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**SLEEP, PSYCHOLOGICAL SYMPTOMS AND QUALITY
OF LIFE IN PATIENTS UNDERGOING CORONARY
ARTERY BYPASS GRAFTING**

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ABSTRACT

In this thesis sleep, psychological symptoms and quality of life (Qol) in patients undergoing coronary artery bypass grafting (CABG) at the University Hospital in Linköping were evaluated. Interviews and 24-hour polysomnography were performed prior to surgery, immediately after surgery and again at one month, with a six-month-follow-up mailed questionnaire. Habitual sleep was evaluated using the Uppsala Sleep Inventory questionnaire and a diary the recorded mornings. The Spielberger State of Anxiety Scale and the Zung's Self-rating Depression Scale were used to measure anxiety and depression, respectively. Physical functional capacity was assessed according to the New York Heart Association's (NYHA) classes and Qol, with the Nottingham Health Profile instrument (NHP).

A retrospective evaluation of nurse's documentation about sleep was also performed. In addition, the quality and quantity of sleep were assessed before surgery and in the immediate postoperative period in a pilot study, with a one-month follow-up interview. The results indicated disturbed sleep, and changes in behaviour and mental state after surgery due to fragmented sleep, pain and anxiety.

Forty-four patients were examined prior to surgery. The results showed that almost two-fifths experienced too little sleep habitually and 50 % had a combination of at least two sleep problems. Poorer health, higher level of anxiety and increased difficulties maintaining sleep (DMS) were consistent with significantly longer sleep latency, increased fragmented sleep, and reduced stages 3 and 4 and REM sleep measured by polysomnography. The level of Qol on the NHP was significantly associated with objectively measured sleep.

In the immediate period following CABG there is a changed distribution of sleep, with a reduction of nocturnal sleep duration and an increase in daytime sleep, which had almost returned to preoperative values one month after surgery. Qol was significantly improved six months after surgery compared to before surgery.

It was noted that patients with a more anxiety prone reactivity during six months following CABG had significantly more sleep disturbances, reduced energy and functional physical capacity, and lower quality of life, compared to those without such reactivity. Significantly more sleep disturbances, reduced energy and lower quality of life were more prominent among those with sadness/depression or cognitive/behavioural fatigue as reactions to sleep loss. A higher degree of cognitive/behavioural fatigue and dysphoria reactions were associated with a higher NYHA class.

In conclusion, patients with coronary artery disease have poor quantity and quality of sleep. Increased psychological symptoms in patients with CAD prior to surgery were associated with greater symptoms six months after surgery. Physical functional capacity and quality of life were significantly improved six months after surgery

Key words: Sleep, polysomnography, coronary disease, surgery, anxiety, psychophysiological disorders, personality.

Original Papers

This thesis is based on the following papers, which will be referred to in the text by their Roman numerals

- I. Ulla Edéll-Gustafsson, Claes Arén, Elisabeth Hamrin & Jerker Hetta. Nurses' notes on sleep patterns in patients undergoing coronary artery bypass surgery: a retrospective evaluation of patient records *Journal of Advanced Nursing* 1994; 20: 331-336
- II. Ulla M Edéll-Gustafsson, Jerker E Hetta, Claes B Arén & Elisabeth KF Hamrin. Measurement of sleep related to quality of life before and after coronary artery bypass grafting - A pilot study. *International Journal of Nursing Practice* 1997; 3: 239-246.
- III. U. Edéll-Gustafsson & J. Hetta Sleep in patients with coronary artery disease – a polysomnographic study. *Submitted* 1998
- IV. Ulla, M. Edéll-Gustafsson, Jerker, E. Hetta, Claes, B. Arén Sleep and quality of life assessment in patients undergoing coronary artery bypass grafting. *Journal of Advanced Nursing* (in press).
- V. Ulla Edéll-Gustafsson & Jerker Hetta Anxiety, Depression and Sleep in Male Patients Undergoing Coronary Artery Bypass Surgery. *The Scandinavian Journal of Caring Sciences* (in press).

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Abbreviations and definitions

BMI	Body mass index (weight in kg)/height in m) ²
CABG	Coronary artery bypass grafting
CAD	Coronary artery disease
CRF	Corticotrophin-releasing factor
CRF/GRF	The corticotrophin-releasing factor and growth-hormone-releasing factor ratio
DIS	Difficulties initiating sleep
DMS	Difficulties maintaining sleep
ECC	Extra corporeal circulation
EEG	Electroencephalogram
EMG	Electromyelogram
EOG	Electrooculogram
Epoch	30 seconds.
GRF	Growth-hormone-releasing factor
GH	Human growth hormone
HPA	Hypothalamic (-limbic-system)-pituitary-adrenal axis
ICU	Intensive care unit
MI	Myocardial infarction
NHP	the Nottingham Health Profile instrument
NREM	Non-Rapid Eye Movement (sleep)
NYHA	New York Heart Association class
Process-S	refers to a homeostatic function
Process-C	refers to a sleep-independent, circadian process
PTCA	Percutaneous transluminal coronary angioplasty
REM	Rapid Eye Movement (sleep)
SWS	Slow Wave Sleep, also called deep sleep or stages 3 and 4 sleep
SCN	Suprachiasmatic nuclei
Sleep Sufficient Index	The ratio of the amount of habitual sleep to the amount of estimated need for sleep expressed in per cent.
STAI-S	the Spielberger State of Anxiety Scale
USI	the Uppsala Sleep Inventory questionnaire
Zung's SDS	Zung's Self-rating Depression Scale

Stage 1 sleep	Low voltage, mixed frequency EEG with a prominence of activity in the 2-7 Hz range – theta activity, slow eye movements (EOG) and normal muscle tension. Stage 1 sleep occurs most often in the transition from wakefulness to the other sleep stages or following body movements during sleep.
Stage 2 sleep	Presence of sleep spindles and/or K complexes and the absence of sufficient high amplitude. As stage 2 sleep progresses there is a gradual appearance of high slow activity.
Stage 3 sleep	Consists of at least 20 % but not more than 50 % of the epoch with slow waves 2 Hz or lower which have amplitudes greater than 75 mikro V from peak to peak. These waves are called slow wave sleep (SWS) or delta sleep.
Stage 4 sleep	The epoch consists of 50 % or more delta waves. During Stages 2-4 eye movements are absent and EMG remains at a lower level than that of wakefulness.
Stage REM sleep	The concomitant appearance of relatively low voltage, mixed Frequency EEG activity and episodic REM. The EEG pattern resembles the one described for stage 1 sleep, except that vertex sharp waves are not prominent in stage REM. In addition distinctive "sawtooth" waves frequently, but not always, appear in conjunction with bursts of REM. Alpha activity is usually somewhat more prominent during stage REM than stage 1 sleep, and the frequency is generally 1-2 Hz Lower than during wakefulness. As with the EEG of stage 1, there is an absolute absence of sleep spindles and K complexes. EMG show absence of muscle activity.

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Abstract

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1. INTRODUCTION

In Sweden, every fifth patient that comes to the hospital emergency rooms, has symptoms of coronary artery disease (CAD), i.e. about 150 000 per annum. Ninety thousand patients are admitted to the coronary care units. Of these about one third have a myocardial infarction (MI) and one third an impending MI. Two thirds of the patients are men (**Nationella riktlinjer för kranskärlssjukvård, Socialstyrelsen, 1998**). Patients with CAD to a certain degree have reported sleep disturbances. This is higher in those with previous MI than in those with angina pectoris (Katz & McHorne 1998). Two fifths of the patients have reported insomnia prior to MI (Carney et al 1990) as have 27 % to 66 % of patients about to undergo heart surgery (Simpson & Lee 1996, Magni et al 1987, Simpson, et al 1996, Moore 1994, Redeker 1993, King & Parrinello 1988, Schaefer et al 1996). Although sleep was improved after heart surgery (Jenkins et al 1983a, Magni et al 1987) the proportion of insufficient sleep was high one year after such intervention (Magni et al 1987).

One early laboratory observation of sleep deprivation and mental changes, in three subjects, was reported by Patrick and Gilbert (1896), and the results showed that individuals vary in their reaction to sleep loss. In 1929 the German psychiatrist, Hans Berger, was the first to record an electroencephalogram (EEG) of the human brain, and in 1937 Loomis, Harvey and Hobert described the electrophysiology of sleep, classifying specific sleep stages (1937). Near four decades later, in 1974, Elwell and co-workers presented their results (Johns et al 1974) i.e., that patients who had undergone heart surgery had impaired sleep in the postoperative period. The same year, Johns et al (1974) published the first article which described sleep measured by polysomnography in four patients undergoing heart surgery.

For the most part, previous studies of sleep in patients undergoing heart surgery have been based on interviews (Kornfeld et al 1965, McFadden & Giblin 1971, Magni et al 1987, King & Parrinello 1988, Eriksson 1988, Tack & Gillis 1990, Moore 1994, Schaefer et al 1996, Grosby et al 1987) and questionnaires (Redeker 1993, Jenkins et al 1988, Knapp-Spooner & Yarcheski 1992, Simpson & Lee 1996, Simpson et al 1996) or a combination of these two methods (Jenkins et al 1983a, 1983b, 1994), whereas observation studies (Walker 1972, Woods 1972), ambulatoric wrist actigraph recordings (Redeker 1998) and polysomnography studies (Johns et al 1974, Orr & Stahl 1977, Witoszka & Tamura 1980) are rare.

Many changes have taken place in coronary revascularization by coronary artery bypass grafting (CABG) since 1967, and new knowledge has contributed to new indicators for a more individualised treatment. Patients undergoing such surgery today are older, which is concomitant with more medical problems, have more severe CAD and the disease is more diffuse than previously. In addition monitoring, postoperative care and rehabilitation programmes have been improved. Less dramatic, but very annoying and handicapping for the patients, are the disturbances in cognitive functions, emotional state and general performance that may occur following CABG. To some extent sleep disturbances may affect these disturbances and influence the quality of life of patients subjected to CABG. A combination of objective and subjective assessments of sleep is important from a nursing perspective, as the nurses usually observe and evaluate sleep in clinical practice without full evidence of whether the patient is asleep or not. Furthermore, based on Neumans model (1986), this can serve as valuable baseline information for developing preoperative nursing interventions designed to improve postoperative outcomes and wellness. With the focus on sleep, the general aim of the present thesis was to evaluate sleep, psychological symptoms and quality of life in patients undergoing CABG.

2. BACKGROUND

2.1 Coronary artery heart disease

Atherosclerosis is the major underlying pathological process in CAD. Ischaemic symptoms develop in an advanced stage of the disease, when the blood flow through the coronary arteries is reduced by the atherosclerotic lesion. A 50 % reduction of the lumen of the artery is considered necessary before reduction of the blood flow occurs and is the base for the term "significant stenosis". Chest pain – angina pectoris- is the cardinal symptoms of ischaemic coronary artery disease. Behavioural and emotional reactions to physical, psychological and social stressors have been shown to provoke the symptom. The ischaemic pain may be relieved by pharmacological treatment that causes dilatation of the coronary vessels or reduces the myocardial oxygen demand. In severe ischaemic coronary artery disease, when pharmacological treatment is insufficient, surgical or catheter-based interventions may be used to increase the blood flow in the diseased coronary arteries. CABG, where the stenosis in the coronary artery is bypassed by a vein from the aorta to the coronary artery, was first used in 1967 by Favaloro (1969). The internal thoracic artery is routinely used nowadays as a bypass graft to one or more of the coronary arteries.

A coronary bypass operation is usually performed on a non-beating heart and requires the use of a heart-lung machine. The number of operations has increased dramatically over the years, especially during the 1980s and beginning of the 1990s. Today, over 6000 coronary bypass operations are performed in Sweden each year (**The Swedish Heart Surgery Registry, 1996**). Recently, new techniques have made it possible to perform such operations on a beating heart in selected patients (Wos et al 1998, Währborg 1997, Mishra et al 1998, Gulielmos et al 1998).

An alternative treatment to CABG is percutaneous transluminal coronary angioplasty (PTCA), which was first performed by Grüentzig in 1977 (Grüentzig 1978). This technique uses a catheter with a balloon at the tip. The catheter is advanced under fluoroscopy through the aorta into the coronary artery, where the balloon is placed at the stenosis. The balloon is then inflated under high pressure and the stenosis dilated. This treatment has improved and increased dramatically over the last five years. Today, 40-50 % of patients in Sweden needing interventions to their coronary artery stenoses have PTCA.

It is well known that the use of the heart-lung machine causes a general inflammatory response in the body and may have adverse effects on the brain and other organs. Macro or micro embolic events as well as insufficient blood perfusion, e.g. from hypotension, are considered the major causes of brain dysfunction (Johansson et al 1995, Sellman et al 1991, Svenmarker et al 1997, Newman et al 1990, Shaw et al 1987, Vingerhoets et al 1997, Mills & Prough 1991, Grosby et al 1987, Kawahito et al 1995, Menasché 1995). The brain damage may vary from focal neurological dysfunction to more diffuse, less apparent, complications like cognitive dysfunction or neuro-psychiatric symptoms.

The mean in-hospital time is short in Sweden and ranges between 7.3 to 12.2 days (Information from Socialstyrelsen, Epidemiologiskt centrum, Stockholm, Sweden). The main benefits of the revascularisation procedures are the prevention of myocardial infarction, the improvement of physical symptoms associated with coronary hypoxia, improved quality of life and the prolongation of life (Jackson 1997, Währborg 1997).

2.2 Sleep

Sleep is necessary and an essential part of the 24-hour cycle, and the quality and quantity of sleep are reflected by the individual's daytime function. However,

there is no consensus about how to define sleep. Today it is evident that sleep is an active process which relates to behavioural, psychological and physiological changes. Carskadon and Dements (1994, p 16) relate sleep to a behavioural definition: *"Sleep is a reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment.... Sleep is usually (but not necessarily) accompanied by postural recumbancy, quiescence, closed eyes, and all the other indicators one commonly associates with sleeping."*

Sleep is defined *"as unconsciousness from which the person can be aroused by sensory or other stimuli. It is to be distinguished from coma, which is unconsciousness from which the person cannot be aroused"* (Guyton 1991, p 265). Wakefulness is defined as *"activity in the brain directed into appropriate channels to give the person a sense of conscious awareness"* (Guyton 1986, p 667).

Henderson (1966) identifies sleep and rest as one of the 14 fundamental needs which comprise the components of nursing care, whereas Neuman (1986) includes the individual's biological needs in a system model of which man and environment are the basic phenomena. Weakening or disruption of the subject's protections against noxious internal (intrapersonal) and external (inter and extrapersonal) environmental stressors causes changes in the individual's core basic structure and energy. Reduced or increased energy depends on the degree of reactions to stressors (Neuman 1986). Regarding nursing practice sleep definitions are less precise. According to sleep in hospital Webster and Thompson emphasise that *"sleep occurs when sleep promoting factors outweigh arousal activity"* (1986, p 454).

Objectively, by electroencephalography (EEG), sleep can be physiologically defined and described as a balance between synchronization and desynchronization. *"Synchronization is a state in which two or more oscillators display the same frequency"* (Steriade 1994, p105), and, for example, spindles or slow wave sleep (SWS) can be identified. *"Desynchronization is the disruption of high-amplitude and synchronous EEG waves and replaces fast rhythms with usually lower amplitude"* (p 106). This occurs in either the waking state, REM sleep or arousals. Rechtschaffen (1994) emphasises that the physiological definition of sleep must correlate highly with behavioural definitions of sleep, just as physiologically measured sleep must correlate with the behaviourally measured criteria.

2.2.1 Sleep distribution

There are two different kinds of sleep i.e. non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. NREM sleep is further divided into four stages (stages 1-4). Figure 1 depicts a hypnogram for a middle-aged subject's nocturnal sleep. Sleep is entered through NREM sleep by progress from the sleep onset period, with a predominance of alpha and beta EEG activities (wakefulness), succeeded by Stage 1 sleep. Stage 1 sleep is followed in turn by a longer period of Stage 2 sleep and then increasing delta waves i.e., Stages 3 and 4 sleep (SWS). This progresses to stage 2 sleep, which precedes REM sleep. This cycle, which includes NREM sleep and REM sleep, lasts about 90 minutes. Usually there are four to five such cycles during the night. SWS predominates in the first third of the night and is linked to the initiation of sleep, whereas REM sleep predominates in the last third of the night. The duration of each stage and the period between stages varies according to age and sex.

Figure 1. Hypnogram for a middle-aged subject's nocturnal sleep. REM=Rapid Eye Movement.

At the beginning of stage 1 sleep slow rolling eye movements and normal muscle tension occur. Muscle tension, blood pressure, heart rate and ventilation decrease progressively during NREM sleep, 10 %-20 %, with small changes in arterial blood gas values. Brain temperature decreases, most likely immediately after sleep onset when the delta activity is highest, which is important for energy conservation and cerebral recovery (Horne 1992). Arousals and body movements activate the sympathetic nervous system, and brief rises in blood pressure and heart rate occur. Long-term sympathetic discharge results in elevated arousals (Terzano et al 1997, Udelsman & Holbrook 1994). REM sleep includes tonic and phasic events. Tonic events last throughout the period of REM sleep and include a mixed frequency, low-voltage EEG similar to stage 1 sleep, with an absence of postural muscle tone. Phasic REM events occur intermittently and include bursts of conjugate rapid eye movements, muscle twitches, fluctuations in blood pressure and heart rate, in addition to decreased cardiac output and breathing. Breathing is maintained by the diaphragm, and the response to carbon dioxide is decreased. Thermo-regulation is impaired.

2.2.2 Homeostatic function and biological rhythms

The homeostatic system refers to the subject's capacity to maintain internal stability by physiological changes (Chrousos & Gold 1992, Hobson 1995, Neuman 1986). It is believed that the homeostatic state is illustrated by the delta activity, whereas REM sleep and sleep duration reflect the circadian rhythm. According to the two-process model of sleep regulation by Borbély (1987, 1994), the propensity for sleep is a combination of Process-S and Process-C. Process-S refers to a homeostatic function. Process-C refers to sleep-independent, circadian processes. Prior quality and quantity of waking time in relation to sleep is a building-up process (S) to produce increased nocturnal SWS. Normally, the first sleep cycle contains most SWS and then decreases gradually.

Several biochemical mechanisms are involved in the regulation of sleep (Sheeran & Hall 1997). Circulating cytokines can stimulate parts of central nervous system peripherally and the release of corticotrophin-releasing factor (CRF). For example Interleukin-1 (IL-1) at a low concentration induces tumor necrosis factor (TNF) and stimulates production of nerve growth factors. TNF α promotes growth by inducing growth hormone releasing factor (GHF). IL-1 and TNF α also induce nitric oxide (NO). NO has been shown to be important for the regulation of blood pressure, coronary blood flow (cardioprotective attributes), and respiratory-, immune-, nerve-, and the reproductive systems (Persson et al 1993).

Body temperature expresses the circadian rhythm (Process-C). Body temperature is important for the beginning (sleep latency) and end of the sleep period. The maximum sleep propensity coincides with the trough of the rhythm, whereas the lowest sleep propensity is close to the peak of the rhythm (Borbély 1987, 1994). The circadian rhythms originate in the suprachiasmatic nuclei (SCN), and send impulses to the pineal gland for melatonin production, normally at or after the habitual sleep onset, leading to increased sleepiness.

REM sleep is generated in the midbrain and pons by acetylcholinergic neurons belonging to the cholinergic system ("REM-on" cells). Firing of noradrenergic or serotonergic neurons of the locus coeruleus and the raphe nuclei belonging to the aminergic system ("REM-off" cells) inhibits the cholinergic system ("REM-on" cells). During waking state both the aminergic and the cholinergic systems are active (Chrousos & Gold 1992, Hobson 1995). At sleep onset "REM-on" neurons are initially quiescent, neurons in the aminergic system decrease and at a certain deactivated threshold "REM-on" neurons become active. In addition, plasma levels of IL-1 vary in phase with sleep-wake cycles in humans. IL-1 enhances NREM without affecting REM sleep, but in high doses inhibits both NREM and REM sleep (Krueger & Majde 1994).

The need for sleep is related to the quality of sleep, and delta sleep seems to play a central role (Borbély 1994, Horne 1992, Hobson 1995). Substances such as the CRF and GRF ratio (CRF/GRF) are hypothesised by Ehlers and Kupfer (1987) to reflect the strength of the two-process model by Borbély (1987). GRF represents Process-S, and CRF, Process-C. GRF reduces the sleep latency onset and promotes SWS. Human growth hormone (GH), which is activated by GRF, is usually released immediately after sleep onset. If GRF is inhibited by CRF, then growth hormone release might occur before sleep onset (during the day), or much later in the night. This may lead to a decrease in Process-S during sleep time. When Process-S is weakened, the subject displays less stages 3 and 4 sleep and a lighter overall sleep pattern. Increased levels of CRF over the 24-hour period may also flatten the Process-C, inhibits IL-1 production and thereby suppress sleep (Krueger & Majde 1994, Moldofsky et al 1986) and in some cases result in increased REM activity and density during the night.

Stress is “*a state of disharmony, or threatened homeostasis*” (Chrousos & Gold 1992, p 1245). It involves the regulation of emotions, cognitive function and behaviour. Emotional reactions can be subdivided into psychological distress and psychological well-being. Psychological distress covers anxiety, depression, anger and irritability. Disorder of the sleep-wake system and biological changes can constitute a form of stress which interferes with the hypothalamic (-limbic-system)-pituitary-adrenal (HPA) axis, the autonomic nervous systems (Moldofsky 1997, Hoehn-Saric & McLeod 1994, Healy & Williams 1988, Thayer 1989, Chrousos & Gold 1992), and the immune system response in combination (Moldofsky 1994, Zachariae 1996). In addition, surgical stress is an ongoing process occurring before, during and after the operative procedure. Surgical stress is evoked by factors such as psychological stress, tissue injury, intravascular volume redistribution, anaesthetic agents and surgical procedures. Besides these above-mentioned changes, surgical stress induce stress response proteins in response to metabolic and environmental stresses. These proteins have also been identified in both chronic disease states and atherosclerotic arteries (Udelsman & Holbrook 1994).

According to the norepinephrine hypothesis in anxiety (Barchas et al 1994), norepinephrine activity is increased particularly in the locus coeruleus, whereas depression is caused by a functional deficiency, particularly of norepinephrine. Anxiety and depression signal overactivity in the HPA axis and an increase in cortisol rates in response to hypersecretion of CRF which directly or indirectly inhibits GRF (Hoehn-Saric & McLeod 1994). This indicates that the distinction

between anxiety and the syndrome of depression can be difficult, as there are overlapping symptoms. Many patients have a mixed anxiety-depressive disorder.

Results from several studies have shown inflammation and inflammatory mediators in plasma and tissue obtained from atherosclerotic tissues as evidence of an ongoing inflammatory or autoimmune disease in the pathophysiology of atherosclerosis (Mehta et al 1998). Results indicate that patients with unstable angina and acute MI have greater reactions of the inflammatory system. It is suggested that repeated episodes of ischaemia may increase the inflammatory process. In addition, cognitive processes e.g. sensory perception, social events that affect the central nervous system are hypothesised by Zachariae (1996) to affect the circadian organization, and biological rhythmicity appears to be one of the basic properties of the immune system.

Most of the vegetative, hormonal and behavioural functions of the human organism are subordinated to the biological clocks. These clocks respond to psychological, environmental and social stimuli, synchronizing the organism's physiology to daily rhythms, with changes in the nervous system and behaviour. Such cues are light, contextual alterations, body temperature and social routines. Subjects in stress or perceived stress, pain, changed social routines or immobilization may alter their biological rhythms (desynchronization).

2.2.3 Insomnia, sleep loss and reactions to sleep loss

Insomnia is the summarised concept of difficulties initiating sleep (DIS), difficulties maintaining sleep (DMS) and early morning awakening. Clinicians and researchers in Sweden have come to an agreement (**Information från Socialstyrelsens läkemedelsavdelning 1988:2** översatt eng) on arbitrary criteria for insomnia and the degree of estimated distress. Insomnia contains any of the following symptoms reported by the subject: total nocturnal sleep duration of less than 6 hours or a Sleep Sufficient Index less than 80 % (the ratio of the amount of habitual sleep to the amount of estimated need for sleep expressed in per cent); a sleep (onset) latency of more than 30 minutes; nocturnal awakenings longer than 45 minutes; nocturnal awakenings five times or more and combined with daytime symptoms causing reduced performance. These symptoms can vary widely in type, intensity, frequency, causative factors and daytime consequences. The effect of sleep loss is modified by the circadian rhythm. Related to the two-process model by Borbély (1994), a short sleep duration is not equivalent in meaning to insomnia as it varies according to the need for sleep. The quality of sleep is more important, as is the sleep distribution. However, it is known that

recurrent or persistent sleep loss over a period of time has an accumulative effect on the individual (Roth et al 1994).

A variety of behavioural and psychological complaints such as anxiety, depression, dysphoria and tiredness/fatigue may be reactions to sleep loss (Broman et al 1996, Bliwise et al 1992, Zammit 1988, Lack 1988). Other symptoms described are profound decrements in cognitive function such as poor memory, concentration problems, motivation deficits, attention deficits and minor neurological changes such as being clumsy and dropping things (Bonnet 1994, Healy 1987). Dysphoria has been reported previously in the general population (Liljenberg et al 1989), among subjects with persistent insomnia (Broman et al 1996) and in subjects with a poor nocturnal sleep (Zammit 1988). Mood changes persist even weeks and months after curtailed sleep. Reactions to sleep loss have been associated with the subject's personality. Carskadon et al (1976) identified poor sleepers as having greater reaction to sleep deprivation than sound sleepers have. In an interview and observation study Harrell and Othmer (1987) examined the relationship between sleep loss and confusion after open heart surgery. They found that postcardiotomy confusion, a commonly reported problem after heart surgery, could not be related to sleep loss as confusion preceded the inability to fall asleep and loss of sleep.

2.2.3.1 The prevalence of too little sleep

On the basis of epidemiological studies, using the Uppsala Sleep Inventory (USI), the prevalence of too little sleep reported in the general Swedish population ranges between 13.8 % and 21 % in those aged 30 to 69 (Gislason & Almqvist 1987, Liljenberg et al 1988) and in elderly males aged between 65 and 79 (Mallon & Hetta 1997). Elderly with somatic diseases such as hypertension, cardiac disease, angina, diabetes, depression and joint pain report more insomnia than does the general elderly Swedish population. In the younger population those with bronchitis or asthma reported most problems (Janson et al 1990, Gislason & Almqvist 1987). Moldofsky (1994) suggests that sleep-deprived subjects are predisposed to infectious diseases.

In studies with different demarcations for insufficient sleep, the prevalence of insufficient sleep varies between 27 % and 66 % in those with cardiac disease or angina and previous MI (Mallon & Hetta 1997, Carney et al 1990, Simpson & Lee 1996, Magni et al 1987, Simpson et al 1996, Moore 1994, Redeker 1993, King & Parrinello 1988, Schaefer et al 1996). Welin et al (1995) found that men with MI and a type-A behavioural pattern reported more problems with sleep, whereas Broman et al (1992) found no significant differences between

insomniacs and normal sleepers for type-A behaviour. Although the sleep is improved after heart surgery (Jenkins et al 1983a, Magni et al 1987) the proportion of insufficient sleep is still high (48 %) one year after such intervention (Magni et al 1987).

Mean values of estimated sleep duration are between 6.75 and 7 hours in men and women aged between 30 and 79 in the general Swedish population (Broman et al 1996, Liljenberg et al 1988, Mallon & Hetta 1997). This is reported to correspond to between 92 % and 98 % of the estimated need of sleep (Broman et al 1996, Liljenberg et al 1988, Mallon & Hetta 1997). Similar sleep duration has been reported in males and females, mean age 73, with angina pectoris or cardiac arrhythmia (Asplund 1994) and prior to cardiac surgery (Simpson & Lee 1996, Woods 1972, Johns et al 1974). The mortality rate has been reported to increase in relation to reduced sleep duration, and is more likely among those with less than six hours sleep duration per night (Partinen et al 1982). Reported causes of short sleep were previous MI, a history of hypertension, coronary-prone behaviour (Type-A), pain (angina pectoris), smoking and the use of cardiovascular drugs (non-antihypertensive drugs).

2.2.3.2 Falling asleep and maintaining sleep

In Swedish epidemiological studies difficulties falling asleep have been demonstrated in 21 % of men aged 50-69 (Gislason & Almqvist 1987) 25 % of men aged 65-79 (Mallon & Hetta 1997), and in 28 % of asthmatic patients (Janson et al 1990). Longer sleep latency has been reported in the elderly (Mallon & Hetta 1997, Asplund 1994) and in those with chronic disease (about 30 minutes) (Katz & McHorne 1998) than in men in the general population (17 minutes) (Liljenberg 1988). Difficulties maintaining sleep have been found in one third of men aged 50-69 (Gislason & Almqvist 1987), in about two fifths of elderly men (Mallon & Hetta 1997) and among those with asthma (Janson et al 1990).

The higher prevalence of falling asleep and maintaining sleep is partly explained by chronic disease (Gislason & Almqvist 1987, Mallon & Hetta 1997, Katz & McHorn 1998). After controlling for depression, Katz and McHorne (1998) found that chronic medical conditions are independently associated with insomnia. This was more likely among those with cardiopulmonary disease, painful musculoskeletal conditions, and prostate problems. This was also so in those with lower education status and depression. The majority of the patients included with insomnia at the baseline had persistent insomnia after a two-year follow-up period. Those with increased insomnia were more likely to report

combined sleep problems. The risk of developing mild insomnia is greater in patients with a previous history of MI (risk ratio of 1.9, 1.2-2.9) over a two-year follow-up period, than in patients with angina pectoris (risk ratio 1.3, 1.0-1.7). Previously difficulties initiating and maintaining sleep have been reported among 44.4 % and 66.7 %, respectively in non-pain exhausted individuals (van Diest & Appels 1992). Other studies have reported disturbances in falling asleep and maintaining sleep in patients with angina pectoris or MI (Redeker 1998, Asplund 1994, Jenkins et al 1983a) and prior to heart surgery (Jenkins et al 1983a, Schaefer et al 1996). Referring to the study by Jenkins et al (1983a) initiation and maintenance of sleep were improved after heart surgery.

2.2.3.3 Tiredness/fatigue

Several studies have shown that disabling tiredness/fatigue is a problem prior to heart surgery (Jenkins et al 1983b, Jenkins et al 1988, King & Parrinello 1988). Tiredness/fatigue has also been reported as a problem after heart surgery (Stanton et al 1984, King & Parrinello 1988, Jenkins et al 1988, Pick et al 1994). Jenkins et al (1988) found that feelings of fatigue were associated with sleep disturbances after heart surgery, whereas King and Perrinello (1988) did not find any relation. However, the degree of tiredness before surgery did associate with the degree of tiredness after surgery. Tiredness is seen as a part of the vital exhaustion syndrome and has been viewed by van Diest and Appels (1994) as a consequence of reduced recovery sleep due to fragmented sleep. Prodromes of sleep disturbances and vital exhaustion, especially being exhausted on morning awakening, have been found as a precursor of MI (Appels & Schouten 1991). However, the vital exhaustion syndrome has also been identified as an independently known risk factor for the progression of CAD (Appels 1996, Appels & Mulder 1988, van Diest & Appels 1992, Appels & Schouten 1991). Appels (1996,1997) suggests that the unusual tiredness preceding MI is partly a homeostatic reaction to prolonged tension. Depressed mood is seen by Appels as “superimposed” on a state of exhaustion in coronary patients.

2.2.3.4 Daytime sleepiness and napping

Daytime sleep is another factor which reflects the quality of nocturnal sleep or a deterioration of sleep distribution (circadian rhythm). The proportion of daytime sleepiness in the general Swedish population is 16.2-20.2 % (Gislason & Almqvist 1987), in elderly males 31.8 % (Mallon & Hetta 1997) and in those with asthma 44 % (Janson et al 1990). The degree of daytime sleepiness is associated with poor health (Asplund 1996), and is more likely in those with cardiovascular diseases, snoring, different painful diseases and diabetes.

The prevalence of daytime naps is common in subjects with increasing age (Asplund 1996), with exhaustion syndrome (van Diest & Appels 1994), with MI or unstable angina (Redeker 1998), respiratory problems (Lindberg et al 1998) and those undergoing CABG. This is partly due to a fragmented sleep (Asplund 1994, 1996, van Diest & Appels 1994, Schaefer et al 1996, Simpson et al 1996, Moore 1994, King & Parrinello 1988, Knapp-Spooner & Yarcheski 1992, Tack & Gillis 1990). It is believed that those with increased daytime sleep are predisposed to poorer quality of sleep the following night (Borbély 1994, Ehlers & Kupfer 1987, Horne 1992, Moore 1994). However, in a group of patients about to undergo heart surgery (Simpson et al 1996) no such influence was found. In other studies daytime-napping patients suffering from CAD experienced even better health (Asplund 1994, 1996, Asplund & Åberg 1998, Trichopoulos et al 1987), recovery and a reduced degree of fatigue following heart surgery interventions (King & Parrinello 1988, Knapp-Spooner & Yarcheski 1992, Schaefer et al 1996,). Other studies of naps (Moldofsky 1994, Davidson et al 1991) show that both body temperature and plasma cortisol were reduced during the naps in association with SWS, compared to wakefulness, independently of time for napping. Furthermore, angina pectoris and cardiac arrhythmia are less prevalent among those with daytime naps compared to those who are unable to sleep in the day despite being sleepy (Asplund 1994, 1996). However, limited data exist upon the reported effects of daytime sleep in patients with CAD, or following surgery.

2.2.3.5 Polysomnography in CAD, before and after surgery

Polysomnographically recorded sleep has been performed previously in studies of nocturnal angina pectoris (Murao et al 1972, Karacan et al 1974, Deamer et al 1972, Karacan et al 1969), on patients with MI (Karacan et al 1974, Richards & Bairnsfather 1988, Broughton & Baron 1978), and on patients undergoing heart and general surgery (Witoszka & Tamura 1980, Orr & Stahl 1977, Johns et al 1974, Ellis & Dudley 1976, Kavey & Altshuler 1979, Aurell & Elmqvist 1985, Lehmkuhl et al 1987, Knill et al 1990, Rosenberg et al 1994). Three studies were based on 24-hour polysomnography (Aurell & Elmqvist 1985, Johns et al 1974, Deamer et al 1972), whereas the other studies were overnight recordings (Murao et al 1972, Karacan et al 1974, Karacan et al 1969, Richards & Bairnsfather 1988, Broughton & Baron 1978, Witoszka & Tamura 1980, Ellis & Dudley 1976, Orr & Stahl 1977, Kavey & Altshuler 1979, Lehmkuhl et al 1987, Knill et al 1990, Rosenberg et al 1994). In post-myocardial infarction patients, severe sleep disturbances have been described. The sleep is characterised by reduced sleep efficiency, and a lighter and fragmented sleep. REM sleep is suppressed, and SWS is absent (Karacan et al 1974, Deamer et al 1972, Broughton & Baron

1978) or unchanged in the initial post-infarction period (Broughton & Baron 1978). SWS increases during the subsequent nights, and remains high until at least nine nights after the infarction (Broughton & Baron 1978). Before surgery, sleep patterns were within normal limits. Prior to heart surgery wakefulness, stage 1 sleep is increased, whereas stages 3 and 4 are slightly suppressed (Orr & Stahl 1977). Kavey & Altshuler (1979) found that even those with shorter sleep duration prior to surgery retained a normal pattern of sleep stages. It was also found that the patients exhibited an inherent sleep rhythmicity prior to general surgery (Ellis & Dudley 1976, Kavey & Altshuler 1979). Unfortunately, it is not clear whether the patients in the different studies of those undergoing surgery took a daytime nap.

After general surgery the sleep rhythmicity is absent in those who underwent general and heart surgery (Johns et al 1974, Ellis & Dudley 1976, Knill et al 1990). Sleep duration is shortened (Johns et al 1974, Orr & Stahl 1977, Kavey & Altshuler 1979, Aurell & Elmqvist 1985), fragmented (Ellis & Dudley 1976, Knill et al 1990, Kavey & Altshuler 1979), and stage 1 sleep is increased (Kavey & Altshuler 1979, Aurell & Elmqvist 1985). In several studies, total elimination of REM sleep and a reduction or absence of stages 3 and 4 sleep or SWS were reported (Orr & Stahl 1977, Johns et al 1974, Ellis & Dudley 1976, Knill et al 1990, Kavey & Altshuler 1979, Aurell & Elmqvist 1985, Lehmkuhl et al 1987, Rosenberg et al 1994). Postoperatively altered sleep/wakefulness rhythms and SWS gradually recover during the first week, with SWS-rebound the second or fourth night after general surgery (Ellis & Dudley 1976, Knill et al 1990, Kavey & Altshuler 1979, Aurell & Elmqvist 1985, Rosenberg et al 1994), followed by the re-appearance and rebound of REM sleep (Orr & Stahl 1977, Ellis & Dudley 1976, Knill et al 1990, Kavey & Altshuler 1979, Aurell & Elmqvist 1985, Rosenberg et al 1994, Johns et al 1974). In patients with open heart surgery, suppressed SWS and suppressed or absent REM sleep are retained during a longer period after surgery (Orr & Stahl 1977, Witoszka & Tamura 1980). On the other, hand relatively minor surgical procedures can cause major, albeit temporary, disruption of night-time sleep. Udelsman et al (1987) found that anaesthesia reversal, endotracheal extubation and early recovery are major determinants for stress, and not the surgical trauma. It is not clear whether sleep disturbances before surgery are associated with sleep disturbances after CABG. It is also unclear whether changes in sleep patterns persist after discharge day from hospital. Moreover, no study has been found which describes the extent to which polysomnographically recorded sleep corresponds with reported (patient-assessed) sleep in patients undergoing CABG.

In a study of general populations van Diest & Appels (1994) used polysomnography to investigate eight non-exhausted subjects and nine exhausted subjects. The results demonstrated that the vitally exhausted subjects spent a significantly shorter time in stages 3 and 4 sleep than did non-exhausted subjects. Spectral analysis showed significantly lower power in the delta band among the exhausted patients (van Diest & Appels 1994). The presence of difficulties initiating sleep, maintaining sleep, decreased total sleep, and reduction of SWS has also been described in those with anxiety and with primary depression. SWS is diminished, particularly in the first NREM sleep period. Patients with generalized anxiety have increased sleep latency, hyperarousal and an altered first night sleep cycle, whereas depressives have shortened REM latency, and increased REM sleep and REM density (Reynolds et al 1983, Bourdet & Goldenberg 1994, den Boer & Sitsen 1994).

2.2.3.6 Physiological, psychological and environmental sleep-disturbing factors

Fragmented sleep is a frequently reported sleep problem in the elderly (Asplund 1994, 1996), in patients with MI, with vital exhaustion syndrome and in those undergoing heart and general surgery. A variety of physiological, psychological, and environmental disturbing factors were reported from the different studies. Physiological contributory factors included angina pectoris, respiratory problems, and arrhythmias in those with CAD, before (Jenkins et al 1983b, Broughton & Baron 1978, Partinen et al 1982, Murao et al 1972) and after surgery (Jenkins et al 1988, Moore 1994). In addition, incomplete relief of pain (Simpson et al 1996, Moore 1994, King & Parrinello 1988, Ellis & Dudley 1976, Knill et al 1990), nocturia (King & Parrinello 1988, Tack & Gilliss 1990, Asplund 1996) and medical agents (Asplund 1996, Ellis & Dudley 1976, Knill et al 1990) were also reported as physiological factors. Other, more behavioural, complaints included taking a long time to go back to sleep after been aroused (Moore 1994) and difficulty lying comfortably (Johns et al 1974, Simpson et al 1996, Schaefer et al 1996, Moore 1994, Ellis & Dudley 1976). Psychological factors included anxiety and stress (Orr & Stahl 1977, Ellis & Dudley 1976, Simpson et al 1996, King & Parrinello 1988, Schaefer et al 1996, Denollet et al 1996, Tack & Gilliss 1990, Grosby et al 1987). It was also observed that some patients seemed to wake up for no particular reason (Orr & Stahl 1977, Aurell & Elmqvist 1985, King & Parrinello 1988, Redeker 1998). When hospitalised, environmentally related factors were the most common. These included aspects such as noise, lights (Simpson et al 1996), stress due to constant activities at the unit (Knapp-Spooner & Yarcheski 1992, Yarcheski & Knapp-Spooner 1994, Orr & Stahl 1977, McFadden & Giblin 1971, Walker 1972), unfamiliar environment, the routines

(Ellis & Dudley 1976, Simpson et al 1996) and inconvenient procedures performed with the patients (Johns et al 1974, Ellis & Dudley 1976, Simpson et al 1996, McFadden & Giblin 1971, Walker 1972, Redeker 1998).

2 . 3 Psychological symptoms

The relationship between preoperative psychological status and postoperative outcome has been equivocal. Studies of patients undergoing general surgery (Christensen et al 1986) and CABG (Horgan et al 1984) have shown high psychological distress before surgery which was not correlated with postoperative psychological distress. Several other studies have shown that psychological symptoms such as anxiety, depression and sleep disturbances can to a certain extent be responsible for the psychological outcome after surgery (Burker et al 1995, Eriksson 1988, Stengrevics et al 1996, Duits et al 1997, Pick et al 1994, Jenkins et al 1983a, 1983b, Crumlish 1994, Timberlake et al 1997, Kos-Munson et al 1988, Carney et al 1988).

It has been reported that the degree of anxiety level is highest on admission day and subsequently declines (Jenkins et al 1983a), doing so more in depressed than non-depressed patients (Timberlake et al 1997). In a study by Stengrevics et al (1996) it was found that higher levels of preoperative state anxiety and state anger were associated with poorer postoperative outcomes. This was not the fact for trait anxiety or trait anger. The author hypothesised that patients' psychological status immediately prior to surgery may be more related to surgical outcomes. In contrast to Stengrevics et al (1996), with respect to the high anxiety level immediately before surgery Jenkins et al (1983a) suggests that such a comparison causes an overestimation of the postoperative recovery. Other studies indicate that long-term psychological distress results in persistent elevated activity (Terzano et al 1997, Udelsman & Holbrook 1994). Spielberger and co-workers characterises the anxiety state as "*subjective feelings of tension, apprehension, nervousness, and worry, and by activation or arousal of the autonomic nervous system*" (Spielberger et al 1983, p 1). Emotional reactions are seen by Spielberger et al (1983) as an expression of the subject's personality states. Depression is defined in terms of mood disorders (feeling blue, downhearted, depressed, concentration problems) and somatic symptoms (sleep problems, fatigue, appetite loss). Depression can interfere with all the activities of the individual, including interpersonal relationships, employment and social life. Research has shown that better health and fewer sleep difficulties are associate with lower anxiety and depression levels both before, and after, heart surgery (Jenkins et al 1983a, Eriksson 1988, Grossi et al 1998).

2.3.1 Sleep and anxiety

Measured on the Spielberger State of Anxiety Scale (STAI-S) the prevalence of anxiety ranged between 22 % and 48 % (Levine et al 1996, Burker et al 1995, Langeluddecke et al 1989, Kos-Munson et al 1988, Horgan et al 1984, Underwood et al 1993) in patients with CAD, prior to heart surgery; and 18-32 % one year after surgery (Langeluddecke et al 1989, Horgan et al 1984, Cay & O'Rourke 1992, Jenkins et al 1988). Younger patients with CAD were more anxious than elderly patients (Redeker 1993, Levine et al 1996).

Different studies show a moderate degree of anxiety (Score on STAI-S 35.6-49.8) after MI (Crowe et al 1996), before heart surgery (Levine et al 1996, Burker et al 1995, Jenkins et al 1983a, 1994, Langeluddecke et al 1989, Vingerhoets et al 1995, Milani et al 1996, Grossi et al 1998) and up to one year after CABG (Levine et al 1996, Timberlake et al 1997, Langeluddecke et al 1989, Grossi et al 1998). A high anxiety level before CABG has been shown to predict a high anxiety level (Grossi et al 1998, Eriksson 1988, Timberlake et al 1997), a high degree of residual angina pectoris, dyspnoea and psychological distress after CABG (Grossi et al 1998).

Sleeping difficulties are common in anxious patients, including 70 % of individuals with generalised anxiety (Hoehn-Saric & McLeod 1994). Their sleep is characterised by trouble falling or staying asleep and the subject wakes up early in the morning. Similar sleep patterns are reported in healthy subjects with intrusive thoughts, which are common in stressful events (Hall et al 1996). Somatic symptoms such as palpitations and shortness of breath may contribute to shallow and fragmented sleep. Muscle tension, tiredness, reduced energy/fatigue, difficulty concentrating, irritability and restlessness are other commonly reported problems during waking hours (Hobson 1995, Chrousos & Gold 1992, Hoehn-Saric & McLeod 1994). Furthermore, cognitive stress was investigated by McFetridge and Yarandi (1997) in patients before and after CABG. It was found that the effect of cognitive stress was reduced after surgery (McFetridge & Yarandi 1997). Multiple regression analysis revealed that anxiety score, dyspnoea score, pre-operative hospitalizations, sleep problems, social support and cigarette consumption were predicting factors for symptoms six months after CABG or cardiac valve surgery (Jenkins et al 1994).

2.3.2 Sleep and depression

Depression is a problem in patients with CAD, and sleep disturbances are a cardinal symptom. The prevalence of depression varies widely in terms of ranges

between the different studies before heart surgery (Timberlake et al 1997, Levine et al 1996, Langeluddecke et al 1989, Eriksson 1988, Moore 1994, Burker et al 1995, Horgan et al 1984, Magni et al 1987, Steine et al 1996) and after surgery (Moore 1994, Milani et al 1996, Timberlake et al 1997, Redeker 1993, Cay & O'Rourke 1992, Langeluddecke et al 1989, Horgan et al 1984, Jenkins et al 1988), with a lower incidence of depression in patients undergoing rehabilitation (Cay & O'Rourke 1992, Milani et al 1996). Using Zung's SDS the mean score ranges were within non-depressed limits (Gokgoz et al 1997, Wiklund & Welin 1992). However, it is suggested that depression is underdiagnosed in cardiac patients as the patients seem to exhibit atypical symptoms compared to criteria usually reported in clinically depressed patients (Freedland et al 1992, Appels 1997, Chrousos & Gold 1992) due to dysregulation of the HPA axis. Other authors use dysphoria, which manifests itself as feelings of sadness, which deviate from the sensation of depression. It arises as a consequence of arousals in chronic mild stress, chronic pain and reaction to sleep loss (Healy 1987, Chrousos & Gold 1992). Dysphoria relates to the disruption of the subject's circadian rhythms and to metabolic changes, and is an important operational criterion in endogenous depression. As those with classical depression also have sleep disturbances, it can be difficult to differentiate these changes in mental state from dysphoria. Pratt et al (1996) found that dysphoria precedes MI. In another study, the degree of dysphoria was reduced after CABG interventions compared with before surgery (Bourdrez et al 1992). Quinlan et al (1974) show that dysphoria significantly correlates with postoperative complications and longer hospitalisation, but not with preoperative depression or emotional distress.

Sleep in depression is characterised by decreased sleep duration, poor quality of sleep and, in some patients, early morning awakenings. The early morning awakenings and diurnal mood variations indicate altered biological rhythms (Healy & Williams 1988, Syvälahti 1994). Patients with CAD had more severe insomnia than non-depressed patients with CAD, whereas insomnia and fatigue were the most frequent somatic complaints (Freedland et al 1992).

Preoperative anxiety and depression levels have been described to be important predictors of cognitive functioning, general performance and of recovery progression up to one year after heart surgery (Jenkins et al 1983a, Eriksson 1988, Horgan et al 1984, Newman et al 1990, Burker et al 1995, Stanton et al 1984). A lower degree of anxiety and depression are associated with better rehabilitation (Eriksson 1988, Kos-Munson et al 1988, Cay & O'Rourke 1992) and functional capacity according to the NYHA class (Eriksson 1988, Burker et

al 1995). In addition, the combination of psychological distress, sleep and personality aspects, mobility and general performance can be important risk factors in the progression of CAD (Denollet et al 1996, Duits et al 1997, Grossi et al 1998). Significant improvements in the degree of anxiety, depression and sleep have been reported six months and one year after CABG (Jenkins et al 1983a, Redeker 1993, Magni et al 1987). It remains unclear as to what extent reported sleep and objectively measured sleep are associated with psychological symptoms before, and after, CABG.

2.4 Sleep and quality of life

Quality of life referring to the good life derives from the Greek philosopher Aristotle's (300 B.P.) concept "eudaimonia," which refers to the importance of living an active life (Ostenfeld 1994), by internal and external conditions which relate to health, physical security, economy, social life, and rational actions of significance. The concept of quality of life is a complex one, and is not open to clear definition. The difficulty in defining this concept may be due to it being defined in different ways in different fields of research. A global consensus has led to the formulation of four processes or domains which make up the quality of life concept. These are "*physical and occupational function, psychological state, social interaction and somatic sensation*" (Schipper et al 1990, p11). Clinicians and researchers have also come to an agreement on the minimum component requirements that should be used when measuring health-related quality of life (Sullivan 1990). These are: physical, psycho-emotional, psycho-cognitive, social-health judgement, and satisfaction with one's life situation.

Measurement of health usually aims to evaluate functioning in daily life or refers to the state of health (Ferrans 1990, Frank-Stromberg 1992), whereas others (Lawton 1991) refer to quality of life as something that is independent of health status. Subjective or perceived health is defined by Hunt as "*an individual's experience of mental, physical and social events as they impinge upon feelings of well-being*" (1988, p 23). Further, Hunt et al (1985) have regarded quality of life as a subjective appraisal of life satisfaction. Neuman describes health on a dynamic continuum, ever changing, between well-being and illness (1996).

Appels et al (1996) found that self-rated health was an important predictor of MI among a Lithuanian cohort, whereas Kristenson et al (1998) found that psycho-social stress related to socio-economic factors is significant. Impaired quality of life is seen as a risk factor in cardiovascular disease (Siegrist 1987). Clinical studies of patients with CAD, with a previous history of MI, and those subjected to heart surgery, have frequently been evaluated for psychometric health-related quality of life using the Nottingham Health Profile instrument (NHP) (Wallwork

& Caine 1985, Caine et al 1991, O'Brien et al 1993, Visser et al 1994, Skinner et al 1995, Chocron et al 1996, Sjöland et al 1996, Albertsson et al 1996, Lukkarinen & Hentinen 1997, Klersy et al 1997, Permanyer-Miralda et al 1991, Grossi et al 1998, Lukkarinen 1998). The evaluation has focused on how quality of life might be positively or negatively affected by disease, interventions, therapy, and the clinical situation. However, measurements of sleep and health-related quality of life in patients with atherosclerosis result in a certain demarcation as they deal predominantly with individuals with a chronic life-threatening disease. CAD can be caused by genetic factors and/or a long series of factors resulting from the patients' reactions to their life situation, life-style, personality and health (Orth-Gomér 1996, Chrousos & Gold 1992, Mehta et al 1998).

The NHP measures health-related behaviour according to the subjective emotional, functional and social impact of the patient's disease (Anderson et al 1993, Hunt et al 1984). The NHP contains two parts. Part I covers six domains of distress: energy, physical mobility, emotional reaction, pain, sleep and social isolation experienced at the time of completing the questionnaire. Part II covers seven areas: distress with work, looking after the home, social life, home life, sex life, interests and hobbies, and holidays.

The results from 13 different studies using the NHP instrument Part I, including over 5000 patients, showed that the patients made a very good cardiac and surgical recovery and improved up to two years after heart surgery (Wallwork & Caine 1985, Caine et al 1991, O'Brien et al 1993, Visser et al 1994, Skinner et al 1995, Chocron et al 1996, Sjöland et al 1996, Albertsson et al 1996, Lukkarinen & Hentinen 1997, Klersy et al 1997, Permanyer-Miralda et al 1991, Grossi et al 1998, Lukkarinen 1998). There was a tendency to approach better quality of life after surgery in those with less quality of life before the intervention (Wallwork & Caine 1985, Sjöland et al 1996). With the exception of pre-transplantation with worse quality of life (Wallwork & Caine 1985), the NHP instrument Part I showed that there was a tendency towards worse sleep in the elderly prior to CABG (Wallwork & Caine 1985, Chocron et al 1996), among those with angina less than nine years after CABG (Skinner et al 1995), those with diabetes (Klersy et al 1997) and those with reduced exercise (Skinner et al 1995, Sjöland et al 1996) or in a higher NYHA class (Permanyer-Miralda et al 1991, Visser et al 1994, O'Brien et al 1993). Persistent sleep problems and energy deficit have been reported six months (Permanyer-Miralda et al 1991) and one year after CABG (Grossie et al 1998, Lukkarinen 1998). The findings of Grossie et al (1998) also showed a high score for emotional distress on the NHP one year after surgery. Albertsson et al (1996) investigated 2639 patients with cardiac chest

pain and pain of cardiac origin prior to coronary angiography, 113 of whom had non-significant stenoses verified by coronary angiography. The patients with non-significant stenoses exhibited greater energy deficit and sleep problems compared to an age-matched healthy population. Albertsson and co-workers (1996) suggest that low energy may partly be due to anxiety. The NHP Part II demonstrated that CAD interfered with all seven areas (Sjöland et al 1996, Wallwork & Caine 1985, Hunt et al 1984). No previous studies have been found which measure the association of reported and polysomnographically recorded sleep to health-related quality of life, using the NHP instrument, in patients´ with CAD or who are undergoing CABG.

3. THE SPECIFIC AIMS

With the focus on sleep, the general aim of this thesis was to evaluate sleep, psychological symptoms and quality of life in patients´ undergoing CABG according to five specific aims:

1. To evaluate nurse´s documentation of sleep and sleep disturbances in the immediate postoperative period of CABG patients.
2. To investigate self-reported sleep and polysomnographically measured sleep in patients scheduled for CABG. Further, to investigate the relationship between self-reported and objectively measured sleep.
3. To investigate whether patients undergoing CABG develop sleep disturbances and to evaluate whether these sleep disturbances are persistent.
4. To assess whether patients with CAD have psychological symptoms and to evaluate whether these symptoms are persistent after CABG. Furthermore, to evaluate the association between the degree of psychological symptoms and sleep disturbances.
5. To examine whether patients with sleep disturbances and psychological symptoms improve their quality of life following CABG.

4. PATIENTS AND METHODS

4.1 Patients

The patients included in the present five studies were all men from south-eastern Sweden, who underwent elective isolated CABG for the first time at the

University Hospital in Linköping, Sweden. Depending of the accessibility of the equipment, the sample was selected consecutively in Papers II-V. Patients with verified cancer, a documented history of cerebrovascular disease, neurological diseases with sequelae, or those undergoing treatment for mental disorders and aged >70 (Papers I-V) were not included.

Eighty patient records were analysed on patients aged between 43 and 76 who underwent CABG during 1990 (Paper I). According to the exclusion criteria, with the exception of age, this constituted a total sample (Paper I).

A pilot study included six patients, aged between 51 and 70 (median 64), living in Östergötland, Sweden who underwent CABG during the period March 1992 and May 1992 (Paper II). Because of depression, post-surgery aggressiveness and pain, two patients withdrew from the polysomnographic recordings on the third day. Both, however, took part in the interview at the one month follow-up. One patient did not participate in the follow-up interview one month after surgery because of family problems. A total of three patients, therefore, completed all stages of the study (Paper II).

The six patients from the pilot study and a further 38 patients were included in paper III, which then comprised 44 men, aged 45-70. The 38 patients underwent CABG during the period February 1994 and October 1995. In Papers IV-V 38 patients, aged between 45 and 69 (mean 61.3 ± 5.0), were further analysed. One month after surgery one patient had a serious mediastinal infection and was considered too weak to participate. One patient declined the polysomnographic recordings and one patient declined to participate in the study because of family problems.

All studies were approved by the Research Ethical Committee, Faculty of Health Sciences in Linköping. The participants were informed, and verbal consent was obtained from all patients.

4.2 Design

To evaluate nurses' documentation retrospectively, a descriptive design for the patients' first four postoperative nights was performed (Paper I).

To test different instruments that focused on sleep, quality of life and personal adjustment in order to evaluate the usefulness of these instruments in a larger study, a one-group pre-test post-test design (within groups) was used. To

describe self-perceptions of sleep and life situation by patients who had undergone CABG, a descriptive design was used (Paper II).

A descriptive comparative design was used to describe reported sleep and polysomnographically measured sleep in patients with verified CAD. By use of a descriptive correlation design, relationships between reported sleep and objectively measured sleep were investigated (Paper III).

A one-group, pre-test-repeated post-test (within groups) design was used to study the sleeping pattern and quality of life prior to and after surgery (Paper IV). Furthermore, we examined the correlation between the subjective evaluation of sleep quality in the NHP instrument and the sleep pattern obtained by polysomnography (Paper IV).

To examine the prevalence of depression and anxiety before and after CABG and to see how those with depression and anxiety differ in sleep patterns, a one-group pre-test post-test design (within groups) and a descriptive comparative design were used. The individual reaction to sleep loss was tested as a predictor of certain emotional symptoms in the follow-up period by using a descriptive comparative design, a predictive design and some correlations (Paper V) (Burns & Grove 1993).

4.3 Procedure

In Paper I a retrospective analysis was performed of the nurses' documentation regarding sleep and wakefulness from 11.00 pm to 07.00 am during the first four postoperative nights. An attempt was made to relate these findings to documentation done by nurses the night before surgery, and the degree of alertness of the patient the following day. Potential causes of sleep disturbance were classified into three groups: patient's health condition, medical and nursing interventions and environmental conditions.

In the pilot study (Paper II) structured interviews with complementary notes were carried out in the homes 14 days before, and again one month after, surgery. In study III structured interviews were conducted in patients' home in 14 cases and at the ward on admission day in 30 cases. All patients responded to a sleep diary on the morning of the polysomnography. In Papers IV and V the structured interviews before surgery were conducted in 30 cases on admission day at hospital, and in eight cases in their homes. Those patients who were interviewed in their home before surgery did not live far from the hospital (Papers III-IV).

The interviews were then repeated one month after surgery and followed-up with questionnaires by mail six months after surgery (Papers IV-V). The measuring points are summarised in Figure 2.

STUDY PROTOCOL

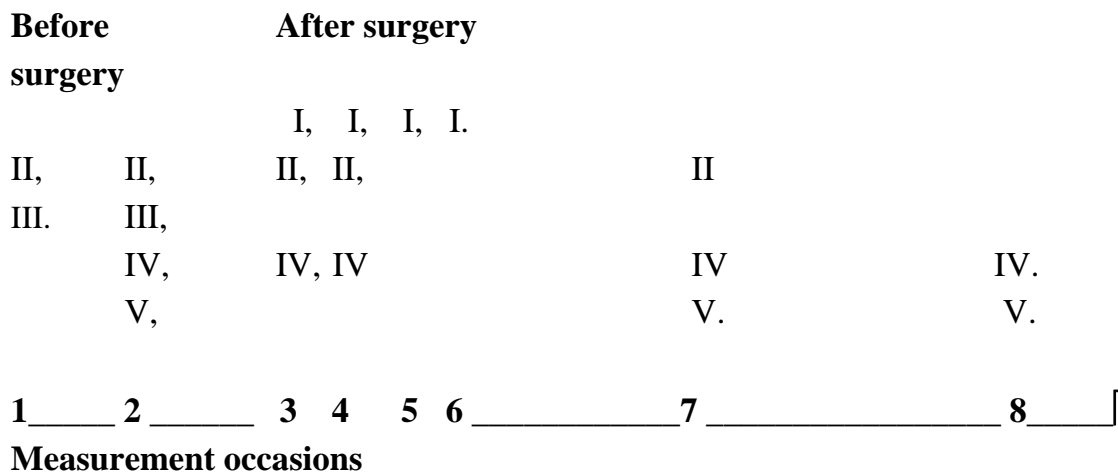


Figure 2. The Roman numerals refer to the individual studies (Papers I-V). The arabic numerals refer to the different measurement occasions: **1**: 14 days prior to surgery. **2**: Two to three days prior to surgery. **3 to 6**: Immediately four first days after surgery. **7**: One month after surgery. **8**: Six months after surgery.

All patients, but eight, were admitted to the ward between one and three days prior to surgery for the standard preoperative preparations. These patients underwent preoperative preparations as outpatients. The night before surgery patients were premedicated with flunitrazepam and fasted overnight, from 12 p.m. After premedication with oxicon-scopolamine intramuscularly, anaesthesia was induced by fentanyl and thiopentone sodium and maintained by fentanyl and isoflurane. For muscle relaxation pancuronium was used. Patients were heparinised to an active clotting time of 400 seconds or above and neutralized with protamine after ECC (Paper II, IV). For cardiopulmonary bypass clearing priming solution, a roller pump, membrane oxygenator (Sorin or Maxima, Medtronic blood systems inc., Minneapolis, Minnesota, USA) moderate hypothermia (mean $31.8 \pm 1.8^{\circ}\text{C}$) and cold NaCL cardioplegia were used. After surgery the patients were transferred to the thoracic intensive care unit (ICU), intubated and put on mechanical ventilation, and later extubated according to standard criteria. In the ICU, a thermal ceiling (OPN Thermal Ceiling, Aragone Ltd., Sweden), suspended above the bed, was used to provide radiant heat (Papers IV). The next day all patients in the pilot study (Paper II) and 36 of 38 patients in the fourth study (Papers IV) were transferred to an intermediary care room. The next forenoon they were transferred to an ordinary ward. The mediastinal tubes were removed on the first postoperative day. During the early

postoperative period analgesia was managed by infusing small doses of ketobemidon with antispasmodics (Paper II), and by ketobemidon only in study IV, followed by propofene and acetaminophen orally (Paper II, IV).

Twenty-four hour periods of continuous ambulatory polysomnographic recordings were performed on the day of admission in all cases (Paper II, III-IV), except for at the homes in eight patients (Paper III-IV) prior to surgery. The polysomnographic recordings immediately postoperatively were started three hours after admission to the ICU, and performed over a 48-hour period (3-51 hours). The recordings one month after surgery were performed at home (Papers IV). Statistical analysis did not reveal differences between the preoperative patterns on the ward or at home, therefore the material was pooled.

4.4 Methods

The pilot study was performed to test the usefulness of different instruments that focused on sleep, quality of life and personal adjustment in a larger study (Paper II). Furthermore, some medical data were obtained from the patient records.

4.4.1 Habitual sleep

Habitual sleep was assessed by the Uppsala Sleep Inventory (USI) questionnaire (Hetta et al 1985) (Papers II-III,V). The USI scale, corresponding to polysomnographically measured sleep (Hetta et al 1998), contains demographic variables; marital status, education level, working situation, residential status and economy, life-style questions, driving, smoking and alcohol habits, coffee and tea consumption. Questions dealing with diseases diagnosed by a physician and whether the subjects felt that they slept too little or too much were answered on 18 dichotomous questions (present/absent). Questions about sleep habits included time of going to bed, time of falling asleep, sleep latency, number of nocturnal awakenings, total sleep time, morning awakening time and daytime napping, as well as medical therapy. The severity of sleeping difficulties and daytime symptoms, difficulties in falling asleep, maintaining sleep, early morning awakening, daytime sleepiness and physical tiredness were assessed on a 5-point graded scale, where 1 point meant no problems and five points, very great problems.

Actual overall health was assessed on a six-point graded scale from very bad (1 point) to very good (6 points) (Paper III). There were separate questions about the duration of coronary heart disease symptoms (Paper V) and socioeconomic status according to profession, which were categorized into the Swedish

socioeconomic classification (1982). The patients' weight and height were assessed on admission day and the body mass index (BMI) was calculated as Quetelets index (weight in kg)/(height in m)² (Keys et al 1972). (Paper III,V). The severity of pain was assessed in five steps, from mild (1 point), diffuse (2 points), distressing (3 points), intolerable (4 points) and depressing (5 points): how often they experienced pain rated from never (no score) to five days/week or more often (4 points). The presence of nocturnal pain was also reported (Paper III).

4.4.2 Sleep diary

A modified form of sleep diary was used to assess actual sleep behaviour (Papers II-III), health (Paper II-III), sleep disturbing factors (Papers II) and behavioural and mental state (Paper II). Assessment of distinct actual sleep behaviours included time of going to bed, time of falling asleep, number of nocturnal awakenings, total sleep time and morning awakening time, and actual overall health and tension/relaxation. Actual overall health was assessed. The degree of tension or relaxation at the time of falling asleep was assessed on a five-point scale from very tense (1 point) to very relaxed (5 points). Further, a five-point graded scale from none (1 point) to very much (5 points) was used to estimate behaviour and mental state i.e., calm, depressed, feeling warm, cold, confused, tension, worried, irritated, difficulties with concentration, tearful and disorientated. **Furthermore, questions about how the patients feeling in a state of being difficulty in rating between real, unreal and dreamings (nightmares or pleasant dreams)** were used (present/absent). In addition, items to be answered in the evening dealt with daytime naps, sleep duration the previous night, if sleep was sufficient the previous night (yes/no) and whether altered nocturnal sleep influenced daytime activities (yes/no) (Paper II).

4.4.3 Assessment of reactions to sleep loss

Reactions to sleep loss were assessed by an instrument developed by the Uppsala Sleep Disorders Unit, Sweden (Paper V) (Broman et al 1996). According to 24 proposed effects of insufficient sleep the patients rated on a five-point graded scale from no problems (1 point) to very great problems (5 points) how this affected them. In the paper the same factors were used, as those identified by Broman et al (1996) in a factor analysis as important for psychologic and psychiatric adverse effects of sleep loss. Three items measured dysphoric mood; disappointed and irritated, too tired to be nice, sad and depressed. The total score thus ranges between 3 and 15 points. Five items measured cognitive/behavioural fatigue effects: memory difficulties, concentration

difficulties, difficulties in making decisions, clumsiness and lack of energy. The score ranges between 5 and 25 points. Sad/depressed reactions to sleep were considered as one important item (1 to 5 points) (Broman et al 1996). One patient refused to answer the questionnaire because he experienced it as too difficult to grade these problems.

4.4.4 Determination of sleep by polysomnography

To determine sleep, standard polysomnographic techniques (Rechtschaffen & Kales 1968) including electroencephalography (EEG), electro-oculography (EOG), and electromyography (EMG) were performed using Oxford Medilog 9000 eight-channels equipment (Oxford, Synetics AB, Stockholm, Sweden, Papers II-IV). The data were digitalised and transferred to the Eudex Nightingale computer (Judex Datasystemer, Aalborg, Denmark), and visually scored from the screen in 30-second epochs. The interpretations of the recordings were carried out using criteria established by Rechtschaffen and Kales (1968). In this study unipolar EEG C₃-A₁ or C₄-A₂, EOG and submental EMG were used.

Twenty-four-hour polysomnographical recordings was used to illustrate daytime sleep. There were no restrictions in activities for the patients, and no special restrictions had to be observed by the staff during the measurement times. No monitoring was done the night before the operation. The following sleep parameters were evaluated in Paper IV:

Total sleep time: Duration of all sleep stages during a 24-hour period.

Nocturnal sleep: Duration of sleep during the period 11 p.m. to 7 a.m., excluding all periods of wakefulness.

Total daytime sleep: Duration of sleep during the period 7 a.m. to 11 p.m., excluding all periods of wakefulness.

Sleep onset: The first epoch of stage 2 with the following scored sleep of at least 10 minutes duration.

Sleep latency: The period from lights off to sleep onset.

REM sleep latency: The interval from sleep onset to the first appearance of REM-sleep in a single sleep episode.

Arousals: An abrupt change from a deeper stage of NREM-sleep and REM-sleep towards wakefulness.

Movement arousal: A body movement associated with an EEG-pattern of arousal or full awakening.

Waking time: Duration of wakefulness between 11 p.m. and 7 a.m.

Nocturnal Sleep efficiency index: The ratio of sleep duration and wakefulness during the period 11 p.m. and 7 a.m.

Slow Wave Sleep (SWS): Synonymous with stages 3 and 4 sleep.

Nocturnal sleep was defined from the reported time of falling asleep p.m. and morning awakening time 07.00 a.m.; the remaining part of the 24-hour period was labelled daytime sleep in Paper III.

4. 4. 5 Anxiety and depression

To measure the state of anxiety the Spielberger State of Anxiety Scale (Spielberger et al 1983) (STAI-S) was used (Papers II-III, V). STAI-S contains 20 items on a four-point Likert-type scale. State of anxiety is a measure of the transient feeling of anxiety experienced by the patient in response to a situation (Spielberger et al 1983). The total score is the weighted sum of all 20 responses and ranges from 20 to 80. A low anxiety score lies below 30, whereas moderate anxiety scores lie between 40 and 59. Values of 42.7 or lower represent normative data in general medical and surgical patients (Spielberger et al 1983). The STAI-S has been validated and tested for reliability (Spielberger et al 1983) in Swedish populations in different strata (Forsberg & Björvell 1993), in patients with insomnia (Broman et al 1992) and after myocardial infarction (Wiklund & Welin 1992), as well as against the NHP instrument (Wiklund & Welin 1992). In the present study the respondents were dichotomized according to non-anxiety scores below 43 and anxiety scores of 43 or higher. The instrument's validity and reliability are well documented. The internal consistency coefficients are higher for the STAI-S when it is given under conditions of psychological stress, ranging from 0.92 to 0.94, and in dichotomous data, ranging from 0.83 to 0.92 (Spielberger et al 1983).

Zung's Self-rating Depression Scale (Zung's SDS) (Zung 1972a) was selected to measure depression (Papers II,III,V) at the time of testing. It is a widely used scale both as a screening instrument and for measuring clinical changes, and includes 20 items on a four-point Likert-type scale, giving a total score between 0.25 and 1.0. A score of 0.49 or less on Zung's SDS represents non-depression, a score within 0.50 and 0.59, minimal to mild depression, a score within 0.60 and 0.69, moderate to severe depression, whereas a score of 0.70 and over represents severe depression (Zung 1972a). Zung's SDS has been found to have good discriminatory power between depressed and non-depressed subjects (Zung 1972a) and between depressive and anxiety reactions. The instrument has been well validated and found to have high reliability (Zung 1972a, Zung 1973). Yesavage et al (1983) reported a Cronbach coefficient alpha of 0.81 for the Zung scale based on a sample of 47 subjects. The reliability of the scale examined in different strata showed a Cronbach coefficient alpha of 0.78 in young subjects (aged 18-25), 0.76 in young older subjects (aged 58-72) and 0.59 in "old-old" subjects (aged 73 - 88) (McGarvey et al 1982). The scale has been tested in many

language versions including Swedish (Zung 1972b). Zung's SDS has been compared against other scales (Yesavage et al 1983, Agrell & Dehlin 1989) to assess depression one month after myocardial infarction in a Swedish population (Wiklund & Welin 1992) and against the NHP instrument (Wiklund & Welin 1992). The patients in the present study were dichotomized as depressed if their score was 0.50 or higher, or non-depressed, if their score was below 0.50 (Papers III,V).

4.4.6 Physical functional capacity

Physician assessment (Paper IV) and both physician assessment and patient assessment (Papers III, V) of physical functional capacity according to New York Heart Association's (NYHA) class were performed. Criteria for functional classification were categorised on a four-level ordinal scale, class I to class IV. Lower class indicates better functional status due to symptoms of fatigue, palpitation, dyspnoea or angina pain. In class I the patients experience no limitation of ordinary physical activity, whereas in class II a slight limitation occurs. Class III is characterised by a marked limitation of physical activity but comfort at rest, while class IV represents an inability to carry out any physical activity without discomfort. The scale is widely used on patients with coronary artery disease (CAD), (Burker et al 1995). In Papers III and V the Swedish version by Persson (1991) was used. In addition, both information about the severity of coronary disease and the results of the exercise test were derived from the patients' records (Paper III-V).

4. 4. 7 Quality of Life

Health-related quality of life was assessed by means of the Nottingham Health Profile Instrument (NHP) (Anderson et al 1993, Hunt et al 1984). The NHP contains 45 subjective statements. The statements are divided into two parts. NHP Part I includes 38 items and covers six domains of distress: energy, physical mobility, emotional reaction, pain, sleep and social isolation experienced at the time of completing the questionnaire. The answer to each statement is binary (yes/no) with a "yes" answer indicating which areas are affected by the respondent's present state of health. The items are weighted, and for each domain scores from 0 to 100 can be calculated. A higher score for each domain indicates a higher level of distress or impairment. In addition, a total score for Part I can be calculated by summing up the weighted values for each domain and then dividing the sum by the number of sections (six). Part II on the NHP reflects seven aspects of life affected by the state of health; occupation, ability to perform jobs around the house, social life, home relationships, sex life,

hobbies, and holidays. For each statement the proportion of yes-answers was calculated. The test-retest showed high reliability coefficients for the sleep section ($r_s=0.94$) on the original version (Anderson et al 1993) and major discrepancies on the sections for pain, sleep, mobility, energy and emotional reaction on the Swedish version (Wiklund et al 1988, Sjöland et al 1996). The NHP scale has been shown to discriminate between major medical conditions, and symptomatic versus non-symptomatic illness (Anderson et al 1993, Albertsson et al 1996).

For quality of life the scoring test after Lawton's hierarchical model of behavioural competence (Paper II) was constructed for this study by reviewing articles about the model. Behavioural competence is part of his concept of quality of life (Lawton 1991). The tool contained 28 items covering health (4 items), functional health (11 items), cognition (5 items), time use (4 items), and social behaviour (4 items). The scoring test included three types of questions: questions to be answered with "present" or "absent", questions to be answered on a graded scale with a range between 1-3 and 1-7 about the extent to which a phenomenon occurs or is perceived, and questions relating to demographic data. The retrospective study and different instruments used in the four studies (Papers II-V) described above are given in Table 1

Table 1. Measurements used in the different Papers (I-V).

	Paper nr				
	I	II	III	IV	V
- Retrospective analysis of patient records	X				
- Polysomnography		X	X	X	
- The Uppsala sleep Inventory (USI)		X	X		X
- Sleep diary		X	X		
- Statements as reactions to sleep loss					X
- Zung's Self-rating Depression Scale (Zung's SDS)		X	X		X
- The Spielberger State of Anxiety Scale (STAI-S)		X	X		X
- Physician-assessed NYHA Class (NYHA)			X	X	
- Patient-assessed NYHA Class (NYHA)			X		X
- The Nottingham Health Profile instrument (NHP)		X	X	X	X
- Items due to the behavioural competence model after Lawton		X			

4.5 Statistical methods

Besides descriptive statistics (Papers I-V), the paired Student's t-test (two-tailed) was used in Paper II to compare the polysomnographic recordings before and after surgery. Comparison between the sleep variables before and after surgery in Paper IV were performed by two-way analysis of variance (ANOVA). For post hoc analysis the Tukey test was calculated (Paper IV). The nonparametric Friedman's two-way analysis of variance by ranks test was used for repeated measures of habitual sleep, actual sleep, and polysomnographically recorded sleep (Paper III), anxiety, depression sleep, NYHA class and the Nottingham Health Profile instrument variables (Papers IV-V) (Siegel & Castellan 1988). Correcting for three comparisons, Bonferroni's post-hoc test was calculated (Paper III-V). To compare between groups the Mann-Whitney U test was used (Papers III-V). The parametric Pearson's product moment correlation coefficient was employed to test for relationships between variables in Paper IV, whereas non-parametric statistical tests, Spearman (r_s) correlation coefficient, was used in Papers III-V. Forced and stepwise multiple regression analyses were performed for predictions (Paper V). The adjusted R^2 was calculated to compensate for any overestimation error. In Papers II to V a p-value of less than 0.05 was considered statistically significant, even when the Bonferroni was used. Crunch statistical software was used for all calculations (Software Corporation, 5335 College Avenue, Suite 27, Oakland California 94618, Crunch 1991).

5. RESULTS

Nurses' documentation of sleep (Paper I) A total of 55 different descriptions were found, which were classified into the categories "sleep quality" and "sleep duration". Notations on sleep were found in 69-86 % of patients' records each night, and were most common on the second night. Descriptions of both quality and quantity of sleep occurred in 12 out of 320 patient-nights. Notes regarding duration of sleep were found for 146 patient-nights (45.6%), of which 103 (32.2 %) contained sleep disturbances. Information on quality of sleep was given for 116 patient-nights (36.3 %), with only 38 patient-nights (11.9 %) of sleep disturbances. For 72 patient-nights, documentation of the patients' sleep was lacking. Frequent awakening was the most common sleep disturbance noted during all but the first night, when continuous awakening dominated. Descriptions of behaviour/mental state were short and non-informative. The nurses' documentation was both cause- and problem-oriented, with short summaries in narrative style. The descriptions were based on short, random observations which varied in number for each summary. The documentation of sleep did not correspond with comparison of the time intervals of medical interventions and care activities. In some cases the nurses had documented that

the patients had slept or slept well during the night, whereas the documented medical and nursing care interventions showed that the patient could not have had the opportunity to sleep. There was no information on patient's habitual sleep or sleep during previous periods of hospitalisation.

Clinical characteristics of the patients before surgery (Papers II-III) Of the 44 included patients prior to surgery, twenty-four had a history of previous myocardial infarction, 20 had respiratory insufficiency/problems, 16 had hypertension and two fifths of the patients had a BMI of 27 kg/m² or higher. Three-vessel disease with 70 % or greater reduction in internal diameter was documented in 31 patients, whereas 13 patients had others. All but three patients complained about angina; 14 patients had angina pectoris at least five days every week. Thirteen patients rated their pain as distressing to depressing and ten patients complained about nocturnal angina pectoris (no information in 9 patients). There were 24 patients in NYHA functional class III-IV. The score on STAI-S showed a moderate degree of anxiety (47.6 ± 5.7), whereas the mean score on Zung's SDS was within the non-depressed range (0.41 ± 0.1 , Papers II-III, V). A lower physical functional capacity according to NYHA class was associated with a higher degree of depression ($r=0.34$, $p=0.02$) prior to surgery (Paper III). In addition, all patients drank coffee every day, 34 patients used alcohol and 3 smoked. Twenty patients were retired full-time and 14 patients were on temporary sick leave full-time. Medical therapy at the time of the interview is given in Table 2.

Table 2. Medical therapy at the time of the interview.

Medication	Number of patients
Beta blockade	23
Calcium antagonists	20
Angiotensine converting	12
Long-acting nitrates	21
Benzodiazepines	3

Reported sleep in patients with CAD (Paper II-V) Self-assessed habitual nocturnal sleep duration before surgery was $388 \pm$ minutes and sleep latency 41 ± 48 minutes, and, on average, the patients fell asleep at 11.34 p.m. (SD=60 minutes). Patients with previous MI reported significantly longer sleep latency ($p<0.05$) (Paper V). Usually the patients woke up twice per night, with a reported morning awakening time in the early hours of the morning (05.49 ± 60 minutes).

The prevalence of too little sleep was 38.6 % (n=17). Moderate or greater difficulties maintaining sleep were the most common sleep problems reported on the USI questionnaire (Table 3). Twenty-two patients (50 %) had a combination of at least two of the following sleep problems; complaints of too little sleep and/or moderate difficulties initiating and, maintaining sleep, or had reported a sleep duration shorter than 6 hours (Paper III). Those in NYHA class III-IV had significantly greater difficulties falling asleep ($p<0.05$), being refreshed by sleep ($p<0.01$) and had more daytime sleepiness ($p<0.05$) than those in NYHA class I-II. Maintaining sleep (3.3 ± 0.5) and physical tiredness (2.5 ± 0.6) were reported as significantly greater problems among depressed patients (n=6) (Zung 's SDS scored ≥ 0.50) than among non-depressed (2.0 ± 1.0 , $p<0.01$ and 1.6 ± 0.9 , $p<0.01$, respectively).

Table 3. The prevalence of too little sleep, moderate difficulties initiating (DIS) sleep, maintaining sleep (DMS), daytime sleepiness, sleep duration less than 6 hours, and combined sleep problems on the Uppsala Sleep Inventory. ¹No information for one patients (n=44).

	n	%
Too little sleep	17	38.6
DIS	12	27.7
DMS	18	40.9
Daytime sleepiness	16 ¹	37.2
Not being refreshed by sleep and physical tiredness	13	29.6
Sleep duration < 6 hr	14	31.8
DIS and DMS	14	31.8

Nearly three quarters of the patients took a daytime nap every day prior to surgery. Similar sleep behaviour was apparent on the sleep diary (Paper III).

One month after surgery, the patients were significantly less anxious (41.7 ± 8.8 , $p<0.0001$), whereas the prevalence of depressed patients had increased to 10 compared to before surgery. The nocturnal sleep duration and sleep latency were unchanged.

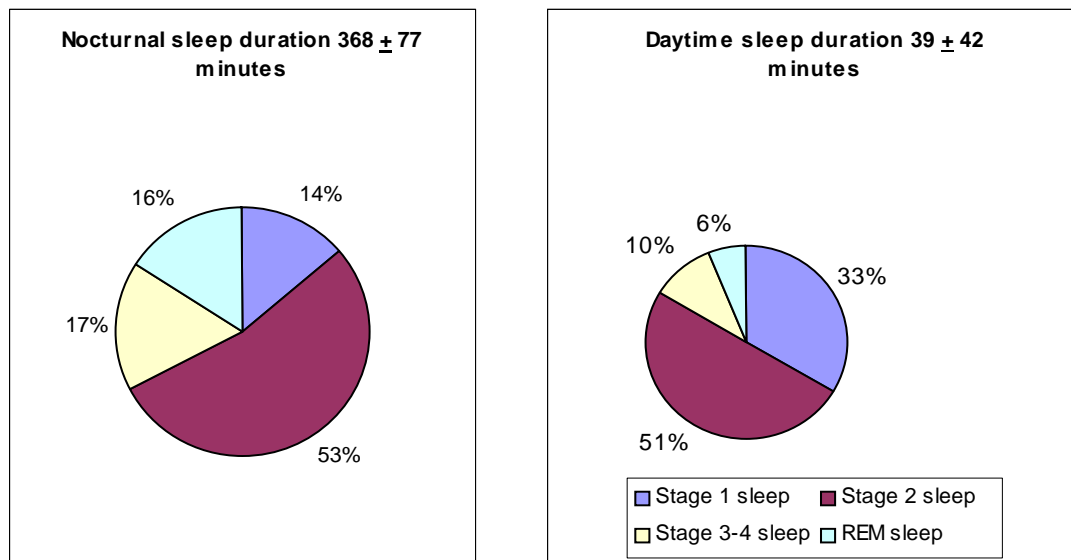
Six months after surgery the incidences of depression, habitual sleep duration and sleep latency were similar to before surgery (Paper V). Moreover, physical functional capacity (NYHA class) was significantly improved (1.7 ± 0.6 , $p<0.0001$). The degree of anxiety was significantly reduced (42.9 ± 7.0 , $p<0.001$)

compared with before surgery (Paper V).

Polysomnographically determined sleep before and after CABG (Papers II-IV)

Polysomnographical total sleep time was measured as 403 ± 89.4 minutes, of which 8.7 % accounted for daytime sleep prior to surgery. Sleep efficiency was reduced, and was $77 \% \pm 15.2 \%$. Nocturnal sleep duration was 368 ± 72 minutes. The proportion of stage 1 sleep was increased and REM sleep was decreased (Figure 3). Sleep onset was at 11.36 p.m. (SD=60 minutes) and sleep latency was 34 ± 25 minutes. Poorer overall health was associated with longer sleep latency ($p < 0.001$) (Paper III), whereas those in NYHA class III-IV had significantly earlier sleep onset than those in NYHA class I-II. REM latency was 106.6 ± 60.5 minutes, the number of arousals/movements, 27.1 ± 16.5 and the number of awakenings, 2.7 ± 2.4 . A higher degree of anxiety was significantly associated with a higher proportion of stage 1 sleep ($r = 0.39$, $p < 0.01$) and more frequent nocturnal awakenings ≥ 3 minutes ($r = 0.54$, 0.0001) before surgery. The depressed patients (score ≥ 0.50 on Zung's SDS) had significantly longer REM latency 147.8 ± 73 minutes) and less REM sleep ($11.2 \pm 5.8 \%$) than the non-depressed (< 0.50 on Zung's SDS, 86.5 ± 58.8 minutes $p < 0.05$ and $16.8 \pm 7.1 \%$, $p < 0.05$, respectively) (Paper III).

Figure 3. Distribution of nocturnal sleep and daytime sleep before surgery. Nocturnal sleep stages are presented in per cent of nocturnal sleep duration. Daytime sleep stages are presented in per cent of daytime sleep duration. The data are expressed in mean per cent ($n = 44$).



The prevalence of daytime sleep was 66 % ($n = 29$), including both SWS and REM sleep (Figure 3). There was no association between nocturnal sleep and daytime sleep.

No essential differences were revealed between reported sleep on the USI and the

sleep diary compared with polysomnographically recorded sleep (Paper II-III), except for significantly ($p < 0.001$) earlier morning awakening reported by 27 patients on the diary (Paper III). The polysomnography showed that 24 of these patients had been awake during five to eighty minutes (md 15 min) at the reported time, but then fell asleep again.

Patients with a moderate or higher degree of being physically tired displayed significantly ($p < 0.05$) lower amounts of stages 3-4 sleep than those without such problems. Increased difficulties maintaining sleep were associated with less stages 3-4 sleep and REM sleep, as well as increased arousals/movements. In addition, poorer health reported on the sleep diary the recorded morning was associated significantly with longer REM latency ($p < 0.001$).

Immediately after surgery the main finding of polysomnography, compared to before surgery, was that even though there were evident changes in both the distribution and nature of sleep at night, and increased daytime sleep, the total sleep duration during the 24-hour period was not significantly changed (Paper IV). The proportion of SWS sleep was suppressed, and a lack, or slight recovery, of REM sleep was found (Figure 4, Figure 5).

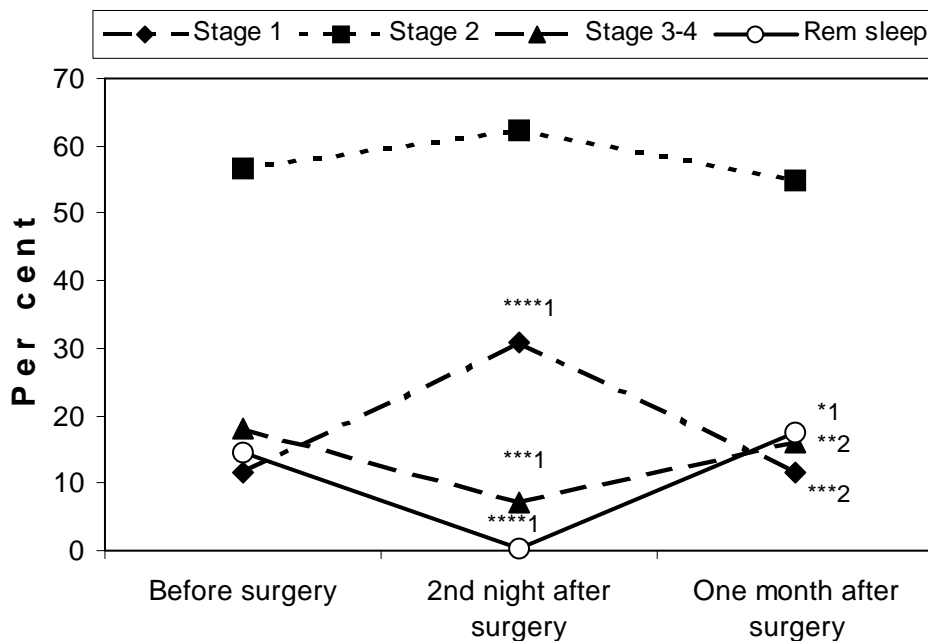


Figure 4. Nocturnal sleep before surgery, second night and one month after surgery. ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$. ¹Compared to before surgery, ²compared to second night after surgery ($n = 38$).

The number of arousals/movements and awakenings had significantly increased (56.6 ± 32.6 , $p < 0.001$ and 12.9 ± 4.8 , $p < 0.0001$, respectively) compared to before surgery (31.9 ± 17.2 and 2.3 ± 1.5 , respectively). On the second

postoperative day the patients slept 40.3 % of their total sleep time. No REM sleep was revealed, but there was a small amount of recovery sleep (SWS) (Paper IV) (Figure 5).

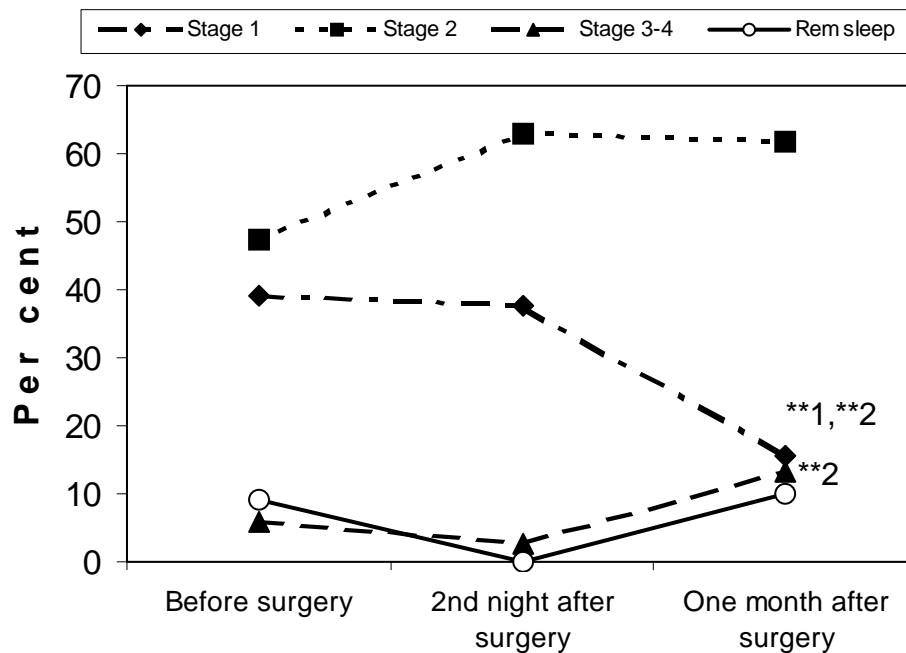


Figure 5. Daytime sleep before surgery, second day after surgery and one month after surgery. * $p < 0.05$, ** $p < 0.01$. ¹Compared to before surgery, ²compared to second day after surgery (n=38).

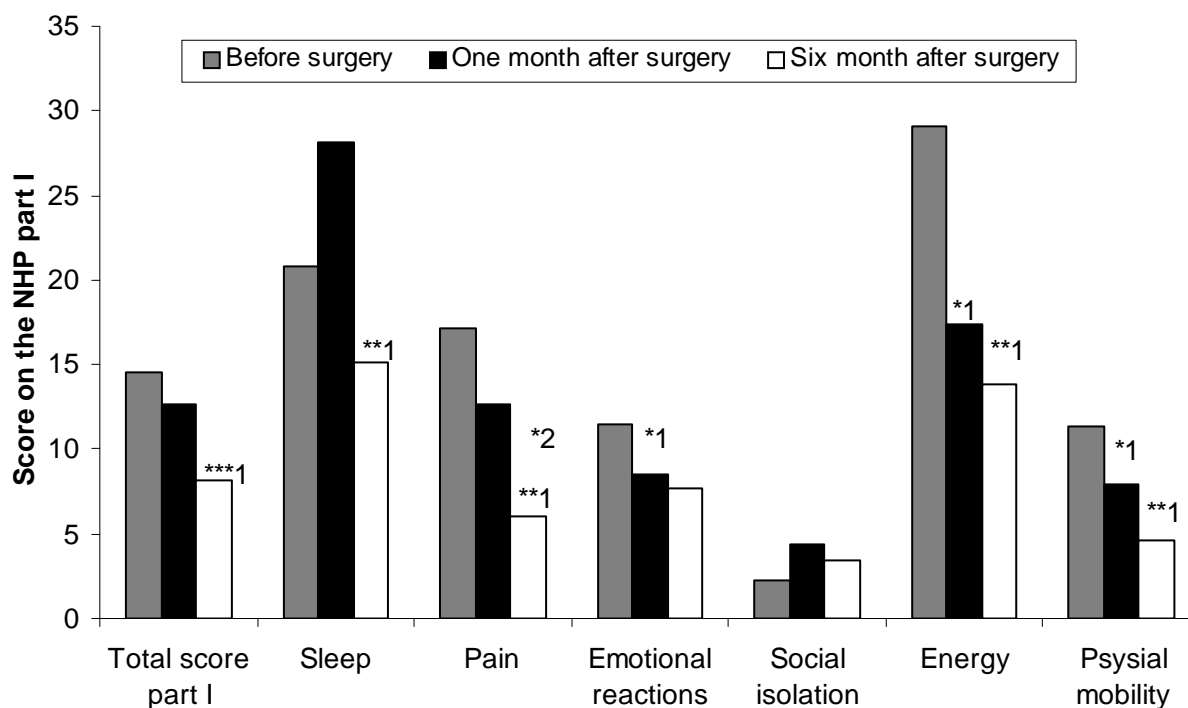
At the one-month follow-up the nocturnal sleep were similar to preoperative values (Figure 4), except for significantly shorter REM sleep latency (77.1 ± 50.6 minutes vs. 109.7 ± 68.2 minutes, $p < 0.01$), a higher proportion of REM sleep (17.5 ± 7.3 % vs. 14.4 ± 5.6 %, $p < 0.05$) and fewer REM sleep periods (5.3 ± 2.9 vs. 7.0 ± 2.7 , $p < 0.05$). The number of arousals/movements remained high (42.9 ± 14.1) compared to before surgery (31.9 ± 17.2). The proportion of daytime sleep duration was longer (16.7 ± 7.7 % vs. 11.6 ± 8.4 %) than before surgery, stage 1 sleep was twice as low (15.7 ± 12.2 % vs. 39.0 ± 33.2 %, $p < 0.01$) and the proportions of stages 3-4 sleep were twice as high (13.1 ± 15.8 % vs. 6.0 ± 12.9 %, ns) (Figure 5).

Anxiety proneness and sleep It was observed that 38.9 % (n=14) had a persistent score of ≥ 43 on the STAI-S during the three measurement occasions. One month after surgery these patients were significantly less refreshed by sleep than non-anxious patients (2.4 ± 0.8 vs. 1.3 ± 0.6 , $p < 0.001$). Six months after surgery the patients who scored ≥ 43 on the STAI-S were more restricted in their physical functional capacity (NYHA class) (2.1 ± 0.5 class), had greater difficulties maintaining sleep (3.2 ± 0.8), were less refreshed by sleep (2.5 ± 0.7), and

experienced a higher degree of daytime sleepiness (2.5 ± 0.7), physical tiredness (2.7 ± 0.8) and more snoring problems (2.7 ± 0.8) than non-anxious patients (1.5 ± 0.6 class $p < 0.01$, 2.1 ± 1.1 $p = 0.002$, 1.5 ± 0.8 $p < 0.01$, 1.8 ± 0.8 $p < 0.02$, 1.4 ± 0.6 $p < 0.001$ and 1.5 ± 0.6 $p < 0.001$, respectively)

Reactions to sleep loss (Paper V) Twelve patients reported being occasionally or very often “sad and depressed” as a reaction to sleep loss prior to surgery (Paper V). Compared to those with a lower degree of reactions, these patients had rated significantly greater difficulties maintaining sleep (3.2 ± 0.9 vs. 2.3 ± 1.1 , $p < 0.02$), not being refreshed by sleep (2.6 ± 0.8 vs. 1.7 ± 0.9 , $p = 0.02$) and a higher degree of daytime sleepiness (2.6 ± 0.5 vs. 1.9 ± 0.9 , $p < 0.03$) six months after surgery. They were also significantly more anxious (47.9 ± 5.5 vs. 40.1 ± 6.4 , $p = 0.0002$) and depressed (0.48 ± 0.1 vs. 0.38 ± 0.1 , $p = 0.0004$). Similar associations were found for higher levels of cognitive/behavioural fatigue as a reaction to sleep loss, with the exception of no significant association for maintaining sleep. Higher levels of dysphoric or cognitive/behavioural fatigue as reactions to sleep loss prior to surgery were associated significantly with being more restricted in physical functional capacity according to NYHA class ($r = 0.47$, $p < 0.01$ and $r = 0.34$, $p < 0.05$, respectively) six months after surgery.

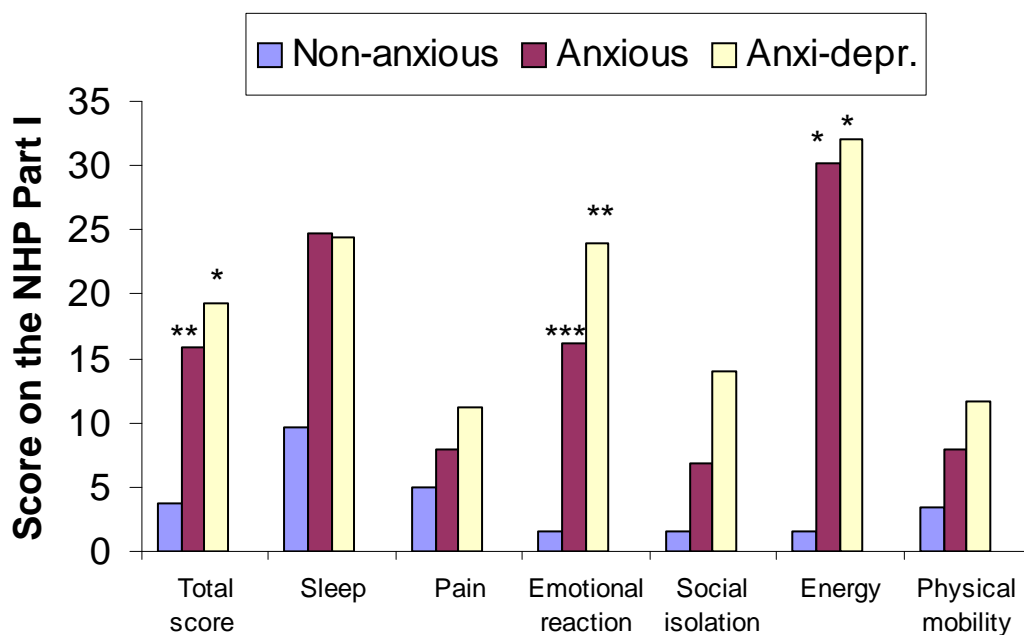
Figure 6. Score on the Nottingham Health Profile instrument Part I before surgery, and one and six months after surgery. The data are expressed as mean. Higher means values indicate greater distress. ¹Compared to before surgery. ²Compared to one month after surgery. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.



Quality of life and sleep (Papers III-V) The total score prior to surgery on Part I was 14.1 ± 12.4 (n=44, Paper III). The greatest health effects on quality of life were related to energy level and sleep (Figure 6). Some were due to angina pectoris (Paper III), depression and physical immobility with reference to a higher NYHA class (Paper III). The score for Part II on the NHP (Paper III) was twice to three times higher than in the general population (Paper III), and distress in sexual life was found to be the greatest problem.

One month after surgery the patients' sleep problems had increased (Figure 6). Six months after surgery, their quality of life had significantly improved compared to before surgery (n=38). The largest reduction from the one-month observation was on the subscale for sleep (Paper IV).

Figure 7. Score on the Nottingham Health Profile instrument Part I six months after surgery among those who scored ≥ 43 at all three measurement times (n=14) on STAI-S and those who scored both ≥ 43 on STAI-S and ≥ 0.50 on Zung's SDS (n=5, Anxie-depr.), compared with a non-anxious group of patients (n=16). The data are expressed as mean. Higher mean values indicate greater distress. Significant differences depict comparisons to the non-anxious group. *p<0.05, **p<0.01, ***p<0.001 (n=38).



Those who scored 43 or higher on STAI-S on the three measurement occasions and those with a combined score ≥ 43 on the STAI-S and ≥ 0.50 on Zung's SDS (Paper V) exhibited a higher total score on the NHP Part I, compared to non-anxious patients and all patients six months after surgery (Figure 7). Patients who occasionally or very often were "sad and depressed" as a reaction to sleep loss prior to surgery had a significantly worse quality of life (14.4 ± 12.0 vs. 6.2 ± 8.3 , $p < 0.02$) six months after surgery than those with "no or less" reactions (Paper V).

Polysomnography showed that those with a higher level of emotional distress, in the NHP Part I, were significantly associated with fragmented sleep ($r = 0.41$, $p < 0.01$) (Paper III) prior to surgery, whereas those with worse sleep problems on the NHP had significantly reduced SWS both before surgery ($r = -0.44$, $p < 0.01$) (Papers III-IV) and one month after surgery ($r = -0.45$, $p < 0.01$) (Paper IV). A higher degree of being refreshed by sleep prior to surgery accounted for 44.5 % ($p < 0.0001$) of the variance outcome for better quality of life six months after CABG, for 35 % of the emotional distress outcome ($p = 0.0001$) and for 30.9 % of the variance of energy outcome ($p = 0.0003$) on the NHP, respectively (Paper V).

6. DISCUSSION

With the focus on sleep, the general aim of this thesis was to evaluate sleep, psychological symptoms and quality of life in patients undergoing CABG. Several limitations should be recognised. First, the present study included men only, due to the fact that few women undergo CABG. Another limitation of this

study was that no control group has been used. In eight patients the polysomnography was performed at home prior to surgery, but did not influence the results. Zung's SDS, the STAI-S and the NHP instruments, which were chosen as the instruments, have been adapted to Swedish populations and the instruments are well-validated and reliability-tested internationally (Anderson et al 1993, Wiklund & Welin 1992, Zung 1972a, 1972b, Forsberg & Björvell 1993, Broman et al 1992, Wiklund et al 1988, Spielberger et al 1983). The combination of subjective rating scales and objective instruments strengthen the results obtained in this study. In addition, there was an agreement of subjective and objective sleep. Positive correlations between the USI questionnaire and polysomnography have been reported previously by Hetta et al (1998) on males and females, mean aged 47 with insomnia. Twenty-four-hour periods of continuous ambulatory polysomnography made it possible to evaluate sleep when the patients were cared for at the ordinary ward, the ICU, the intermediary care room, and in their home. From a clinical perspective it is important to follow the patients' sleep situation during different times within the care chain.

6.1 Nurses' documentation

According to the general recommendations and directions regarding the Patients' Records Act of the National Board of Health and Welfare (Socialstyrelsen, SOSFS 1993:20) the documentation of nursing care is recommended to be problem-oriented and follow the nursing process. The present study showed that nurses' documentation of sleep was both cause- and problem-oriented, with short summaries in narrative style. The documentations were non-informative for research purposes. The descriptions were based on short, random observations, which varied in number for each summary. Further, the documentation of sleep did not correspond with medical intervention and care activities. There is an increased awareness today among care personnel of the importance of documentation.

From some observations and polysomnographically studies of sleep it has been shown that nurses tend to overestimate patients' sleep (Aurell & Elmqvist 1985, Fontaine 1989). Edwards and Schuring (1993) found that nurses' assessments concurred with 81.9 % of the polysomnographically determined nocturnal sleep time in a medical intensive care unit. Difficulties describing the nature of the practice have constituted obstacles for documentation by the personnel. On the other hand, it is known that patients express their sleep quality and daytime functioning in a variety of ways, and symptoms of sleep disturbances can be difficult to differentiate from symptoms related to their CAD. The present study showed that it is not necessary to use polysomnography to assess the patients' sleep, as polysomnographically determined sleep essentially corresponds with

reported sleep when a systematic assessment of the patients' sleep/wakefulness is performed. However, from the nature of clinical practice, it is necessary that care personnel increase their knowledge of sleep, sleep disturbances and their effects in relation to the patients CAD. The documentation of patients' sleep must be more systematised and derive from the patients' basic habitual sleep in relation to their life-style, physical functional capacity, activities and health. This must be followed up with continuous documentation when patients are hospitalised, as well as after discharge, and be included in a rehabilitation programme (Edéll-Gustafsson & Ek 1992). For sufficient assessment of the patient's quality and quantity of sleep it is necessary to reflect a 24-hour perspective, which also necessitates continuity in the documentation between night and day. Information about the patients' sleep situation from previous hospitalisations is also important. Our study highlights the necessity for the different professionals responsible for the care of the patients to have a joint documentation.

Good documentation means that the whole care episode can be followed in the patient's records based on the nursing process according to the patients' sleep quality and circadian rhythm. Furthermore, it must be possible to evaluate the nursing quality from the standpoint of quality assurance.

6.2 Reported and polysomnographically determined sleep before CABG

This study showed that sleep disturbances were common prior to CABG. To begin with, it is necessary to emphasise that CAD is associated with chronic pain, and, the majority of the patients in this study have inconvenient angina, half of the patients have previous MI and one fifth of the patients respiratory problems. The majority of the patients were moderate anxious and some were in a bad mood. Results from different studies show that atherosclerosis is associated with inflammation and chronic immunology (Mehta et al 1998, Blum et al 1998). CAD is also a "stress-related illness" since its onset often coincides with physical or psychological stress (Kop 1997). During stress, the central nervous system and peripheral functions are generally altered to re-establish homeostasis and to preserve life. Complaints about too little sleep, and difficulties initiating and maintaining sleep were more prevalent in this study than are reported in the general Swedish population (Liljenberg et al 1988, Gislason & Almqvist 1987) and among the elderly (Mallon & Hetta 1997) using the USI questionnaire. The proportion of too little sleep corresponds with Simpson and Lee's (1996) results, but is less prevalent than that reported by Magni et al (1987) in men and women prior to cardiac valve replacements and CABG. Twenty-two patients (50%) in

the present study had combined sleep problems. This corresponds with results reported prior to MI and/or major depression (Carney et al 1990), after MI in rehabilitation (Hyypä & Kronholm 1989), among elderly men with angina pectoris and arrhythmia (Asplund 1994), and in subjects with a chronic disease with severe insomnia and/or depression (Katz & McHorney 1998). However, a higher prevalence of sleep disturbances was reported in those with the syndrome of exhaustion (van Diest & Appels 1992, 1994), asthma (Janson et al 1990) and obstructive airway disease (Katz & McHorney 1998) than was revealed in this study.

The sleep latency in this study corresponds with results reported among insomniacs with chronic medical diseases (Katz & McHorney 1998), the elderly (Mallon & Hetta 1997) and elderly men with angina pectoris and arrhythmia (Asplund 1994). However, sleep duration in the present study was shorter than reported previously (Liljenberg et al 1988, Broman et al 1996, Mallon & Hetta 1997, Asplund 1994, van Diest & Appels 1992, 1994, Simpson & Lee 1996, Woods 1972, Eriksson 1988). Our results also showed that a large group of the patients had problems caused by early morning awakenings.

We found that one third of the patients had a moderate or higher degree of physical tiredness and not being refreshed by sleep, which is higher than has been reported in Swedish epidemiological studies (Mallon & Hetta 1997, Liljenberg et al 1988, Broman et al 1996). This was in line with findings (22 % to 39 %) reported in patients about to undergo CABG (Eriksson 1988, Simpson & Lee 1996, King & Parrinello 1988). In a multiple regression equation by Jenkins et al (1983b) the results showed that waking up tired after the usual amount of sleep was the strongest variable for more frequent emotional angina in men awaiting CABG. Waking up exhausted or fatigued (1 item) was also found by Appels & Schouten (1991) to be an independent predictor of MI in healthy males aged 39-65 during a 4.5-year period. It was more likely in the younger and those with slightly lower systolic blood pressure.

When comparing polysomnographically determined sleep in our study with values from normal control data in Williams et al (1974) and Hume et al (1998), the result showed that the patients' sleep in the present study was characterised by reduced sleep efficiency. They had also longer sleep latency, short sleep duration, a fragmented sleep with frequent arousals/movements, and early morning awakenings prior to surgery. This appeared to be more likely among those in NYHA classes III-IV, whereas longer sleep latency was reported in those with previous MI.

These sleep disturbances are essentially in accordance with results on patients with angina pectoris (Murao et al 1972, Karacan et al 1974, 1969), after MI (Karacan et al 1974, Richards & Bairnsfather 1988), generalised anxiety (Reynolds et al 1983), altered mood (Benca 1994), and in those with verified sleep apnoea (Valencia-Flores et al 1996, Lindberg et al 1998). In line with findings reported by van Diest & Appels (1994) on exhausted patients, this study showed that being tired/fatigued produced a lower proportion of SWS and less REM sleep, to some extent due to a fragmented sleep. Slightly suppressed SWS, increased wakefulness and stage 1 sleep have also been reported by Orr & Stahl (1977) prior to heart surgery. These sleep disturbances have not been found in patients about to undergo general surgery (Orr & Stahl 1977, Johns et al 1974, Ellis & Dudley 1976, Kavey & Altshuler 1979, Aurell & Elmquist 1985, Lehmkuhl et al 1987, Knill et al 1990, Rosenberg et al 1994). The prevalence of a daytime nap was common in this study. On average the patients slept 40 minutes during the day, of which 10 % was SWS and 6 %, REM sleep.

According to Borbély's two-process model of sleep regulation (1987, 1994, Ehlers & Kupfer 1987), longer sleep latency, reduced SWS, and a lighter and fragmented sleep might be explained by a weakened Process-S, whereas a shortened sleep duration and reduced REM sleep reflect altered Process-C, which is compensated by daytime napping. The consequence of reduced SWS is lighter sleep and increased arousals (Terzano et al 1997, Ehlers & Kupfer 1987). The sleep disturbances found in this study can partly be explained as secondary caused by their CAD and other medical problems. Other causes may refer to chronic pain, immobilisation and stress.

The results indicated that the short sleep duration and the poor sleep quality caused an increased need of daytime sleep in order to recover. It is suggested that the sleep disturbances increased the demands on the cardiovascular system with increased sequelae from their CAD (Udelsman & Holbrook 1994, Asplund 1994, 1996, Jenkins et al 1983a, 1983b, 1994, Mehta et al 1998,ref, Keyl et al 1994). In addition, sleep loss may affect the resiliency of the stress response with the development of metabolic and cognitive-behavioural consequences. Other primary physiological and psychological effects are hyperactivity, increased sensitivity to pain and environmental stress. In agreement with our results, the patients may experience a higher degree of fatigue, not being refreshed by sleep and daytime sleepiness (van Diest & Appels 1994).

It is known that SWS has suppressing effects on cortisol, an important

intracerebral thermoregulation effect for cerebral recovery, a positive effect on the immune system and anabolic metabolic effects (Horne 1992, Zachariae 1996, Krueger & Majde 1994, Moldofsky et al 1986, Moldofsky 1997, Healy & Williams 1988, Thayer 1989, Chrousos & Gold 1992).). It is also more likely in the first part of the night sleep, whereas REM sleep is also important for the cognitive performance functions.

6.3 Polysomnographically determined sleep after CABG

This study showed further weakened Process-S and an altered sleep/wakefulness rhythms according to Process-C immediately after surgery (Borbély 1987, Benca 1994). The distribution of sleep was changed, with a marked reduction in nocturnal sleep and increased daytime sleep. Even when the sleep architecture immediately following surgery was changed, the total sleep time during 24 hours at the four measurement times was essentially similar. In agreement with previous results after general (Johns et al 1974, Ellis & Dudley 1976, Knill et al 1990, Kavey & Altshuler 1979, Aurell & Elmqvist 1985, Lehmkuhl et al 1987, Rosenberg et al 1994) and heart surgery (Johns et al 1974, Orr & Stahl 1977, Witoszka & Tamura 1980) the polysomnography revealed reduced sleep efficiency, and light fragmented sleep, whereas stage 2 sleep was almost unchanged compared to before surgery. Stages 3 and 4 sleep were notably reduced and REM sleep was absent or with only a small recovery the second night after surgery. Nocturnal sleep loss was compensated with extremely increased daytime sleep. This has not been found previously following heart surgery or general surgery. The quality and quantity of sleep disturbances can partly be explained by the summated effects of activating the HPA axis, including the limbic system, the sympathetic nervous system and the immune system (Farr et al 1986, Udelsman et al 1987, Udelsman & Holbrook 1994, Lanuza 1995, Sheeran & Hall 1997) during the pre-, peri- and postoperative period.

Excessive daytime sleepiness following CABG has been associated with inflammatory reactions (Menasché 1995, Gill & Murkin 1996), changed cerebral circulation and differences in individual response to anaesthetics (Udelsman et al 1987, Toner et al 1997) or other medical agents (Rosen & Kostis 1995, Knill et al 1990, Sheeran & Hall 1997). Additional factors triggering the neuro-endocrine inflammatory responses are the use of heart-lung machine (Gill & Murkin 1996, Kawahito et al 1995, Sheeran & Hall 1997), hypothermia (Giuffre et al 1994), the surgical procedures (Sheeran & Hall 1997), the anaesthesia procedure

(Udelsman et al 1987, Beydon et al 1992, Sheeran & Hall 1997), hypoxemia (Rosenberg et al 1994, Gill et al 1992), pain (Heye 1991, Sheeran & Hall 1997, Simpson et al 1996, Moore 1994, King & Parrinello 1988, Soehren 1995), cognitive stress (McFetridge & Yarandi 1997), and the fact of having CAD per se (Mehta et al 1998). Pain is a significant important problem postoperatively, which has not been examined in detail in this study.

In previous studies several sleep disturbing factors have been reported (Soehren 1995), mainly during the first week, including factors such as incomplete relief of pain (Simpson et al 1996, Moore 1994, King & Parrinello 1988, Soehren 1995) and nocturia (King & Parrinello 1988, Tack & Gillis 1990) and difficulties lying comfortably (Johns et al 1974, Simpson, et al 1996, Schaefer et al 1996, Moore 1994). In addition, the patients are more sensitive to environmental factors. Noise and lights, inconvenient procedures performed with the patients (Simpson et al 1996, Johns et al 1974, McFadden & Giblin 1971, Walker 1972, Redeker 1998) and stress due to constant activities at the unit, an unfamiliar environment and routines are environmentally related sleep-disturbing factors described previously (Simpson et al 1996, Knapp-Spooner & Yarcheski 1992, Yarcheski & Knapp-Spooner 1994, Orr & Stahl 1977, McFadden & Giblin 1971, Walker 1972).

It is evident from our study that daytime sleep is important for the maintenance of the restorative process after surgery. Daytime sleep also included stages 3 and 4 sleep, and daytime sleep appeared not to influence the nocturnal sleep. It is the nurses' responsibility to provide undisturbed daytime sleep periods to compensate for the reduced nocturnal sleep. In contrast to previous studies, the early transfer to the intermediary care room may have enabled the patients in this study to compensate for some of their sleep loss from the preceding night. In previous studies the patients received conventional intensive care. These patients had particular difficulties compensating for nocturnal sleep disturbances by taking daytime naps (Johns et 1974, Orr & Stahl 1977). Altered circadian rhythms have been reported after general and heart surgery (Johns et al 1974, Redeker et al 1994, Aurell & Almqvist 1985, Farr 1986) and following MI (Redeker et al 1994, Karacan et al 1974) among the ageing population (Hume et al 1998, Bliwise 1992, Evans & Rogers 1994) and in those with obesity without sleep apnoea (Vgontzas et al 1998).

At a one-month follow-up the disorganised sleep pattern immediately postoperatively had almost returned to the sleep which was revealed prior to surgery, with the exception of additional significant shorter REM latency and an

increased proportion of REM sleep. Similar physiological sleep disturbances are described in depressives (Ehlers & Kupfer 1987, Syvälahti 1994), in patients with untreated sleep apnoea (Lindberg et al 1998) and after being treated with CPAP for sleep apnoea (Valencia-Flores et al 1996). However, the number of arousals/awakenings was twice as high in this study as that reported by Valencia-Flores et al (1996) following CPAP treatment, whereas lower sleep efficiency was reported by Lindberg et al (1998) compared to our results. Broughton & Barron (1978) have reported a great number of awakenings and stage changes after MI.

The daytime sleep in our study contained twice as much SWS at the one-month follow-up as before and immediately after surgery. Increased daytime sleep has previously been reported in MI (Broughton & Barron 1978). This supports the suggestions of Karacan et al (1974) that daytime SWS gradually increases during the recovery period. Previous results showed that daytime sleep does not influence the nocturnal sleep in those with CAD (Simpson et al 1996, Moore 1994). Other studies indicate that a daytime nap improve the health (Asplund 1994, Asplund & Åberg 1998, Trichopoulos et al 1987, Moldofsky 1994, Davidson et al 1991) and reduce the degree of fatigue after CABG (King & Parrinello 1988, Knapp-Spooner & Yarcheski 1992, Schaefer et al 1996). Studies indicate that a daytime nap may reduce the further progression of CAD (Trichopoulos et al 1987, Moldofsky 1994, Davidson et al 1991).

It appeared in this study that the frequency of arousal/movements was relatively high on all measurement occasions, and higher than has been reported by Carskadon et al (1976) in patients aged 50-68, with complaints of chronic insomnia. Arousals are registered as a sense of awareness without consciousness, and in some people generate substantial physiological reactions. Clinically, arousals have been identified in somatised anxiety. Arousals are associated with reduced refreshing sleep, an increase in drowsiness, fatigue and a reduction of daytime performance (Terzano et al 1997, Carskadon et al 1976). The severity of arousals/movements can to some extent also be explained by respiratory problems (Terzano et al 1997, Koehler et al 1993), in some cases by an ongoing inflammatory process (Krueger & Majde 1994, Zachariae 1996) or as a consequence of chronic pain (ref). In a review study Chrousos and Gold (1992) concluded that arousal becomes dysphoric hyperarousal and anxiety and/or depression as a consequence of prolonged generalised stress response with increased and prolonged endocrine secretion of CRH. The arousal/hypervigilance-associated stress is important to immune functioning per se, and probably more so than anxiety symptoms.

In general it has been found that pleasant, relaxing exercise taken early in the day or early in the evening promotes sleep, and in some with increased SWS. However, increased SWS induced by of exercise can be negated by stress. In addition, postoperative overtrained patients can have increased nocturnal body movements and a more fragmented sleep.

6.3 Psychological symptoms and their association with sleep disturbances

The present study showed that the majority of the patients were moderately anxious. The level of anxiety corresponded to several other studies, using the STAI-S, in patients with CAD (Burker et al 1995, Jenkins et al 1983a, 1994, Borbély et al 1987, Vingerhoets et al 1995, Milani et al 1996, Grossi et al 1998, Stein et al 1990) and after heart surgery (Langeluddecke et al 1989, Timberlake et al 1997). Levine et al (1996) reported a lower degree of anxiety in men and women, mean age 63.9 (SD 12.8 years), six months after MI, CABG and PTCA.

Our study showed that a small group of patients were depressed prior to surgery. The low prevalence of depression corresponds with that reported by Eriksson (1988) and by Levine et al (1996). In agreement with other studies (Jenkins et al 1983a,1994, Eriksson 1988, Grossi et al 1998), those who were in a better health and better physical functional capacity according to the patient-assessed NYHA prior to surgery were less anxious or depressed. One month after surgery, our results showed that the incidence of anxious-depressives had slightly increased, but was similar to before surgery, at the six-month follow-up. The incidence corresponds to results reported by Cay & O'Rourke (1992) among patients in rehabilitation and by Redeker (1993) up to six months after CABG.

We found that nearly two-fifths of the patients exhibited an individual anxiety-prone reactivity over a six-month period. At one-month follow-up these patients had significantly greater problems maintaining sleep, which also persisted six months after surgery. The anxiety prone were significantly less refreshed by sleep, had a higher degree of daytime tiredness, sleepiness and more snoring problems than non-anxious patients or those with transient anxiety. They were also significantly more restricted in their physical capacity according to NYHA class. Degree of anxiety was significantly associated with an increased proportion of stage 1 sleep and fragmented sleep and with less stages 3 and 4 sleep. This corresponds with results reported in those with generalized anxiety (Hoehn-Saric & McLeod 1990, Reiman et al 1994, Chrousos & Gold 1992) and

those with cognitive stress (Hall et al 1996, McFetridge & Yarandi 1997). With reference to McFetridge and Yarandi (1997) a successful revascularisation by CABG reduced the effects of cognitive stress.

Davidson et al (1991) have suggested that assessment of reactions to sleep loss and resumption of sleep are indirect assessments of the neuro-endocrine effects of sleep. Interestingly, it appeared from the present study that sadness/depression, cognitive/behavioural fatigue and dysphoria as reactions to sleep loss prior to surgery were significantly associated with a higher level of combined sleep disturbances i.e., initiating and/or fragmented sleep, a higher degree of daytime symptoms, psychological symptoms and lower physical functional capacity six months after surgery. Dysphoria as a reaction to sleep loss has previously been reported in patients after MI (Pratt et al 1996) and after CABG (Quinlan et al 1974). This indicates that reaction to sleep loss could reduce the resiliency of stress and delay the recovery.

The sleep disturbances is multifactorial in patients subjected to surgery. However, this study showed that the patients examined had a certain degree of sleep disturbances even before the operation. These continued after the operation which can promote the progression of the CAD (Williams 1996, Evenden 1997, Syvälahti 1994, Fava et al 1996, Zachariae 1996, Mehta et al 1998). Denollet and co-workers (1996) have hypothesised that the combination of psychological stress, poor sleep and physical immobility relate to the subject's personality (the distressed personality Type-D), which is associated with CAD. Unusual tiredness, increased irritability and feelings of demoralisation, defined as vital exhaustion, is a common personality (van Dies & Appels 1994). Loss of energy is the most prevalent and dominant characteristic. The syndrome is an independent predictors of new cardiac event (Kop et al 1994) and even when controlled for depression (Appels 1997). Appels (1994) suggests that tiredness is part of a homeostatic reaction to prolonged tension. A depressed mood is seen as "superimposed" on a stage of exhaustion.

6.7 Quality of life

This study showed that quality of life and physical functional capacity according to NYHA class was significantly improved six months after CABG. The findings emphasise the value of examining patients' sleep when their quality of life is assessed in relation to CABG intervention. By means of the Nottingham Health Profile instrument, we found support for the view that poor sleep quality was related to lower level of quality of life, before and one month after surgery. To some extent this can be explained by less recovery sleep and a fragmented sleep,

which were partly consequences of anxiety. A higher degree of sadness/depression as a reaction to sleep loss prior to surgery was also associated with reduced quality of life six months after surgery. Individuals with anxiety-prone reactivity and anxious-depressives had significantly worse quality of life six months after surgery, with prominent sleep problems and energy deficits. In addition, the anxious-depressives had slightly more pain, and a higher degree of emotional distress. They were also more socially isolated and physically immobile. Being anxious/depressed interfered with all of the patient's activities including interpersonal relationships, such as family life, social life and sex life as well as householding, hobbies and holiday. However, most distress was experienced with the sex life six months after surgery.

It is known that fragmented sleep deficits accumulate over time with neuro-psychological, cognitive and psychosocial consequences which interfere with the patient's quality of life (Valencia-Flores et al 1996). Recently, Grossi et al (1998) reported a significant intercorrelation between a section of emotional reaction on the NHP and STAI-S. Kos-Munson et al (1988) found that the score on Zung's SDS before CABG correlated significantly with quality of life six months postoperatively.

Using stepwise multiple regression analysis this study showed that rated feelings of not being refreshed by sleep prior to surgery predicted 44.5 % of the variance outcome of quality of life six months after surgery, accounting for 30 % of reduced energy outcome and 35 % of increased emotional reactions outcome, respectively. Chochron et al (1996) found that a predictor of improved quality of life on the NHP instrument 3 months after CABG was higher energy levels related to NYHA functional class III or IV prior to surgery.

7. IMPLICATIONS FOR NURSING PRACTICE

From a primary prevention perspective early detection of patients with sleep disturbances are important in order to reduce possible sleep disturbing factors. It is the nurse's responsibility, together with the patients, and in some cases family members, to identify potential noxious stressors before surgery, which must be followed up during the patients' hospitalisation.

For appropriate interventions to improve sleep, nurses should perform an accurate assessment of what extent potential internal or external factors can interfere with their recovery process. The assessment should include habitual sleep, daytime sleep (naps) and **health perception**. (se **Kop:s artikel 1997**). The

level of anxiety and sadness/depression, and daily physical and social activities, should include the assessment. Lifestyle factors, reactions to sleep loss, behavioural/cognitive factors and general performances are also important. The findings emphasise the value of examining patients' sleep when their quality of life is assessed in relation to the surgery. The goal of the interventions in nursing practice is to retain, attain, or maintain optimal quality and quantity of sleep (Neuman 1996).

Corresponding to the nurses' documentation and based on previous studies it has been shown that some regularly interrupting factors coincided with the organisation of the general nursing care and interventions when patients were hospitalised (Edéll-Gustafsson & Ek 1992, Simpson et al 1996, Johns et al 1974, Ellis & Dudley 1976, McFadden & Gibblin 1971, Walker 1972, Redeker 1998, Knapp-Spooner & Yarcheski 1992, Yarcheski & Knapp-Spooner 1994, Orr & Stahl 1977, Soehren 1995). With support from the physician, it is the nurse's responsibility to co-ordinate the organisation of general and specific nursing care and medical interventions to promote sleep and rest when patients are hospitalised. In addition, the nurses should plan for an undisturbed time for rest or sleep during the day for patients.

From a primary prevention perspective it is important to provide information related to the patient's competence and situation (Neuman 1986, Lawton 1991). It is important to explain to patients that sleep disturbances and altered sleep rhythms can partly explain feelings of reduced energy and psychological distress, as well as memory, concentration problems and reduced general performance both before and after surgery. These experiences can partly also be explained by pain, and the new environment and routines. It is also important to inform the patients that these experiences can influence their quality of life.

The nurses should explain to the patients the importance of having a daytime schedule to approach a more regular sleep and daytime rhythm. In addition, the nurses should inform the patients about the importance of a deactivating period before nocturnal sleep. The patients should practise relaxation, "cognitive-behavioural interventions" and appropriate physical activities, which can improve recovery and the feeling of well-being.

It is obvious from this study that polysomnography is not necessary for the assessment of the patients' sleep/wakefulness. A more systematised assessment and documentation can provide a sufficient evaluation of the patient's sleep. It is necessary that the patients' habitual sleep in relation to psychological symptoms,

life-style, pain, and daytime activities can be determined on admission day. This can be followed up by a simple diary report by the nurses during hospitalisation and after discharge from hospital.

Our study showed that the patients had sleep disturbances after discharge from hospital. Apparently, it is important that a nurse, who is responsible for following-up the patients at home during their rehabilitation, also evaluates the patients' sleep situation.

In the future it is important to develop educational programmes providing help:

- for the CABG patients on how to improve their sleep
- for care personnel on how to educate the patients and family in sleep and sleep hygiene
- for assessment of sleep and documentation of sleep

It is also necessary to develop a Circadian Sleep Assessment Profile (CSAP) instrument for clinic nursing practice.

8. CONCLUSIONS

1. The nurses' documentation of sleep was both cause- and problem-oriented, with short summaries in narrative style. The descriptions were based on short, random observations, which varied in number for each summary. Further, the documentation of sleep does not correspond to medical interventions and care activities.
2. Polysomnographically recorded sleep patterns were essentially consistent with reported sleep. Sleep disturbances are common in patients with verified obstructive CAD.
3. Immediately following CABG there was a redistribution of the sleep, with a reduction of nocturnal sleep compensated by increased daytime sleep. Sleep quality was severely altered immediately following CABG. These changes had almost returned to preoperative values one month after surgery.
4. Most patients about to undergo CABG were moderately anxious, and one small group was depressed. Anxiety proneness over a six-month period in patients with CAD was a factor for increased fragmentation of sleep, reduced refreshing sleep, an increasing daytime sleepiness and tiredness. Reported mood and cognitive/fatigue behaviours as reactions to sleep loss before surgery were associated with increased sleep disturbances, psychological symptoms and immobility after surgery.
5. Quality of life and physical functional capacity were significantly improved after CABG. Patients prone to anxiety or who were in a combined anxious-

depressive state exhibited a lower level of quality of life six months after surgery. A higher score for the sleep section in the NHP was associated with less time in delta sleep before, and one month, after CABG. The statements of being refreshed by sleep turned out to be a predictor for the level of quality of life, energy deficits and emotional distress outcomes six months after surgery.

6. ACKNOWLEDGEMENTS

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