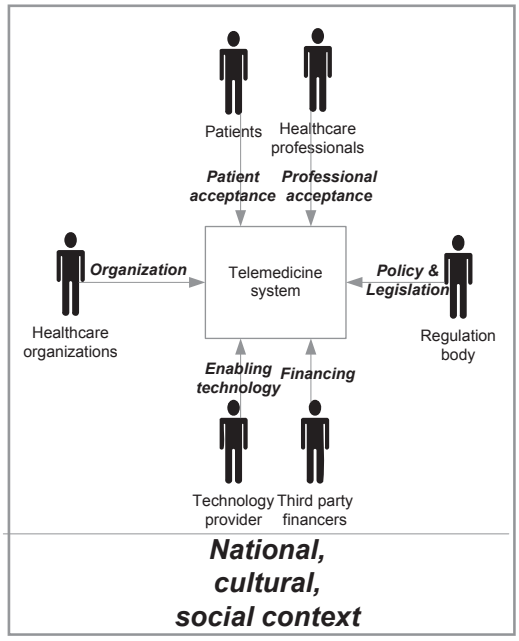

Figure 7.2 Identified determinant categories and their stakeholders

With all technical applications, repetitive training to reinforce familiarity and to maintain skill level is recommended. In addition, it is essential to provide adequate system maintenance. System failures may directly affect the attitude of both professionals and patients.

Second, the acceptance of the users is required. Users (i.e. patients, healthcare providers) of a telemedicine system must be satisfied with its operation and effectiveness. Therefore, as suggested by Berg (1999)[6] users should be involved in the early stages of the development process. There is a lack of methodology to perform well-designed research on the (cost and clinical) effectiveness of telemedicine interventions[53]. Therefore, methodologies need to be developed in order to perform evidence based telemedicine. A staged approached for telemedicine evaluation is proposed by DeChant *et al.* (1996)[54] in which small evaluations are followed by large comprehensive evaluations. In addition, widespread dissemination of telemedicine is important to create awareness among stakeholders, either by impersonal channels or mass media, to motivate the introduction and usage of telemedicine[55].

Third, introducing telemedicine influences the financial situation of various parties in the healthcare process. For example, the distribution of costs and revenues among

these stakeholders might be different from traditional (non-telemedicine) health-care financing. Costs can be related to (1) investments, (2) maintenance and (3) operational costs of the new system. There is a need to redesign business models so that all participants benefit from telemedicine. Finding financial support after the research stage will then be easier. In addition, the way that healthcare is financed in the different countries varies. Therefore, similar telemedicine implementations are likely to require business models to be adapted to the national context.

Fourth, telemedicine influences the healthcare organization. The introduction of telemedicine systems not only influences the working protocols of a single institution (intramural), but might also influence the way healthcare is provided across the boundaries of the institutions (transmural). Furthermore, consideration is needed about how to improve cooperation between health and non-health stakeholders (e.g. technology partners). This requires adapting the organization structure of individual institutes and healthcare in general. It is, however, questionable whether existing healthcare institutes are capable of supporting and executing all aspects of a telemedicine service (e.g. training, consultancy, maintenance and administration). New types of organizations may need to be developed which offer specific aspects needed to provide telemedicine services.

Finally, telemedicine implementations are subject to policy and legislation imposed on different levels (i.e. international, national, regional) by regulatory bodies[56]. This includes policies in the form of legislation, standardization and security. Due to the novelty of telemedicine, policies are mainly focused on non-ICT related aspects of healthcare and not tailored to the specific issues of telemedicine[57 58]. Commonly needed policies are related to the protection of the patient's privacy and the patient's safety. We need better methods and technologies to securely store, transfer and acquire healthcare information without hampering the performance and usability of telemedicine. Furthermore, there is a need for standards to ensure conformance of telemedicine implementations at: (1) the technical level to establish interoperability between the telemedicine implementation parts, and (2) the organizational level to guarantee the quality of the telemedicine process. Systems that conform to a certain standard, which is certified, are more likely to be accepted by governments and possibly patients and healthcare professionals.

The results described in the present study need to be interpreted in the light of some limitations. Currently, there is no generally accepted methodology to systematically identify and score determinants for telemedicine implementations. However, we included methodological information with regard to the study design of the included studies to give an impression of their type. Nevertheless, we acknowledge that other issues (such as high rates of drop-outs and low validity of the outcome measures) might influence the relevance of the reviewed study for our analysis. However, these details were not clearly provided in the reviewed studies. Therefore, the determinants described in this study are the result of a qualitative analysis. Furthermore, the sample of reviewed studies was limited to a selection of the totality of telemedicine papers.

As indicated, developing telemedicine implementations is a multidisciplinary activity (as shown in Figure 7.2). Therefore, it is necessary to collect domain-specific knowledge on the different determinants by involving domain-specific stakeholders. However, the main challenge for telemedicine implementation is not only to address the domain-specific issues but also to integrate the different related domains by interorganizational collaboration (business, government and healthcare). This collaboration is different from market collaboration since in telemedicine the participants usually remain relatively autonomous and must be convinced to act even though mutual interests (e.g. business versus quality of care) and a legitimate authority is lacking. In order to cope with the multidisciplinary complexity, we propose a layered implementation model in which the primary focus on individual determinants changes throughout the development life cycle of the telemedicine implementation. Different determinants should gain focus during the maturity of the telemedicine implementation (Figure 7.3). However, the other determinants should not be ignored. In the prototype phase, the evaluation deals mainly with the technological feasibility such as the availability, quality and support of the used technology. In the small-scale pilot phase, users need to work with the system, which shifts the focus to acceptance. When small-scale telemedicine pilots move to a larger scope, financing and organization become increasingly important. When the systems become an operational product, policy issues must have been tackled. This does not mean that when the scale of telemedicine implementations increases, determinant categories in lower layers are not of interest in higher layers,

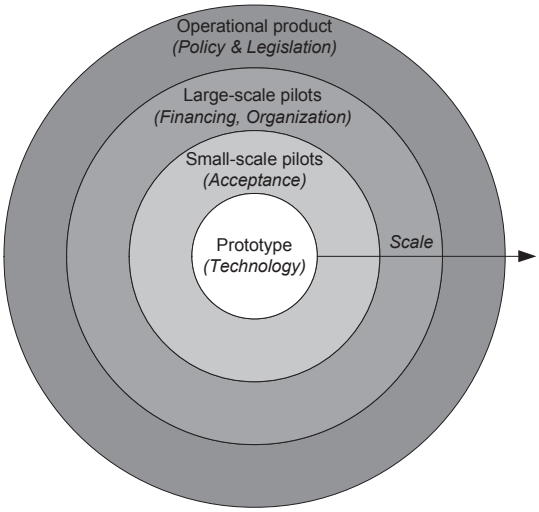

Figure 7.3 Layered implementation model

only that the focus shifts to a specific determinant in that layer. In conclusion, telemedicine implementations implies a visionary approach, which goes beyond tackling specific issues in a particular development phase. Parallel efforts towards the next phases of the telemedicine life cycle can increase the probability of success: "start small, think big". When gaining maturity (i.e. scaling-up) the determinants shift from being specific to an individual implementation to more generic problems common in the telemedicine domain. Therefore, efforts to solve these determinants should not be restricted to the individual implementations but can also benefit from interaction with other initiatives. As stakeholders come to share a vision of the implementation problem there may be mutual agreement upon directions and boundaries, which then become more permanent structures, surviving even after the project (funding) has ended[59].

Acknowledgements

This work is part of the Freeband AWARENESS project sponsored by the Dutch government under contract BSIK 03025. We thank Frans Grobbe for his valuable contribution to this study.

Reference List

1. Dutch Ministry of Health Welfare and Sport (VWS). Health Care in an Ageing Society: A Challenge for all European Countries [Web Page]. 2004; Available at http://www.minvws.nl/images/2508976C.doc_tcm20-107926.pdf.

2. US Department of Health and Human Services. Prevalence of Selected Chronic Conditions [Web Page]. 2006; Available at last checked 3 April 2007.

3. Hjelm NM. Benefits and drawbacks of telemedicine. J Telemed Telecare 2005; 11(2):60-70.

4. Perednia DA, Allen A. Telemedicine technology and clinical applications. JAMA 1995; 273(6):483-8.

5. Tanriverdi H, Iacono CS. Diffusion of telemedicine: a knowledge barrier perspective. Telemed J 1999; 5(3):223-44.

6. Berg M. Patient care information systems and health care work: a sociotechnical approach. Intern Journ of Med Inform 1999; 55:87-101.

7. Banki IS. Dictionary of Administration and Management. Los Angeles, United States of America: Systems Research Inst, 1986.

8. Wootton R, Krupinksi E. Telemed and eHealth '04: Citizen-Centred Care. Journal of Telemedicine and Telecare, 2005.

9. Brebner JA, Brebner EM, Ruddick-Bracken H. Experience-based guidelines for the implementation of telemedicine services. J Telemed Telecare 2005; 11 Suppl 1:3-5.

10. Kavamoto CA, Wen CL, Battistella LR, Bohm GM. A Brazilian model of distance education in physical medicine and rehabilitation based on videoconferencing and Internet learning. J Telemed Telecare 2005; 11 Suppl 1:80-2.

11. MacFarlane A, Clerkin P, Murphy AW. Role flexibility among telemedicine service providers in the north-west and west of Ireland. J Telemed Telecare 2005; 11 Suppl 1:62-4.

12. Tinker A, Lansley P. Introducing assistive technology into the existing homes of older people: feasibility, acceptability, costs and outcomes. J Telemed Telecare 2005; 11 Suppl 1:1-3.

13. Grealish A, Hunter A, Glaze R, Potter L. Telemedicine in a child and adolescent mental health service: participants' acceptance and utilization. J Telemed Telecare 2005; 11 Suppl 1:53-5.

14. Aas IH, Geitung JT. Teleradiology and picture archiving and communications systems: changed pattern of communication between clinicians and radiologists. J Telemed Telecare 2005; 11 Suppl 1:20-2.

15. Brox GA. MPEG-21 as an access control tool for the National Health Service Care Records Service. J Telemed Telecare 2005; 11 Suppl 1:23-5.

16. Chiantera A, Scalvini S, Pulignano G et al. Role of telecardiology in the assessment of angina in patients with recent acute coronary syndrome. J Telemed Telecare 2005; 11 Suppl 1:93-4.

17. Malasanos TH, Burlingame JB, Youngblade L, Patel BD, Muir AB. Improved access to subspecialist diabetes care by telemedicine: cost savings and care measures in the first two years of the FITE diabetes project. J Telemed Telecare 2005; 11 Suppl 1:74-6.

18. Malasanos TH, Patel BD, Klein J, Burlingame JB. School nurse, family and provider connectivity in the FITE diabetes project. J Telemed Telecare 2005; 11 Suppl 1:76-8.

19. Padgham K, Scott J, Krichell A, McEachen T, Hislop L. Misconceptions surrounding videoconferencing. J Telemed Telecare 2005; 11 Suppl 1:61-2.

20. Ryan D, Cobern W, Wheeler J, Price D, Tarassenko L. Mobile phone technology in the management of asthma. J Telemed Telecare 2005; 11 Suppl 1:43-6.

21. Taleb AC, Bohm GM, Avila M, Wen CL. The efficacy of telemedicine for ophthalmology triage by a general practitioner. J Telemed Telecare 2005; 11 Suppl 1:83-5.

22. Jones O. Measurements of the clinical competence of doctors and nurses to process telmedicine referrals for burns patients. J Telemed Telecare 2005; 11 (Suppl. 1):89-91.

23. Courreges F, Vieyres P, Istepanian RS, Arbeille P, Bru C. Clinical trials and evaluation of a mobile, robotic tele-ultrasound system. J Telemed Telecare 2005; 11 Suppl 1:46-9.

24. Huis in't Veld MH, van Til JA, Ijzerman MJ, Vollenbroek-Hutten MM. Preferences of general practitioners regarding an application running on a personal digital assistant in acute stroke care. J Telemed Telecare 2005; 11 Suppl 1:37-9.

25. Scheffler M, Hirt E. Wearable devices for telemedicine applications. J Telemed Telecare 2005; 11 Suppl 1:11-4.

26. Bratan T, Clarke M, Jones R, Larkworthy A, Paul R. Evaluation of the practical feasibility and acceptability of home monitoring in residential homes. J Telemed Telecare 2005; 11 Suppl 1:29-31.

27. Finch T, Mort M, May C, Mair F. Telecare: perspectives on the changing role of patients and citizens. J Telemed Telecare 2005; 11 Suppl 1:51-3.

28. Lee HR, Yoo SK, Jung SM, Kwon NY, Hong CS. A Web-based mobile asthma management system. J Telemed Telecare 2005; 11 Suppl 1:56-9.

29. Linke S, Harrison R, Wallace P. A Web-based intervention used in general practice for people with excessive alcohol consumption. J Telemed Telecare 2005; 11 Suppl 1:39-41.

30. Powell JA, Lowe P, Griffiths FE, Thorogood M. A critical analysis of the literature on the Internet and consumer health information. J Telemed Telecare 2005; 11 Suppl 1:41-3.

31. Kunkler IH, Fielding RG, Brebner J et al. A comprehensive approach for evaluating telemedicine-delivered multidisciplinary breast cancer meetings in southern Scotland. J Telemed Telecare 2005; 11 Suppl 1:71-3.

32. Morgan GJ, Grant B, Craig B, Sands A, Casey F. Supporting families of critically ill children at home using videoconferencing. J Telemed Telecare 2005; 11 Suppl 1:91-2.

33. Nelson EL, Spaulding R. Adapting the Roter interaction analysis system for telemedicine: lessons from four specialty clinics. J Telemed Telecare 2005; 11 Suppl 1:105-7.

34. Pedley DK, Beedie S, Ferguson J. Mobile telemetry for pre-hospital thrombolysis: problems and solutions. J Telemed Telecare 2005; 11 Suppl 1:78-80.

35. Klein D, Davis P, Hickey L. Videoconferences for rural physicians' continuing health education. J Telemed Telecare 2005; 11 Suppl 1:97-9.

36. Mort M, Finch T. Principles for telemedicine and telecare: the perspective of a citizens' panel. J Telemed Telecare 2005; 11 Suppl 1:66-8.

37. Bryson M, Tidy N, Smith M, Levy S. An online survey of nurses' perceptions, knowledge and expectations of the National Health Service modernization programme. J Telemed Telecare 2005; 11 Suppl 1:64-6.

38. Port K, Palm K, Viigimaa M. Daily usage and efficiency of remote home monitoring in hypertensive patients over a one-year period. J Telemed Telecare 2005; 11 Suppl 1:34-6.

39. Soopramanien A, Pain H, Stainthorpe A, Menarini M, Ventura M. Using telemedicine to provide post-discharge support for patients with spinal cord injuries. J Telemed Telecare 2005; 11 Suppl 1:68-70.

40. Mair FS, Goldstein P, May C et al. Patient and provider perspectives on home telecare: preliminary results from a randomized controlled trial. J Telemed Telecare 2005; 11 Suppl 1:95-7.

41. Varga-Atkins T, Cooper H. Developing e-learning for interprofessional education. J Telemed Telecare 2005; 11 Suppl 1:102-4.

42. Black LA, McMeel C, McTear M, Black N, Harper R, Lemon M. Implementing autonomy in a diabetes management system. J Telemed Telecare 2005; 11 Suppl 1:6-8.

43. Lowe P, Hearnshaw H, Griffiths F. Attitudes of young people with diabetes to an Internet-based virtual clinic. J Telemed Telecare 2005; 11 Suppl 1:59-60.

44. Omar A, Wahlqvist ML, Kouris-Blazos A, Vicziany M. Wellness management through Web-based programes. J Telemed Telecare 2005; 11 Suppl 1:8-11.

45. Vontetsianos T, Giovas P, Katsaras T et al. Telemedicine-assisted home support for patients with advanced chronic obstructive pulmonary disease: preliminary results after nine-month follow-up. J Telemed Telecare 2005; 11 Suppl 1:86-8.

46. Malone M, Mathes L, Dooley J, While AE. Health information seeking and its effect on the doctor-patient digital divide. J Telemed Telecare 2005; 11 Suppl 1:25-8.

47. Scalvini S, Capomolla S, Zanelli E et al. Effect of home-based telecardiology on chronic heart failure: costs and outcomes. J Telemed Telecare 2005; 11 Suppl 1:16-8.

48. Scalvini S, Zanelli E, Martinelli G, Baratti D, Giordano A, Glisenti F. Cardiac event recording yields more diagnoses than 24-hour Holter monitoring in patients with palpitations. J Telemed Telecare 2005; 11 Suppl 1:14-6.

49. Spaulding RJ, Russo T, Cook DJ, Doolittle GC. Diffusion theory and telemedicine adoption by Kansas health-care providers: critical factors in telemedicine adoption for improved patient access. J Telemed Telecare 2005; 11 Suppl 1:107-9.

50. Scalvini S, Martinelli G, Baratti D et al. Telecardiology: one-lead electrocardiogram monitoring and nurse triage in chronic heart failure. J Telemed Telecare 2005; 11 Suppl 1:18-20.

51. Barlow J, Bayer S, Castleton B, Curry R. Meeting government objectives for telecare in moving from local implementation to mainstream services. J Telemed Telecare 2005; 11 Suppl 1:49-51.

52. Kerr C, Murray E, Stevenson F, Gore C, Nazareth I. Interactive health communication applications for chronic disease: patient and carer perspectives. J Telemed Telecare 2005; 11 Suppl 1:32-4.

53. Huis in 't Veld MH, van Dijk H, Hermens HJ, Vollenbroek-Hutten MM. A systematic review of the methodology of telemedicine evaluation in patients with postural and movement disorders. J Telemed Telecare 2006; 12(6):289-97.

54. DeChant HK, Walid WG, Mun SK, Hayes WS, Schulman KA. Health systems evaluation of telemedicine: a staged approach. Telemedicine Journal 1996; 2(4):303-12.

55. Rogers EM. Diffusion of innovations. NY, United States of America: The Free Press, 1995.

56. Darkins A, Cary M. Telemedicine and Telehealth: Principles, Policies, Peformance and Pitfalls. New York, United States of America: Springer, 2000.

57. Grigsby J, Sanders JH. Telemedicine: where it is and where it's going. Ann Intern Med 1998; 129(2):123-7.

58. Patel A, Watson M, Habibi P. Unattended home sleep studies for the evaluation of suspected obstructive sleep apnoea syndrome in children. J Telemed Telecare 2005; 11 Suppl 1:100-2.

59. Trist E. Referent organizations and the development of interorganizational domains. Hum Relat 1983; 36:269-84.

CHAPTER 8

General Discussion

8 | General Discussion

Neck-shoulder pain related to computerwork is a major sociomedical and economic problem. The prevalence of neck-shoulder pain is highest in elderly female workers[1,2]. Due to the foreseen increase in computerwork related jobs and the aging of the working population[3], the number of neck-shoulder pain subjects are expected to increase further in the upcoming years. In The Netherlands, work-related complaints in the neck-shoulder region are commonly treated with medications, physiotherapy and/or ergonomic adjustments at the workplace[4]. Despite these interventions roughly half of the subjects continue to experience elevated levels of pain intensity and disability after treatment[5].

There might be several explanations for the limited effectiveness of the currently existing interventions. Two have been addressed in more detail in the present thesis:

1) The current interventions predominantly focus on the somatic components of pain, whereas literature on musculoskeletal pain disorders emphasizes the important contribution of cognitions and coping to pain experience and behaviour[6-8].

2) It can be speculated that treatment is not specific enough due to a lack of individual tailoring of the treatment, and not employed intensively at the workplace itself. As most conservative treatments are provided with a weekly frequency and with a maximum duration of about 30 to 60 minutes, the translation of the learned skill into adaptive behaviour in daily practice is, to a large extent, left to the subject him/herself. A potentially interesting treatment with respect to this "translation of skill" problem is an ambulant biofeedback system which provides continuous feedback to the subject in his/her own daily environment. As an example, the myofeedback system developed by Hermens *et al*. (2002)[9] has proven to be effective by reducing pain intensity and disability after four-weeks of myofeedback[9-11]. However, the myofeedback intervention as such requires a weekly in vivo consultation, which is very time consuming and costly, and therefore the intervention was further developed into a remotely supervised tele-treatment.

This thesis focused on both aforementioned elements to increase the effectiveness of treatment for subjects with neck-shoulder pain as a result of computerwork by

1) obtaining better understanding of the role of cognitive-behavioural factors in the occurrence and the persistence of neck-shoulder pain (Chapter 2 and 3) and,
2) by investigating the feasibility of a new and intensive treatment, namely remotely supervised myofeedback treatment (RSMT). Since teletreatment concepts, such as RSMT, are a relatively new approach in healthcare in general, and the treatment of neck-shoulder pain in specific, its viability with respect to the susceptibility of subjects and professionals (Chapter 4), and the proper research methodology (Chapter 5) was investigated before a pilot study (Chapter 6) could be carried out on the technical feasibility and changes in clinical outcomes of RSMT. Chapter 7 described the determinants that influence successful implementation of these remote treatment concepts. In this final chapter, the main findings of the studies are integrated and evaluated in the context of existing literature and the objective of the current thesis.

The role of cognitive-behavioural factors

In psychology, the beliefs and thoughts subjects have about their pain are called "cognitions"[8], a term which is derived from the Latin word cognosere ("to know"). According to the cognitive-behavioural approach[6 7], cognitions are believed to influence a person's behaviour and vice versa. In relation to pain, this means that subjects employ (un-)conscious cognitive strategies and show pain-related behaviour to modify their pain experience. Little is known about the role of (mal-)adaptive cognitions in a working sample of subjects with neck-shoulder pain.

The results of the present study (Chapter 2) show that perceived neck-shoulder pain and associated disability are indeed not solely determined by the somatic component (pathology), but also by the way subjects think and believe about their pain. A direct relationship between fear-avoidance beliefs, in particular about work, and neck-shoulder pain disability was found. This finding is in line with the literature which state that pain-related fear has a strong predictive power on perceived disabilities, as is postulated in the fear-avoidance model[12-15]. The fear-avoidance model suggests that an individual with musculoskeletal pain will tend to reduce or avoid the physical activity because he/she fears that these activities will increase the pain and suffering. However, in our study not fear-avoidance beliefs about physical activity but fear-avoidance beliefs about work showed the strongest correlation with perceived disability (Chapter 2). In order to measure the nature and amount of fear-avoidance

beliefs in the current sample, the Fear-Avoidance Beliefs Questionnaire (FABQ)[16] and the Tampa Scale for Kinesiophobia (TSK)[17] were used. The FABQ-work subscale was highest correlated with the level of perceived disability. However, the FABQ-work subscale is quite a generic scale and does not provide sufficient information on what exactly the subjects fear in relation to their work. It could be the actual physical activity of the painful trapezius muscle that induces fear, but also conflicts with the supervisor, low social support from co-workers, tight deadlines, or the (future) aversive consequences of their pain, such as loss of income and social exclusion when sick listed. The understanding of fear constructs in work-related neck-shoulder pain would greatly benefit from further refinement, e.g. content distinction, of important fear constructs in work-related neck-shoulder pain.

Whereas in Chapter 2 the path of the fear-avoidance model was explored, it was also hypothesized that other cognitive-behavioural paths can be important in the development and maintenance of musculoskeletal pain. The results of Chapter 3 show that three main coping strategies are used by subjects with neck-shoulder pain, and that subjects can be clustered into three coping profiles, based on these coping strategies. In two subgroups, subjects reported to predominantly use "distraction" along with "suppression and ignorance" strategies to cope with their pain. One of these two subgroups, the so-called "worried suppressors", might perceive the pain to be threatening as illustrated by their use of "worrying and catastrophizing" strategies. "Catastrophizing" is an element of the fear-avoidance circle in which subjects will end up in a vicious circle of fear-avoidance behaviour[14 18]. In correspondence with the fear-avoidance model, this subgroup tended to report the highest level of fear-avoidance beliefs levels. It would therefore be interesting to replicate the study conducted in Chapter 2 in this subgroup. This subgroup together with the subgroup using "distraction" along with "suppression coping" in the absence of "catastropizhing and worrying coping", seem to have some validity because they show resemblances to the subgroups which are discerned in the avoidance-endurance model[12] (Chapter 3). Additionally, in clinical care settings therapists have the ability to empirically classify subjects in line with the avoidance-endurance principles, and start tailoring treatment to these principles. Although the avoidance-endurance model is appealing, it is essentially descriptive, and still lacks scientifically support[19]. In order to further assess the face validity of the

coping profiles discerned, it would be interesting to examine the agreement in the results of our statistical classification to the empirical classification provided by therapists.

The present thesis merely focused on pain-related cognitions and coping which are found to be important factors in the occurrence and persistence of neck-shoulder pain. However, there are other factors which might also be interesting to take into account when classifying subjects. For subjects who are still functioning at the work-place, it would be especially relevant to include the individual's work stress perceptions such as job demands, job control, and support[20] since these are well-known risk factors in neck-shoulder pain[21 22]. Social support (among which could be from co-workers or supervisors) also appears to influence the way subjects cope with their pain. For instance, lack of perceived support from others is shown to stimulate worrying and/or avoidance of fearful activities (for instance physical and social activities), and has a maladaptive impact on functional disability and pain[23 24].

An interesting finding, which was not in line with the hypothesis, was the improvement of our structural equation model by allowing fear to directly predict disability (Chapter 2). In contrast to the assumptions of the fear-avoidance model, this finding seems to indicate that elevated levels of fear-avoidance beliefs are not directly associated with decreased levels of maximum voluntary contraction (MVC) during a shoulder elevation task of the painful trapezius muscle. Also in contrast to our expectations, no significant differences in MVC could be detected between the three subgroups (Chapter 3). As a result of these findings (Chapter 2 and 3), the behavioural avoidance concept could not be supported. Therefore, one could speculate that pathways other than behavioural avoidance described in the fear-avoidance model exist in neck-shoulder pain. In line with this reasoning, when compared to "catastrophizing and worrying" strategies which were previously linked to behavioural avoidance, our results show that subjects used "distraction" (e.g. when I feel pain I leave the house and do something) and "suppression and ignorance" coping (e.g. when I have pain I just go on as if nothing happened) more often (Chapter 3). In contrast to behavioural avoidance, distraction and suppression coping are more likely to be related to behavioural per-sistence. Likewise, previous research has shown that some patients with

chronic pain, especially work-related upper extremity pain, tend to persist rather than escape or avoid physical activity[19]. Yet, more research needs to be performed on the identification of these behavioural strategies and their relation to the coping profiles.

One difficulty in our studies that might have influenced the lack of support for the behavioural avoidance concept was the operationalization of behavioural avoidance as the maximum voluntary contraction (MVC) of the trapezius muscle (Chapter 2 and 3). In relation to the assumptions of the fear-avoidance model, the threat expectancy of shoulder elevation during the MVC task might not have been specific enough and may therefore not have approximated the threat subjects perceive during their computer related activities. Literature suggests that fear-avoidance beliefs are event and/or movement-specific and that pain expectancies are not generic for all physical activities[25]. So, future research should be aimed at further establishing the construct of fear in subjects with neck-shoulder pain and identifying the overt pain-related behavioural avoidance in daily life but also at the workplace.

When considering all abovementioned aspects in relation to treatment, it is recommended to tailor treatment to the needs of subjects with neck-shoulder pain related to computerwork, especially by taking into account the influence of maladaptive cognitions and the strategies to cope with the pain. Extending existing literature on pain coping and associated pain-related behaviour to a working population, as was done in the present thesis, could help to design new effective treatment modalities at the workplace for the management of pain but, perhaps even more important, the prevention of prolonged pain and all its aversive consequences.

The role of remotely supervised treatment

As remotely supervised myofeedback treatment (RSMT) is a relatively new concept in the provision of treatment in neck-shoulder pain, the susceptibility of both professionals and patients for remote treatment in daily practice was investigated. Both patients and healthcare professionals were found to have a positive attitude towards intended usage (Chapter 4). An interesting point, related to the self-efficacy in using remote concepts, was raised by the professionals. As remote treatment changes the way the therapist and the patient communicate, these concepts are feared to become

a new barrier in an already complex professional-patient relationship, e.g. is feared to lead to depersonalization, and could thereby affect the health outcomes of patients[26]. In relation to the self-efficacy to appropriately deliver RSMT, professionals indeed stressed the importance of non-verbal communication and physical interaction (Chapter 4). The professional-patient relationship is defined in literature as "one of the most complex interpersonal relations, in that it involves individuals who are not on the same level, it has not been sought by both individuals, it is emotionally loaded and it requires close mutual co-operation towards a shared goal"[27]. The extent to which the absence of non-verbal communication and physical interaction could affect the patient-professional relationship is still unclear. For instance, a previous study concluded that professionals had a tendency to express less empathy in remote consultations compared with face-to-face consultations[28]. Contrastingly, the remote communication mode has the ability to empower (ask more questions) patients in their attitude to the professional, who in turn used more verbal cues to gain confirmation that the message which was sent was clear[29]. Based upon literature and the results of Chapter 4, it was chosen to apply a hybrid (remote and in vivo) consultation set-up in the introduction of RSMT (Chapter 6). In future research, alterations in the content of the communication and the affective elements in the professional-patient interaction in RSMT are recommended to be investigated compared to usual care and/or non-remote myofeedback treatment.

The results indicate that RSMT show equal or slightly better changes in pain intensity and disability in subjects with neck-shoulder related to computer work compared to myofeedback treatment provided in vivo (Chapter 6). However, it needs to be remarked that the initial pain intensity scores (median of 6.0) found at baseline in our study are higher compared to the initial pain intensity scores (mean below 4) reported in previous studies investigating myofeedback[9 11]. This could have affected the potential for improvement and treatment effect.
Several explanations can be put forward to explain the additional positive outcome of RSMT. An important factor may be that, during treatment, subjects are aware that the therapist is able to view their data on the secured server at anytime and anyplace. This notion could have increased their treatment compliance. An increase of the intensity of the treatment, as a result of increased treatment compliance, is likely to

be associated with improved learning and better health outcomes[30]. Other favorable components of RSMT could be the feedback provided to the subject. First, the display of the PDA provided subjects with visual feedback on the amount of muscle activation and relaxation. Literature shows that visual feedback is dominant over other types of feedback (tactile, auditory) and increases learning[31]. Second, the vibrating signal which is coupled with insufficient levels of muscle relaxation in traditional myofeedback treatment is thought to be a rather negative reinforcement for the patient. The possibility to actually view the level of muscle relaxation on the visual display of the PDA in RSMT adds feedback on success, i.e. sufficient muscle relaxation, a form of positive reinforcement. Compared to negative reinforcement, positive reinforcement is often associated with increased learning and greater learning effects[32]. Third, along with knowledge of "results" (e.g. sound and vibration) subjects are provided with knowledge of "performance" by view-ing their muscle activation and relaxation patterns on the visual display of the PDA. Knowledge of performance is considered important in the acquisition of a skill[30], i.e. relaxation of the trapezius muscle.

Despite the positive clinical outcome of RSMT in a considerable part of the study population, there is a subgroup that did not report a reduction in pain intensity and disability after four weeks of treatment. Prior research suggests that myofeedback training is especially effective in subjects who ignore and suppress pain-related sensations in dealing with their neck-shoulder pain[33]. Therefore, RSMT is hypothesized to be especially effective in two of the three subgroups discerned in Chapter 3, i.e. the subjects who reported elevated levels of suppression and ignorance. Another potential way to increase the effectiveness of RSMT is the provision of subgroup-tailored feedback. It was shown (Chapter 3) that one of the subgroups, i.e. "worried suppressors", feels threatened by the pain. This subgroup is speculated to benefit more from positive reinforcement ("rewarding" appropriate behaviour), whereas negative reinforcement, i.e. feedback about their failure, might further increase the level of pain-related fear when "punished" for maladaptive pain-related behaviour[34 35].

The determinants which influence the successful implementation of RSMT can be classified into five major domains namely acceptance, technology, organization, financing, and policy and legislation (Chapter 7). Results show that one of the determinants

within the acceptance domain is the scientific evidence about the effectiveness of remote treatment concepts (Chapter 7). Nevertheless, Chapter 5 revealed that the focus of effect-evaluation of remote treatment concepts is still on technical feasibility and user satisfaction, and to a lesser extent on the clinical effectiveness. Therefore, together with measures on technical feasibility and user satisfaction relevant clinical outcome measures were included in the effect evaluation of RSMT (Chapter 6). An added benefit was that these results could be compared to the results of non-remote myofeedback treatment in a historical-cohort[9 11].

In the evaluation of the technical feasibility and changes in clinical outcome of RSMT, a staged approach methodology for telemedicine evaluation[36] is applied (Chapter 6). According to DeChant *et al*. (1996)[36], telemedicine research in later stages may profit from small scale testing and "hands-on experience" of potential end-users in the developmental stage[37]. This comprehensive approach emphasizes the importance of adjusting the study design to the (im)maturity of the technology. The benefit of small scale testing is that valuable end-user input is obtained that can result in product refinement within a reasonable period of time[38]. This corresponds very well with the iterative character of the sociotechnical approach of Berg (1999)[39].
Likewise, the results of our small scale evaluation of RSMT (Chapter 6) provide useful indicators for likely problems during implementation. The results show that RSMT is technically feasible but refinements are needed, particularly in the body area network, before further deployment and effect-evaluation should take place. Only when the technology has been proven to be "ready for clinical use", conducting a randomized control trial on a large scale is recommended and the working mechanisms of the RSMT in neck-shoulder pain subjects, which are still working, can be more usefully and fundamentally investigated by measuring alterations in cognitive-behavioural factors. Besides the challenge of assessing the multidimensional spectrum of possible effects of remote treatment concepts, effect evaluation of telemedicine interventions also poses other challenges on traditional effect evaluation. For instance, in conducting an RCT one has to keep in mind the selection of a valid control intervention (e.g. usual care versus non-remote myofeedback treatment?) which is dependent on the study objective (e.g. effectiveness of RSMT compared to what?)[40]. In addition, the performance and efficacy of an immature technology compared to a control intervention

(e.g. usual care) can negatively influence the measured effectiveness in a way that is not a reflection of its true effectiveness in more mature stages of development. Furthermore, blinding may be difficult or impossible when the intervention is provided remotely (as in RSMT) and the control intervention is not. Finally, it may be difficult to recruit and enroll patients for reasons other than in non-remote interventions because of lack of access to the technology, lack of skills and intimidation or fear of technology[40].

In line with the methodology of DeChant *et al.* (1999)[36] future research has to move to evaluating the global impact of RSMT on health care. In these evaluations, sample sizes should be large enough to obtain scientific evidence in all domains of interest (quality, access, costs). Aside from obtaining high-quality scientific evidence on the impact of RSMT, future implementation is believed to benefit from obtaining insight in the financial revenues after external sources of (project) funding are withdrawn (Chapter 7)[41 42]. The results show that it is important to have a "vision" on how RSMT should be provided in routine care (Chapter 7). A clear business model, which is essentially a description of the way an entity or network of entities intends to benefit from or create added value through the application of technology[43], may be a conceivable starting point for the definition of the endpoints for a more global assessment of RSMT.

Methodological considerations

Because the prevalence of neck-shoulder pain is higher in women and increases with age, older female workers were included in Chapter 2 and 3 of the present thesis. However, the generalizability of the results on cognitive-behavioural factors in neck-shoulder pain related to computerwork is probably limited, and the extent to which the results are gender-specific and age-related deserves further attention. Although still inconclusive, literature suggests that women rate pain more intense and male have more anxiety[44 45]. With respect to age, Cook *et al.* (2006)[46] found a stronger mediating role for fear-avoidance beliefs between catastrophizing and disability for older (>55 years) as compared their middle-aged (41-54 years) pain patients, among which is the age of our study population (mean 49.5 years, SD=5).

As a result of the in- and exclusion criteria applied in Chapter 2 and 3 (subjects had to work at least 20 hours a week), a healthy workers effect could have occurred. All

subjects were still functioning despite their complaints at a relatively high age. In addition, due to the voluntary character of the request for participation in the present study, typical "avoiders" as postulated in the fear-avoidance model could have been excluded because they avoided participation or they were already sick listed from work. Due to a lack of standardized diagnostic tests[47], subjects were included based on qualitative assessment of their pain by means of questionnaires. This could have resulted in a rather heterogeneous study population (Chapter 2, 3, and 6). This issue is reflected in the fact that the mean pain intensity and disability level of subjects included in RSMT (Chapter 6) is much higher compared to the pain intensity and disability levels of the study population in Chapter 2 and 3. However, this heterogeneity could be representative of the working pain population seen in the daily practice of occupational health therapists. Finally, in evaluating the clinical changes in RSMT (Chapter 6) no non-intervention group was included which makes it hard to control for non-specific effects like time-effects. However, the study population contained subjects with a long duration of complaints (range 10-300) who received a variety of treatments in the past which were not sufficiently successful and any spontaneous recovery is thought to be unlikely.

Conclusion

From the studies presented in this thesis it can be concluded that maladaptive cognitions can play an important role in the pain experience of older highly functional female subjects, suffering from neck-shoulder pain related to computerwork. Catastrophizing and worrying, suppression and ignorance, distraction and fear-avoidance beliefs (about work) probably are important dimensions in sustaining pain complaints related to computerwork. In addition, subgroups of subjects seem to exist characterized by their specific subgroup-unique coping profiles being suppression, worried suppression and minimized copers. Treatment for neck-shoulder pain could be more effective when these underlying cognitions and coping strategies are taken into account when selecting treatment.

It was shown that remotely supported myofeedback treatment (RSMT) would be accepted by professionals on condition that in vivo-interaction between the professional and the patient remained a part of the treatment protocol. Small-scale evaluation of the RSMT appeared to show beneficial changes in clinical outcomes in a considera-

ble part of the study population. These preliminary results suggest that an individually tailored and high-intensity treatment at the workplace potentially contributes to more effective treatment in neck-shoulder pain. However, the technology should be improved before further evaluation and deployment is considered. Future research should be aimed at investigating the effectiveness of RSMT on a larger scale, with more mature technology, while taken into account the cost-effectiveness as well.

Reference List

1. Treaster DE, Burr D. Gender differences in prevalence of upper extremity musculoskeletal disorders. Ergonomics 2004; 47(5):495-526.

2. Ostergren PO, Hanson BS, Balogh I et al. Incidence of shoulder and neck pain in a working population: effect modification between mechanical and psychosocial exposures at work? Results from a one year follow up of the Malmo shoulder and neck study cohort. J Epidemiol Community Health 2005; 59(9):721-8.

3. de Hecker DE, Occupational Employment projections to 2010 [Web Page]. 2001; Available at http://www.bls.gov/opub/mlr/2001/11/art4full.pdf.

4. Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D. Survey of chronic pain in Europe: Prevalence, impact on daily life, and treatment. European Journal of Pain 2006; (10):287-333.

5. Enthoven P, Skargren E, Oberg B. Clinical course in patients seeking primary care for back or neck pain: a prospective 5-year follow-up of outcome and health care consumption with subgroup analysis. Spine 2004; 29(21):2458-65.

6. Turk DC, Meichenbaum D, Genest M. Pain and behavioural medicine, a cognitive-behavioural perspective. New York: Raven Press, 1983.

7. Turk DC, Meichenbaum D. A cognitive-behavioural approach to pain management. In P.D. Wall & Melzack R. (Eds) Textbook of Pain. Edinburgh: Churchill Livingstone, 1994.

8. Fernandez E, Turk DC. The utility of cognitive coping strategies for altering pain perception: a meta-analysis. Pain 1989; 38(2):123-35.

9. Hermens HJ, Hutten MMR. Muscle activation in chronic pain: its treatment using a new approach of myo-feedback. Int J Indust Ergon 2002; 30:325-36.

10. Voerman GE, Vollenbroek-Hutten MM, Hermens HJ. Changes in pain, disability, and muscle activation patterns in chronic whiplash patients after ambulant myofeedback training. Clin J Pain 2006; 22(7):656-63.

11. Voerman GE, Sandsjö L, Vollenbroek-Hutten MM, Larsman P, Kadefors R, Hermens HJ. Effects of Ambulant Myofeedback Training and Ergonomic Counselling in Female Computer Workers with Work-Related Neck-Shoulder Complaints: A Randomized Controlled Trial. J Occup Rehabil 2007.

12. Hasenbring M, Hallner D, Klasen B. Psychologische mechanismen im prozess der schermzchronifizierung: unter- oder überbewertet? [Psychological mechanisms in the transition from acute to chronic pain: over- or underrated?]. Schmerz 2001; 15(6):442-7.

13. Hasenbring M, Marienfeld G, Kuhlendahl D, Soyka D. Risk factors of chronicity in lumbar disc patients. A prospective investigation of biologic, psychologic, and social predictors of therapy outcome. Spine 1994; 19(24):2759-65.

14. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995; 62(3):363-72.

15. Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000; 85(3):317-32.

16. Vendrig A, Duetz P, Vink I. Nederlands vertaling en bewerking van de Fear-Avoidance Beliefs Questionnaire (FABQ) [Dutch translation and modification of the Fear-Avoidance Beliefs Questionnaire]. Nederlands Tijdschrift Voor Pijn En Pijnbestrijding 1998; 18:11-4.

17. Miller RP, Kori SH, Todd DD. The Tampa Scale. Unpublished Report 1991.

18. Vlaeyen JW, Crombez G. Fear of movement/(re)injury, avoidance and pain disability in chronic low back pain patients. Man Ther 1999; 4(4):187-95.

19. Vlaeyen JW, Morley S. Active despite pain: the putative role of stop-rules and current mood. Pain 2004; 110(3):512-6.

20. Karasek R, Theorell T. Healthy work. New York, United States of America: Basic Books, 1990.

21. Andersen JH, Kaergaard A, Mikkelsen S et al. Risk factors in the onset of neck/shoulder pain in a prospective study of workers in industrial and service companies. Occup Environ Med 2003; 60(9):649-54.

22. Andersen JH, Kaergaard A, Frost P et al. Physical, psychosocial, and individual risk factors for neck/shoulder pain with pressure tenderness in the muscles among workers performing monotonous, repetitive work. Spine 2002; 27(6):660-7.

23. Cohen S, Wills TA. Stress, social support and the buffering hypothesis. Psychological Bulletin 1998; 98:310-57.

24. Evers AWM, Kraaimaat FW, Geenen R, Jacobs JWG, Bijlsma JWJ. Pain coping and social support as predictors for long-term functional disability and pain in early rheumatoid arthritis. Behaviour Research and Therapy 2007; 41:1295-310.

25. Goubert L, Crombez G, Eccleston C, Devulder J. Distraction from chronic pain during a pain-inducing activity is associated with greater post-activity pain. Pain 2004; 110(1-2):220-7.

26. Miller EA. Telemedicine and doctor-patient communication: a theoretical framework for evaluation. J Telemed Telecare 2002; 8(6):311-8.

27. Onor ML, Misan S. The clinical interview and the doctor-patient relationship in telemedicine. Telemed J EHealth 2005; 11(1):102-5.

28. Liu X, Sawada Y, Takizawa T et al. Doctor-patient communication: a comparison between telemedicine consultation and face-to-face consultation. Intern Med 2007; 46(5):227-32.

29. Tachakra S, Rajani R. Social presence in telemedicine. J Telemed Telecare 2002; 8(4):226-30.

30. Schmidt RA, Lee TD. Motor control and learning: A behavioural emphasis. San Francisco, United States of America: Human Kinetics, 1999.

31. Halsband U, Lange RK. Motor learning in man: a review of functional and clinical studies. J Physiol Paris 2006; 99(4-6):414-24.

32. van Dijk H, Voerman GE, Hermens HJ. The influence of stress and energy level on learning muscle relaxation during gross-motor task performance using electromyographic feedback. Appl Psychophysiol Biofeedback 2006; 31(3):243-52.

33. Voerman GE, Vollenbroek-Hutten MMR, Sandsjö L, Kadefors R, Hermens HJ. Prognostic factors for the effect of interventions for work-related neck-shoulder complaints: Myofeedback training and ergonomic counseling. Submitted 2007.

34. van den Hout JH, Vlaeyen JW, Houben RM, Soeters AP, Peters ML. The effects of failure feedback and pain-related fear on pain report, pain tolerance, and pain avoidance in chronic low back pain patients. Pain 2001; 92(1-2):247-57.

35. Levine FM, Krass SM, Padawer WJ. Failure hurts: the effects of stress due to difficult tasks and failure feedback on pain report. Pain 1993; 54(3):335-40.

36. DeChant HK, Walid WG, Mun SK, Hayes WS, Schulman KA. Health systems evaluation of telemedicine: a staged approach. Telemedicine Journal 1996; 2(4):303-12.

37. Finch T, May C, Mair F, Mort M, Gask L. Integrating service development and evaluation in telehealthcare: an ethnographic study. BMJ 2003; 327:1205-9.

38. Bonder S, Zajtchuk R. Changing the paradigm for telemedicine development and evaluation: a prospective model-based approach. Socio-Econ. Plann. Sci. 1997; 4:257-80.

39. Berg M. Patient care information systems and health care work: a sociotechnical approach. Intern Journ of Med Inform 1999; 55:87-101.

40. Dansky HK, Thompson D, Sanner TA, framework for evaluating eHealth research. Evaluation and Program Planning 2006; 29:397-404.

41. Al-Qirim N. Championing telemedicine adoption and utilization in healthcare organizations in New Zealand. Int J Med Inform 2007; 76(1):42-54.

42. McCue MJ, Paslbo SE. Making the business case for telemedicine: an interactive spreadsheet. Telemedicine and EHealth 2006; 12(2):99-106.

43. Freeband Consortium. Freeband Business Blueprint Method [Web Page]. 2004; Available at http://www.freeband.nl/kennisimpuls/projecten/b4u/businessmodellen.html.

44. Edwards R, Augustson EM, Fillingim R. Sex-specific effects of pain-related anxiety on adjustment to chronic pain. Clin J Pain 2000; 16(1):46-53.

45. Frot M, Feine JS, Bushnell MC. Sex differences in pain perception and anxiety. A psychophysical study with topical capsaicin. Pain 2004; 108(3):230-6.

46. Cook AJ, Brawer PA, Vowles KE. The fear-avoidance model of chronic pain: validation and age analysis using structural equation modeling. Pain 2006; 121(3):195-206.

47. Buckle PW, Devereux JJ. The nature of work-related neck and upper limb musculoskeletal disorders. Appl Ergon 2002; 33(3):207-17.

SUMMARY

SAMENVATTING

DANKWOORD

CURRICULUM VITAE

Summary

Neck-shoulder pain related to computerwork has become a major sociomedical and economic problem because it affects a considerable part of the working population. In the Netherlands, subjects with these complaints are often treated with medications (e.g. muscle relaxants), ergonomic adjustments and/or physiotherapy.

Whereas these interventions achieve beneficial effects in some subjects, the complaints and associated disabilities remain in a considerable part of the subjects. The aim of the present study was to contribute to more effective and efficient treatment of neck-shoulder pain related to computerwork by 1) obtaining better understanding of the role of cognitive-behavioural factors in the occurrence and persistence of neck-shoulder pain, and 2) investigating the feasibility of an innovative and highly-intensive treatment, e.g. remotely supervised myofeedback treatment.

With respect to the first objective, literature on musculoskeletal pain disorders emphasizes the important contribution of cognitions to pain experience and behaviour. A well-known cognitive-behavioural model addressing this aspect is the fear-avoidance model. This model assumes that subjects who experience the pain to be highly threatening tend to avoid physical activities in anticipation and expectation on pain, instead of a response to it. Consequently, due to a detriment in both physical and psychological condition, the pain experienced becomes more severe which in turn reinforces fear. Subjects will end up in a vicious circle of pain experience and pain avoidance behaviour. In addition to this fear-avoiders coping profile, the avoidance-endurance model postulates an alternative coping profile in which subjects, irrespective of the level of pain, deliberately attempt to suppress or ignore the pain and continue their activities. To date, studies which examine the role of the different cognitive-behavioural models mainly involve clinical populations and most often concern low back pain patients who are on sick leave. There are, however, preliminary indications that these models might also be valid in a population suffering from neck-shoulder pain who are still working. This issue is explored further in the first part of the current thesis.

With respect to the second objective, it is often speculated that current treatment of pain syndromes should be more intense, more individually tailored and more integrated in the activities of daily living to be more effective. Most conservative treat-

ments are provided on weekly basis with a maximum duration of about 30-60 minutes. Consequently, the translation of the skill, which was learned during treatment to accomplish adaptive behaviour, to the workplace is left to the subject him/herself. A portable myofeedback system, which provides continuous feedback to the subjects while working, has the potential to increase treatment effectiveness by creating a highly intensive treatment in the subject's own daily environment. Results show that this treatment is effective in a considerable part of subjects with work-related neck-shoulder pain. However, to make this treatment more effective and efficient it was further developed into a remotely supervised (tele-)treatment. Its viability with respect to the susceptibility of subjects and professionals was investigated in the second part of this thesis. Also a review on the proper research methodologies for telemedicine effect evaluation was performed, followed by a pilot study on the feasibility and changes in clinical outcomes of remotely supervised myofeedback treatment (RSMT). In addition, a review was carried out into the determinants that influence successful implementation of such remote treatment concepts.

In Chapter 2 the role of the fear-avoidance model was investigated in a working population of female computer workers suffering from neck-shoulder pain. In line with the fear-avoidance model, the results revealed a significant association between fear-avoidance beliefs, about work (assessed with the Fear Avoidance Beliefs Questionnaire work subscale) in particular, and self-reported disabilities (assessed with the Neck Disability Index). Remarkably, and in contrast to the assumptions made in the fear-avoidance model a direct relationship was found between fear-avoidance beliefs and disability, without the mediating role of affected levels of maximal voluntary contraction (MVC) of the trapezius muscle. It was concluded, that fear-avoidance beliefs play an important role in computerwork-related neck-shoulder pain disability, regardless of physical performance, i.e. physical impairment.

In Chapter 3 different coping strategies, which are commonly applied by a working population to deal with their neck-shoulder pain, were explored (assessed with the Coping Strategies Questionnaire). The results showed that subjects with neck-shoulder pain who are still functional at the workplace used "suppression and ignorance", "distraction", and "catastrophizing and worrying" strategies to cope with their pain.

Three subgroup-specific coping profiles, i.e. combinations of the beforementioned coping strategies, could be differentiated in our study sample. The largest subgroup consisted of subjects using suppression and ignorance along with distraction coping in dealing with their pain and was therefore labeled “suppressors”. This subgroup might correspond with the endurance copers of the avoidance-endurance model. The second subgroup was made up of subjects who used catastrophizing and worrying strategies besides suppression and ignorance, and distraction. This subgroup was named “worried suppressors” and might show resemblances with the fear-avoiders profile as postulated in the fear-avoidance model. The smallest subgroup consisted of subjects without any outspoken coping profile, i.e. “minimized copers”. In line with our expectations and the fear-avoidance model, the worried suppressors tended to report the highest level of catatstrophic thoughts and showed the lowest level of maximal voluntary contraction (MVC). However, none of these differences reached statistical significance. The fact that at least two of the three subgroup-specific coping profiles show resemblances with profiles known from the cognitive-behavioural models supports the hypothesis that subjects can be classified in subgroups which, in turn, might enable to tailor treatment to the specific needs and/or pain-related working mechanisms. More research, however, is needed to identify the optimal method of, and variables to be included in, differentiating subgroups of subjects with neck-shoulder pain related to computerwork.

Chapters 4, 5 and 6 elaborated on the possible acceptance and effectiveness of remotely supervised myofeedback treatment (RSMT). In RSMT, subjects wear a harness under their clothes during their daily work that continuously measures the amount of muscle relaxation of the trapezius muscle. When the amount of muscle relaxation is insufficient the ambulant feedback device, which the subject wears with him, starts to vibrate. This vibration serves as a sign for subjects to relax their trapezius muscle. In RSMT, the ambulant myofeedback system is equipped with a (secured) wireless connection over which the muscle relaxation data are send to a secured server which is accessible by the therapist at anytime at anyplace. So, the treatment is no longer hampered by the necessity of in vivo visits between the subject and the therapist as consultations can take place remotely.

In Chapter 4 the susceptibility of subjects with neck-shoulder pain related to computerwork and healthcare professionals toward RSMT was examined by means of the Attitude- social Support- self Efficacy (ASE) model. The results indicated a positive attitude in subjects and professionals. The majority of patients reported to be willing to undergo RSMT. In addition, 40% of the subjects and all professionals who provide the non-remote myofeedback treatment believed their self-efficacy to be sufficient for RSMT. With respect to this self-efficacy, the importance of non-verbal communication and physical interaction was stressed in remote treatment concepts. The complete absence of in vivo consultation was feared to negatively affect the therapeutic relationship. Based on these findings, in vivo consultation was alternated with remote consultation in the RSMT protocol, which was evaluated in Chapter 6.

In Chapter 5 a review on the methodology, which is used in the evaluation of telemedicine interventions for postural and movement disorders, was conducted. The results showed that most studies are primarily focused on examining the technical feasibility and acceptability of the telemedicine service rather than on the overall effect of the introduction of the telemedicine service into routine health care. It was suggested that alternative methodologies, than those currently applied in traditional pharmaceutical research, could be valuable in the evaluation of telemedicine evaluations. The Staged Approach Evaluation of Telemedicine of DeChant is an example of such an alternative methodology.

Based on this methodology, in Chapter 6, RSMT was evaluated in a small sample of workers with neck-shoulder pain related to computer work. The results showed that RSMT s technical feasible for clinical use, and that subjects were satisfied with the remote consultation sessions. After four weeks of RSMT, a considerable part of the population (50-80%) reported a clinical relevant reduction in pain intensity and disabilities. The changes in clinical outcomes induced by RSMT tended to be equally or slightly better compared to myofeedback provided in vivo. The methodology of DeChant appeared to be a useful methodology as it contains a comprehensive evaluation covering multiple endpoints, allows user input and deals with the (im)maturity of the technology. Thereby, RSMT can be optimized within a reasonable short time span. Chapter 6 was considered to be a practical illustration of this rather abstract methodology.

In Chapter 7 the factors associated with the successful implementation of remote treatment concepts were identified. The results showed that these factors can be categorized in five major categories namely acceptance, technology, organization, financing and policy and legislation. It was concluded that telemedicine implementation is a difficult process as it requires a multidisciplinary, interorganizational and transsectorial collaboration. A layered implementation model implying a visionary approach was proposed. The basic underlying philosophy is "start small, think large". As stakeholders come to share a vision of the implementation, there may be mutual agreement upon directions and boundaries for collaboration, which then become more permanent structures surviving after project (funding) has ended.

In the final chapter (Chapter 8) the findings of the different studies, which were presented in this thesis, were integrated and discussed and recommendations for future research were proposed. It was concluded that maladaptive cognitions probably play an important role in neck-shoulder pain related to computerwork and that subgroup-unique coping profiles can be discerned, at least in the elderly female. Although additional research into the relation between the subgroup-unique coping profiles and fear-avoidance beliefs is necessary, these results indicate the importance of taking psychological aspects into account in the treatment of subjects with work-related neck-shoulder pain who are still functioning at the workplace. The different coping profiles could plead for more tailored treatment. By means of remotely supervised myofeedback treatment an individually tailored and highly intensive treatment is offered to subjects with neck-shoulder pain at the workplace. A preliminary evaluation showed that this treatment was technically feasible and induced changes in clinical outcomes.

Samenvatting

Nek-schouder klachten als gevolg van computerwerk vormen een groot sociomedisch en economisch probleem, omdat het een aanzienlijk deel van de werkende populatie treft. In Nederland worden mensen met nek-schouderklachten veelal behandeld met medicatie (zoals spierverslappers), ergonomische werkplek-aanpassingen en fysiotherapie. Hoewel deze interventies bij een gedeelte van de mensen een gunstig effect hebben, blijven de klachten en beperkingen bij een aanzienlijk deel van de mensen bestaan. Het doel van dit proefschrift is een bijdrage te leveren aan het vergroten van de effectiveit en efficiëntie van behandelingen voor mensen met nek-schouder klachten die gerelateerd zijn aan computerwerk door 1) beter begrip te krijgen van de rol van cognitief-gedragsmatige factoren in het ontstaan en in stand houden van nek-schouder klachten en 2) de haalbaarheid van een hoog-intensieve en innovatieve behandeling, zijnde een op-afstand gesuperviseerde myofeedback behandeling, te onderzoeken.

Met betrekking tot het eerste doel wordt in de literatuur benadrukt, dat cognities een belangrijke rol spelen bij het ontstaan en in stand houden van pijn en pijngedrag. Een welbekend cognitief-gedragsmatig model is het angst-vermijdings model (Nederlandse vertaling van het fear-avoidance model). Dit model gaat ervan uit, dat mensen die hun pijn als bedreigend ervaren geneigd zijn lichamelijke activiteiten te vermijden als anticipatie en verwachting op pijn in plaats van een respons op pijn. Door het vermijden van lichamelijke activiteiten verslechtert de fysieke en psychologische conditie, waardoor de pijn zal verergeren en angst-gevoelens worden verstrekt. Mensen belanden in een vicieuze cirkel van pijn en pijn-vermijdingsgedrag. Naast dit angst-vermijdings profiel, wordt in het over- en onderbelastingsmodel (Nederlandse vertaling van het avoidance-endurance model) een alternatief coping-profiel onderscheiden, waarin mensen met pijn opzettelijk proberen de pijn te onderdrukken en ontkennen en door gaan met hun activiteiten, ongeacht de mate van pijn. De studies die de rol van cognitief-gedragsmatige modellen hebben onderzocht richten zich tot op heden voornamelijk op klinische patiëntenpopulaties met lage rugpijn en met ziekteverlof. Er zijn echter eerste indicaties dat deze modellen ook van toepassing kunnen zijn op een populatie met nek-schouder pijn die nog aan het werk is. Dit is verder onderzocht

in het eerste gedeelte van dit proefschrift.
Met betrekking tot het tweede doel wordt vaak gespeculeerd dat de huidige behandelingen van pijn onvoldoende toegespitst zijn op het individu, onvoldoende intensief zijn en onvoldoende worden geïntegreerd in de dagelijkse omgeving van de patient. De meeste conservatieve behandelingen worden op een wekelijkse basis gegeven met een maximum duur van ongeveer 30-60 minuten. Als gevolg daarvan wordt het leren toepassen van de, in de behandeling geleerde vaardigheid voor gezond gedrag op de werkplek voornamelijk overgelaten aan het individu zelf. Een draagbaar myofeedback systeem dat continue terugkoppeling geeft aan het individu terwijl deze aan het werk is, heeft de mogelijkheid de effectiviteit van behandelingen te vergroten, omdat daardoor een hoog-intensieve behandeling wordt bewerkstelligd in de dagelijkse omgeving van het individu. Resultaten laten zien dat deze behandeling effectief is voor een aanzienlijk deel van de mensen met werkgerelateerde nek-schouder klachten. Echter, om deze behandeling nog effectiever en efficiënter te maken is deze verder ontwikkeld in een op-afstand gesuperviseerde behandeling. In het tweede gedeelte van dit proefschrift is de ontvankelijkheid ervan onder behandelaars en patiënten onderzocht. Ook is een literatuur-studie uitgevoerd naar adequate onderzoeks-methodologieën voor effect evaluatie van zorg-op-afstand diensten (Nederlandse vertaling van telemedicine), gevolgd door een pilot studie omtrent de haaldbaarheid en veranderingen in klinische uitkomstmaten van op-afstand gesuperviseerde myofeedback behandeling (RSMT). Daarnaast is een literatuur-studie uitgevoerd naar de determinanten die van invloed zijn op succesvolle implementatie van dergelijke behandeling op-afstand concepten.

In Hoofdstuk 2 is de rol van het angst-vermijdings model onderzocht in een werkende populatie vrouwen met nek-schouder pijn als gevolg van computerwerk. In overeenstemming met dit model werd een significante relatie gevonden tussen angst-vermijdingsgedachten, over werk in het bijzonder (gemeten met de Fear Avoidance Beliefs Questionnaire subschaal-werk), en beperkingen (gemeten met de Neck Disability Index). Een opmerkelijk resultaat was dat, in tegenstelling tot het model, een directe relatie werd gevonden tussen angst-vermijdingsgedachten en beperkingen, zonder de mediërende rol van beperkte maximale willekeurige contractie (MVC) van de trapezius spier. Er is geconcludeerd dat angst-vermijdingsgedachten een belangrijke rol spelen

in beperkingen als gevolg van computerwerk-gerelateerde nek-schouder klachten; ongeacht de fysieke conditie, dat wil zeggen fysieke achteruitgang.

In Hoofdstuk 3 zijn de verschillende coping strategieën onderzocht die veelal gebruikt worden in een werkende populatie om, om te gaan met nek-schouderklachten (gemeten met de Coping Strategies Questionnaire). Resultaten lieten zien dat mensen met nek-schouderklachten die nog steeds werken ondanks hun klachten, proberen hun pijn te "onderdrukken en ontkennen", "afleiding" te zoeken, en "catastroferen en zorgen maken". Gebaseerd op verschillende combinaties van deze coping strategieën konden drie coping profielen worden onderscheiden. De grootste subgroep bestond uit mensen die naast het "onderdrukken en ontkennen" van de pijn "afleiding" zoeken, ook wel "doorbijters" (Nederlandse vertaling van suppressors) genoemd. Zij lijken overeenkomsten te vertonen met het overbelastings-profiel in het onder- en overbelastings model. Naast het onderdrukken/ontkennen en afleiding zoeken, werden de mensen in de tweede subgroep gekenmerkt door "catastroferen en zorgen maken". Deze tweede subgroep heet "bezorgde doorbijters" (Nederlandse vertaling van worried suppressors) en vertoont mogelijk overeenkomsten met het angst-vermijdings profiel uit het angst-vermijdingsmodel. De kleinste subgroep bestond uit mensen zonder uitgesproken copingsprofiel, genaamd de minimale copers (Nederlandse vertaling van minimized copers). In overeenstemming met onze verwachtingen en het angst-vermijdingsmodel rapporteerden de "bezorgde doorbijters" de meeste catastroferende gedachten en hadden ze de laagste waarde voor de maximale willekeurige contractie (MVC) van de trapezius spier. Deze verschillen waren echter niet significant. Het feit dat tenminste twee van de drie subgroup-specifieke coping profielen overeenkomsten lijken te vertonen met profielen die bekend zijn uit cognitief-gedragsmatige modellen, ondersteunen de hypothese dat mensen onderverdeeld kunnen worden in subgroepen, zodat behandelingen meer toegespitst kunnen worden op de specifieke behoefte en/of pijn-gerelateerde werkingsmechanismen. Echter, meer onderzoek is nodig naar de methode van, en de variabelen die geïncludeerd moeten worden in, het onderscheiden van subgroepen van mensen met nek-schouderklachten als gevolg van computerwerk.

De Hoofdstukken 4, 5 en 6 gingen uitgebreid in op de mogelijke acceptatie en effectiviteit van op-afstand gesuperviseerde myofeedback behandeling (RSMT). In RSMT dragen mensen een vestje onder hun kleren dat continu de mate van spierontspanning van de trapezius spier meet. Wanneer de hoeveelheid spierontspanning onvoldoende is gaat het ambulante feedback-apparaat, dat mensen bij zich dragen, trillen. Dit trillen is een teken voor het individu om de trapezius spier te ontspannen. In RSMT is het ambulante feedback-apparaat uitgerust met een (beveiligde) draadloze verbinding waarover de spierontspannings-data draadloos wordt overgestuurd naar een beveiligde server, waarop een therapeut altijd en overal kan inloggen. Daardoor zijn in vivo consultaties tussen patiënt en therapeut niet langer nodig en kan op-afstand een behandeling plaatsvinden.

In Hoofdstuk 4 werd aan de hand van het Attitude- social Support - self Efficacy (ASE) model de ontvankelijkheid voor myofeedback op afstand (RSMT) van zorgprofessionals en patiënten met nek-schouder klachten onderzocht. Resultaten toonden een positieve attitude onder patiënten en zorgprofessionals. Het merendeel van de patiënten gaf aan een myofeedback behandeling op-afstand te willen ondergaan. Bovendien vonden 40% van de patiënten en alle myofeedback therapeuten hun self-efficacy (Engels woord voor “geloof in eigen kunnen”) voldoende voor RSMT, maar allen benadrukten het belang van non-verbale communicatie en fysieke interactie in behandeling op-afstand concepten. Men vreesde dat een volledig gebrek aan in vivo consultaties een ongunstig effect zal hebben op de therapeutische relatie. Als gevolg hiervan is besloten in vivo consultaties af te wisselen met op-afstand consultaties in RSMT, zoals geëvalueerd in Hoofdstuk 6.

In Hoofdstuk 5 is de methodologie onderzocht die gebruikt wordt in de evaluatie van zorg-op-afstand (Nederlandse uitleg van telemedicine) interventies op het gebied van houdings- en bewegingsproblematiek. Resultaten lieten zien dat de meeste studies zich primair focussen op het onderzoeken van de technische haalbaarheid en acceptatie ervan en minder aandacht besteden aan het evalueren van de algehele effecten op de zorg. Er is gesuggereerd dat alternatieve methodologieën, anders dan degene die toegepast worden in traditioneel farmaceutisch onderzoek, waardevol kunnen zijn in de evaluatie van telemedicine interventies. De “Staged Approach Evaluation of

Telemedicine" van DeChant is een voorbeeld van een mogelijke alternatieve onderzoeksmethodologie.

Deze methodologie werd dan ook gebruikt in Hoofdstuk 6 om de op-afstand gesupervi-seerde myofeedback behandeling (RSMT) te evalueren in een kleine groep werkneem-sters met nek-schouder pijn gerelateerd aan computerwerk. De resultaten lieten zien dat RSMT technisch haalbaar was voor klinisch gebruik, en dat men tevreden was over de consultaties die op-afstand, per telefoon, plaatsvonden. Na vier weken RSMT werd bij een aanzienlijk deel van de mensen (50-80%) een klinische relevante reductie in pijn intensiteit en beperkingen gevonden. De veranderingen in klinische uitkomstma-ten na afloop van RSMT leken minstens even groot of iets beter vergeleken met my-ofeedback behandeling in vivo. De methodologie van DeChant bleek een waardevolle methodologie, omdat het een veelomvattende evaluatie bewerkstelligt met meerdere uitkomstmaten, de input van eindgebruikers toestaat en rekening houdt met de (on-) volwassenheid van de technologie, waardoor RSMT in een redelijke korte tijdspanne kan worden geoptimaliseerd. Hoofdstuk 6 werd beschouwd als een praktische illustra-tie van deze abstracte methodologie.

In Hoofdstuk 7 zijn de factoren geïndentificeerd die van invloed zijn op de succes-volle implementatie van behandeling op afstand concepten. De resultaten lieten zien dat deze factoren gecategoriseerd kunnen worden in vijf categorieën namelijk acceptatie, technologie, financiering, organisatie en wet- en regelgeving. Er is ge-concludeerd dat telemedicine implementatie een moeilijk proces is, omdat het een multidisciplinaire, multiorganisationele and transsectorale samenwerking vereist. Een gelaagd implementatie-model, dat een visionaire benadering impliceert, is voorgesteld. De onderliggende filosofie van dit model is "begin klein, denk groot". Wanneer stakeholders tot een gedeelde visie omtrent de implementatie komen, kan dit leiden tot gezamenlijke overeenstemming over richtingen en afbakeningen, het-geen een permanentere structuur zou kunnen geven aan de samenwerking die moge-lijk, wanneer het project (en financiering) is beëindigd, blijft voortbestaan.

In het laatste hoofdstuk (Hoofdstuk 8) zijn de bevindingen van de verschillende stu-dies uit dit proefschrift geïntegreerd en bediscussieerd en aanbevelingen voor ver-

volgonderzoek gedaan. Een belangrijke conclusie was dat maladaptieve cognities en subgroep-specifieke coping-strategieën mogelijk een belangrijke rol spelen in nek-schouder klachten als gevolg van computerwerk, althans bij oudere vrouwelijke werkneemsters. Hoewel aanvullend onderzoek nodig is naar de relatie tussen subgroep-specifieke coping profielen en angst-vermijdingsgedachten, suggereerden de resultaten het belang van psychologische aspecten in de behandeling van individuen met nek-schouderklachten die nog steeds werkzaam zijn ondanks deze klachten. De verschillende coping profielen zouden kunnen pleiten voor meer toegespitste behandelingen. Door middel van op afstand gesuperviseerde myofeedback kan een individueel toegespitste en hoog-intensieve behandeling worden aangeboden op de werkplek. Een eerste evaluatie liet zien, dat deze behandeling technisch haalbaar was en veranderingen in klinische uitkomsten indiceerde.

Dankwoord

Als bewegingswetenschapper wil ik graag de analogie met de sport zoeken om mijn ervaringen omtrent het volbrengen van dit promotieonderzoek te verwoorden. Een promotieonderzoek is goed te vergelijken met een hardloopwedstrijd waar ik aan ben begonnen zonder te weten hoe het af te leggen parcours er precies uit zou zien en wat ik onderweg allemaal tegen zou kunnen komen. Gaandeweg bleek het een zeer afwisselend parcours te zijn dat bestond uit relatief eenvoudige maar zeker ook lastige delen. Aan de tijd (jaren in geval van dit promotieonderzoek) die verstreken was sinds de start kon ik afleiden hoe ver ik ongeveer verwijderd zou moeten zijn van de finish. Onvoorspelbare weersomstandigheden (ik denk aan de wateroverlast bij RRD afgelopen zomer) maakten dat ik mijn tactiek voor de eindsprint aan moest passen. Maar, getuige dit proefschrift is de finish uiteindelijk geheel volgens schema behaald. Temidden van deze "overwinningsroes" wil ik graag een aantal mensen bedanken.

Allereerst wil ik mijn twee "trainer-coaches", promotor Prof. Hermie Hermens en assistent-promotor Dr. Miriam Vollenbroek-Hutten, bedanken voor alle mogelijkheden en ruimte die ik van hen heb gekregen om mezelf te ontwikkelen. Hermie, naast dat je me kennis hebt laten maken met het feit dat wetenschap "fun" kan en mag zijn, heb je me wegwijs gemaakt in de wereld van de "lastige" projecten. Miriam, al tijdens mijn afstuderen hielp je me richting geven aan mijn onderzoek en nog steeds kan ik op je inhoudelijke expertise rekenen. Tijdens de dagelijkse begeleiding van het promotieonderzoek hebben je betrokkenheid, gedrevenheid en de prettige samenwerking indruk op me gemaakt. Tevens een woord van dank aan de leden van de promotiecommissie Prof. Konstantas, Prof. Van der Beek, Dr. Smeets, Prof. Nieuwenhuis, Prof. IJzerman en Prof. Rietman voor de tijd en moeite die zij hebben genomen om dit proefschrift te lezen en te beoordelen.

Zonder een sterk "deelnemersveld" had ik niet tot deze prestatie kunnen komen. De (ex)collega's van RRD voorzagen me, naast inhoudelijke samenwerking en belangstelling, van een motiverende werkomgeving. Een aantal collega's wil ik in het bijzonder bedanken. Hans, ik denk met veel plezier terug aan onze samenwerking in mijn eerste project en aan onze vele discussies over de inbedding van innovatieve zorg-telediensten in de dagelijkse

zorgpraktijk. Gerlienke en Laura, al sinds mijn aanstelling bij RRD heb ik veel zaken die spelen in het leven van een promovendus met jullie kunnen bespreken. Karlein, je expertise als psycholoog maar tevens als wetenschapper hebben me enorm geholpen bij de analyse en interpretatie van mijn onderzoeksresultaten. Bedankt ook voor de tijd die je nam om altijd "even" een vraag van mij te beantwoorden. Jitske, geregeld heb ik interessante artikelen van je doorgestuurd gekregen die van pas kwamen in mijn onderzoek. Karin, bedankt voor je hulp bij de statistische analyses die niet altijd even eenvoudig waren. Barbara, samen hebben we heel wat obstakels moeten overwinnen in het onderzoek naar de effectiviteit van de myofeedback behandeling op-afstand maar mede dankzij jou ben ik er in geslaagd het onderzoek succesvol af te ronden (ookal hebben we daarvoor zo'n beetje heel Nederland door moeten crossen!). Elles, ik waardeer je (vaak aanstekelijke) opgewekte houding en enthousiasme evenals de "stand-in" paranimf activiteiten die je op je hebt genomen. Ik wil jou, en Margit, hartelijk bedanken voor de organisatie van het symposium dat, gerelateerd aan dit promotieonderzoek, de dag voor de verdediging van dit proefschrift plaatsvindt. Thijs, bedankt voor het doorlezen van dit proefschrift op punten en komma's. Jan Hindrik, je assistentie bij het printen (ik denk aan kruisjes en nummertjes) getuigt van een groot technisch inzicht. Ook een woord van dank aan de mede-auteurs Henk, Tom, Aart en Bart.
Collega's van het cluster beheer wil ik bedanken voor de ondersteuning tijdens de uitvoering van mijn dagelijkse werkzaamheden. Leendert, in geval van technische problemen tijdens metingen in het lab of ten tijde van de myofeedback op afstand heb ik altijd een beroep op je mogen doen. Brigitte, jij wist precies aan te voelen wanneer ik een steuntje in de rug kon gebruiken, bedankt! Een groep mensen zonder wie dit onderzoek nooit plaats had kunnen vinden zijn de patiënten die bereid waren deel te nemen aan de diverse studies.

Uiteraard mogen mijn twee "trainingsmaatjes", de paranimfen Janine en Anke, in dit rijtje niet ontbreken. Fijn dat jullie op de dag van de verdediging aan mijn zijde willen staan. Janine, ik had me geen betere kamergenoot kunnen wensen. Ik kan altijd bij je terecht variërend van computer vraagjes, correcties op mijn artikelen (zoals het schrappen van woorden en corrigeren van mijn Engels) tot (on-)diepzinnige gesprekken over zaken die speelden op dat moment. In de afgelopen jaren is een hechte band ontstaan en het feit dat je temidden van je zwangerschapsverlof mijn paranimf wilt zijn vind ik echt heel bijzonder. Anke, bedankt voor je interesse zowel binnen als buiten het werk, de leuke gesprekken onder het genot van een kopje thee aan je bureau, maar zeker ook je relativerende vermogen (waar

was deze trouwens toen we in camping-smoking een bruiloft bezochten in het noorden van het land?). Jullie zijn beide het afgelopen jaar eigenlijk ook een beetje gepromoveerd door middel van het verwerven van de bevoorrechte “moeder” titel. Ik wens jullie dan ook veel succes toe met die “andere promotie”!

Een speciaal woord van dank aan mijn “sponsoren”, mijn ouders, van wie ik de belangrijkste eigenschappen meegekregen heb voor het voltooien van dit promotietraject. Dankzij jullie heb ik kunnen studeren en vier mooie jaren in Groningen kunnen doorbrengen. Ik ben blij dat ik op deze manier iets terug kan geven. Het is altijd fijn om weer even “thuis” te zijn en te weten dat er volle vertrouwen is in mijn kunnen. Pa, naast je rol als “sponsor” zorg je geregeld voor goede “PR” door in alle trots over de prestaties van je dochter(s) te vertellen!

Ook wil ik de “toeschouwers” bedanken die een belangrijke rol hebben gespeeld door me geregeld aan te moedigen onderweg. Laura en Carien, ik ben trots op jullie en de bijzondere manier waarop we met elkaar omgaan. Wim en Hermien, jullie oprechte belangstelling in mijn onderzoek, maar ook in mij persoonlijk, waardeer ik enorm. Mariël, dankzij jouw vakmanschap ziet dit boekje er geweldig uit. Dank voor alle tijd die je de afgelopen maanden samen met mij aan dit boekje hebt geschonken. We zullen de afhaal-maaltijden op zondagavond nog gaan missen! Zonder iedereen bij naam te noemen wil ik alle vriendinnen en vrienden bedanken voor hun interesse, kaartjes, telefoontjes, sms-jes, zaterdagmiddag-gesprekken bij Stromboli, etentjes, vakanties en andere gezellige momenten die voor de nodige afleiding en ontspanning hebben gezorgd.

Tenslotte wil ik mijn “pacer”, Wilfried, bedanken. Je weet me op de goede momenten te stimuleren en te motiveren maar durft op andere momenten ook mijn gedrevenheid en enthousiasme naar niveau van realiteit terug te brengen. Een “pacer” die, zoals jij, de hele wedstrijd met me uit heeft gelopen en voortdurend een ondersteunde rol heeft weten te vervullen is echt heel bijzonder. *Jij* bent bijzonder! Lieve Wilfried, bedankt voor alles maar dan ook alles.

Iedereen die ik nog vergeten mocht zijn nodig ik van harte uit om bij mij langs te komen voor een persoonlijk bedankje!

Curriculum Vitae

Rianne Huis in 't Veld werd geboren op 2 Januari 1980 te Almelo. De middelbare school volgde zij in Almelo aan het Pius X college, waar zij in 1998 haar gymnasium diploma haalde. Aansluitend begon ze aan de Universiteit Groningen met de opleiding Bewegingswetenschappen. In december 2001 startte ze haar afstudeeropdracht bij Roessingh Research and Development binnen het door de EU gesubsidieerde NEW-project (Neuromuscular Assessment in the Elderly Worker). Deze afstudeeropdracht werd in september 2002 afgerond waarna ze als wetenschappelijk onderzoeker in dienst kwam bij Roessingh Research and Development. Naast het pijnonderzoek, werkt(e) Rianne aan een aantal projecten op het gebied van telemedicine (zorg op afstand door middel van informatie en communicatie technologie) te weten: Telecare (Freeband Impulse), ExoZorg (SenterNovem), ALS Teleconsultatie (Innovatiecentrum Het Roessingh), Smart Surroundings (BSIK), Awareness (Freeband Communication), Awareness Valorisatie (Freeband Communication) en MyoTel (EU).

Journal articles

Huis in 't Veld MHA, van Til JA, IJzerman MJ, Vollenbroek-Hutten MMR, Preferences of general practitioners regarding an application running on a personal digital assistant in acute stroke care. Journal of Telemedicine and TeleCare 2005; 11 (S1): 37-39.

Huis in 't Veld MHA, van Dijk HJ, Vollenbroek-Hutten MMR, Hermens HJ, The methodology of telemedicine evaluation: a systematic review. Journal of Telemedicine and Telecare 2006; 12: 289-297.

Huis in 't Veld MHA, Vollenbroek-Hutten MMR, Groothuis-Oudshoorn CGM, Hermens HJ, The role of the fear-avoidance model in female workers with neck-shoulder pain related to computerwork. Clinical Journal of Pain 2007; 23(1): 28-34.

Huis in 't Veld MHA, Voerman GE, Hermens HJ, Vollenbroek-Hutten MMR, The receptiveness toward remotely supported myofeedback treatment. Telemedicine and eHealth 2007; 13(3):293-202.

Huis in ‘t Veld MHA, Huijgen BCH, Schaake L, Hermens HJ, Vollenbroek-Hutten MMR, The feasibility of remotely supported myofeedback treatment in women with neck-shoulder pain related to computerwork 2007, submitted.

Huis in ‘t Veld MHA, Vollenbroek MMR, Groothuis-Oudshoorn CGM, Schreurs KMG, Hermens HJ, Coping profiles in female computer workers suffering from neck-shoulder pain 2007, submitted.

Nijeweme-d’Hollosy WO, Janssen EP, Huis in ’t Veld MHA, Spoelstra J, Vollenbroek-Hutten MMR, Hermens HJ, Tele-treatment of patients with amyotrophic lateral sclerosis. Journal of Telemedicine and Telecare 2006; 12 (S1): 31-34.

Broens TF, Huis in ‘t Veld MHA, Vollenbroek MMR, Hermens HJ, van Halteren AT, Nieuwenhuis LJM, Determinants for successful telemedicine implementation; a literature study, Journal of Telemedicine and Telecare, 2007;13(6): 303-309.

Kotte EMW, Huis in ’t Veld MHA, Vollenbroek-Hutten MMR, Hermens HJ, Effectiveness of personal stress interventions in working subjects: a systematic review of randomized controlled trials 2007, submitted.

Conference contributions

Huis in ’t Veld MHA, Vollenbroek-Hutten MMR, Keppelink L, Hermens HJ, Explaining disabilities in women with work-related neck-shoulder pain. In: Proceedings of the International Symposium on Neuromuscular Assessment in the Elderly Worker, February 20-21, Torino, Italy, 2004.

Huis in ‘t Veld MHA, van Til JA, Vollenbroek-Hutten MMR, A wireless ICT application in acute stroke care: The TeleCare pilot. In: Proceedings of TeleMed and eHealth: Citizen Centred Care, Telemed conference November 29-30, London, United Kingdom, 2004.

Huis in ‘t Veld MHA, van Dijk H, Vollenbroek-Hutten MMR, Hermens HJ, The methodology of telemedicine evaluation. In: Proceedings of Telemed and eHealth TeleMed conference November 30-31, London, United Kingdom, 2005.

Huis in ‘t Veld MHA, Vollenbroek-Hutten MMR, Hermens HJ, Context-aware telemonitoring and teletreatment services, TTeC2006 conference June 12-15, Tromso, Norway, 2006.

Huis in ‘t Veld MHA, Huijgen BCH, Schaake L, Hermens HJ, Vollenbroek-Hutten MMR, The feasibility of remotely supported myofeedback treatment in women with neck-shoulder pain related to computerwork, MedeTel conference April 18-20, Luxembourg, 2007.

Vollenbroek-Hutten MMR, Huis in ‘t Veld MHA, Bloo JKC, Michel-Verkerke MB, Grootveld MJ, ICT applications for tele-consultation to increase efficiency and effectiveness of care, ICMCC conference June 2-4, The Hague, The Netherlands, 2003.

Grootveld M, Swaak J, Brusse R, Huis in ’t Veld MHA, Michel-Verkerke MB, Virtual Organisations in Health Care: Organisation, People and Technology, eChallenges conference October 27-29, Vienna, Austria, 2004.

Nijeweme-d’Hollosy WO, Janssen EP, Huis in ’t Veld MHA, Spoelstra J, Vollenbroek-Hutten MMR, Hermens HJ, Tele-treatment of patients with amyotrophic lateral sclerosis, TeleMed conference November 30-31, London, United Kingdom, 2005

Hermens HJ, Vollenbroek-Hutten MMR, Bloo JKC, Huis in ’t Veld MHA, Use of information and communication technology in health care. ICMCC conference May 30-31, The Hague, The Netherlands, 2005. In: Stud Health Technol Inform 2005; 114: 205-9.

Vollenbroek-Hutten MMR, Hermens HJ, Huis in ‘t Veld MHA, Context aware tele-monitoring and tele-treatment services. ICMCC conference May 30-31, The Hague, The Netherlands, 2005. In: Stud Health Technol Inform 2005; 114: 230-240.

Vollenbroek-Hutten MMR, van Weering M, Huis in ’t Veld MHA, Hermens HJ, Context-aware mobile teletreatment for patients with chronic pain, MedeTel conference April 18-20, Luxembourg, 2007.

Hermens HJ, Vollenbroek-Hutten MMR, Huis in ‘t Veld MHA, ICT for improving care: Experience in rehabilitation, MedeTel conference April 18-20, Luxembourg, 2007.

Progress range

The following publications have also been published in the Progress range by Roessingh Research and Development, Enschede, the Netherlands. Copies can be ordered, when available, via info@rrd.nl.

1. Pot JWGA, Boer H, van Harten WH, Hermens HJ, Seydel ER. Comprehensive Need-Assessment. Ontwikkeling van een meetinstrument voor zorgbehoeften en kwaliteitsbeoordeling door patiënten. Roessingh Research and Development, The Netherlands, September 1994, ISBN 90-25452-01-2.
2. Van Leerdam NGA, Hermens HJ. Revalidatietechnologie in Euregio. Roessingh Research and Development, The Netherlands, July 1995, ISBN 90-75452-02-0.
3. Duda L, van Noort LO, Röseler S, Greitemann BOL, van Harten WH, Klazinga NS. Rehabilitation in Germany and the Netherlands, A comparison of two rehabilitation-systems. Roessingh Research and Development, The Netherlands, August 1995, ISBN 90-75452-03-9.
4. Hermens HJ, Nene AV, Zilvold G. Electrophysiological Kinesiology. Proceedings of the 11th congress of the International Society of Electrophysiologie and Kinesiology in Enschede, The Netherlands 1996, Roessingh Research and Development, the Netherlands, October 1996, ISBN 90-75452-04-7.
5. Van Harten WH. Bouwen aan een kwaliteitssysteem in de revalidatiezorg. Een poging tot constructieve technology assessment van een kwaliteitssysteem in een gezondheids-zorginstelling. Roessingh Research and Development, The Netherlands, December 1997, ISBN 90-75452-07-1.
6. Baardman G, IJzerman MJ. Design and evaluation of a hybrid orthosis for people with paraplegia. Roessingh Research and Development, The Netherlands, November 1997, ISBN 90-75452-08-X.
7. Hutten MMR. Lumbar Dynamometry: A useful method for assessment of patients with chronic low back pain? Roessingh Research and Development, The Netherlands, November 1999, ISBN 90-75452-13-6.
8. Van der Salm A, van Harten WH, Maathuis CGB. Ketenkwaliteit Cerebrale Parese Zorg. Een beschrijving van de cerebrale parese zorg en mogelijke verbeteringen hierin. Roessingh Research and Development, The Netherlands, April 2001, ISBN 90-75452-19-5.
9. Nederhand MJ. Muscle activation patterns in post traumatic neck pain. Roessingh Research and Development, The Netherlands, March 2003, ISBN 90-75452-27-6.
10. Jannink MJA. Usabillity of custom-made orthopaedic shoes in patients with degenerative disorders of the foot. Roessingh Research and Development, The Netherlands, September 2004, ISBN 90-75452-28-4.
11. Blokhorst, M. State-dependent factors and attention in whiplash associated disorder. Roessingh Research and Development, The Netherlands, January 2005, ISBN 90-365-2111-4.
12. Buurke JH. Walking after stroke co-ordination patterns & functional recovery. Roessingh Research and Development, The Netherlands, February 2005, ISBN 90-365-2140-8.
13. Van der Salm A. Spasticity reduction using electrical stimulation in the lower limb of spinal cord injury patients. Roessingh Research and Development, The Netherlands, October 2005, ISBN 90-365-2253-6.
14. Snoek GJ. Patient preferences for reconstructive interventions of the upper limb in tetraplegia. Roessingh Research and Development, The Netherlands, December 2005, ISBN 90-365-2255-2.
15. De Kroon J. Therapeutic electrical stimulation of the upper extremity in stroke. Roessingh Research and Development, The Netherlands, December 2005, ISBN 90-365-2269-2.
16. Van Dijk H. Motor skill learning, age and augmented feedback. Roessingh Research and Development, The Netherlands, March 2006, ISBN 90-365-2302-9.
17. Mes CAJ. Improving non-optimal results in chronic pain treatment. Roessingh Research and Development, The Netherlands, January 2007, ISBN 90-365-2435-0.
18. Voerman GE. Musculoskeletal neck-shoulder pain: a new ambulant myofeedback intervention approach. Roessingh Research and Development, the Netherlands, March 2007, ISBN 90-365-2460-1
19. Kallenberg LAC. Multi-channel array EMG in chronic neck-shoulder pain. Roessingh Research and Development, The Netherlands, March 2007, ISBN 90-365-2459-8

Notes